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Authors: Dagleish, M. P., Ali, Qurban, Powell, R. K., Butz, D., and Woodford, M. H.

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Fatal *Sarcoptes scabiei* Infection of Blue Sheep (*Pseudois nayaur*) in Pakistan

M. P. Dagleish,[1,6] Qurban Ali,[2] R. K. Powell,[3] D. Butz,[4] and M. H. Woodford[5] [1] Moredun Research Institute, Pentlands Science Park, Bush Loan, Penicuik, Near Edinburgh, EH26 OPZ Scotland, UK; [2] National Veterinary Laboratories, Park Road, Islamabad, Pakistan; [3] Great Bettws Farm, Great Bettws, Abergavenny NP7 7LG, Wales, UK; [4] Brock University, St Catharine's, Ontario L2S 3A1, Canada; [5] Apdo, 1084, 8100 Loule, Algarve, Portugal; [6] Corresponding author (email: mark.dagleish@moredun.ac.uk)

ABSTRACT: *Sarcoptes scabiei* was detected for the first time in skin scrapings, hair pluckings, and histologic sections from a blue sheep (*Pseudois nayaur*) from the Shimshali Pamir in the Karakorum range of the western Himalaya in Pakistan (36°28′N, 75°36′E). Local reports suggest many hundred animals have been affected by a severe skin disease over a 10-yr period, but the shy nature of this species and the extreme climate that they inhabit meant only a single affected animal was available for detailed evaluation. The severe skin lesions were confined to the forelegs and brisket, and many *Sarcoptes scabiei* mites were present in all the samples examined. Histologic preparations of the skin showed hyperkeratotic and parakeratotic hyperkeratosis of the epidermis with a severe exudative dermatosis with many polymorphonuclear neutrophils and gram-positive cocci, yet no eosinophils. These findings might suggest the lack of an appropriate immune response to the parasite or other coping strategies because there has been no abatement of the clinical signs in affected animals over several years. Treatment options are limited due to the behavior of the species and its habitat. The blue sheep is a primary source of prey for the endangered snow leopard (*Panthera uncia*) and continued depletion could have serious consequences for the survival of the latter.

Key words: Blue sheep, *Pseudois nayaur*, *Sarcoptes scabiei*, scabies, skin disease.

Sarcoptic mange, or scabies, is a highly contagious parasitic skin disease caused by *Sarcoptes scabiei*, a mite that infects domestic and wild animals as well as humans (Fain, 1968, 1978). This species of mite has been divided into morphologically indistinguishable host-adapted varieties which rarely cross-infect between different species of animals, yet most will parasitize humans. However, they fail to complete their life cycle when man is an aberrant host (Yager and Scott, 1993).

Blue sheep (*Pseudois nayaur*) or "Bharals" inhabit the Tibetan plateau including northeastern Pakistan, the high mountain regions of China, northwestern Nepal, and the border between India and China, at altitudes of 2,400–6,000 m above sea level (Wang and Hoffman, 1987). This species is well-adapted to life in a high-altitude mountainous environment in that it has physiological modifications in cardiopulmonary hemodynamics, the ability to exist on a diet of sparse graminoids and herbs, and exceptional agility on steep rocky terrain (Wang and Hoffman, 1987; Sakai et al., 2003; Mishra et al., 2004). Blue sheep are classified as "Least Concern" in the IUCN Red List of Threatened Species (Harris, 2003) and are a primary source of prey for the snow leopard (*Panthera uncial*; Fox et al., 1991). Western hunters consider blue sheep to be trophy animals with their large horns and also because they reside in remote areas near precipitous cliffs (which they can descend rapidly when approached to avoid predation), making them difficult to hunt. They are important both in the conservation of the highly endangered snow leopard and as a potential source of income through trophy hunting for local people, including the inhabitants of the Shimshali Pamir in the Karakorum range of the western Himalaya (36°28′N, 75°36′E). As such, they are not considered to be unwanted competition for their 5,000 domestic sheep and goats plus the 1,000 yaks, which share the same high altitude grazing during the summer months.

From 1996, Shimshali yak herders reported finding increasing numbers of dead blue sheep in poor condition with

considerable numbers of skin lesions, especially on the forelegs and chest, and live affected individuals that did not attempt to flee when approached. During early summer 2000 an estimated "several hundred" carcasses were present in the area of the Shimshali Pamir used for summer grazing of local domestic stock. However, the disease appeared not to be seasonal and affected both sexes and all age groups of the blue sheep. In response to this emerging problem, assistance was requested to investigate these deaths.

Because it was not possible to transport an affected carcass to the village, a local herder shot an affected animal (male, approximately 3 yr old) showing the typically described lesions and buried it in a glacier so it would be readily available for postmortem examination by veterinarians when they had completed the lengthy and difficult journey to reach the plateau. Gross postmortem examination was performed in the field after the carcass had been dug out of the ice and thawed. Deep skin scrapings for ectoparasite investigation and full thickness skin samples were taken for histopathology, and both were stored in 10% formal saline. Identification of parasites was done by examination of morphological characters (Soulsby, 1986) after mounting skin scrapings on glass microscope slides. Histologic examination of skin samples was performed after routine processing; briefly, samples were dehydrated through graded alcohols, embedded in paraffin-wax to enable 5-μm-thick sections to be cut and mounted on glass microscope slides, and stained with either hematoxylin and eosin or Gram's stain. Plucked hairs from the formal-saline-fixed full thickness skin samples were also examined for ectoparasites after mounting on glass microscope slides.

Gross postmortem examination confirmed that the carcass was emaciated. Alopecia, marked lichenification, and a thick grey scaling crust was present on the surface of both forelegs from the elbows to the carpi, both axillae, and the brisket (Fig. 1). The affected skin contained areas of excoriation, presumably from self trauma, and deep fissures. No gross abnormalities were found in the rest of the organs examined.

Many mites were present in both the deep skin scrapings and plucked hair preparations, all of which were identified as *Sarcoptes scabiei* by morphologic criteria such as a globose body, eight short legs (third and fourth pairs not projecting beyond the body margin), and dorsal triangular scales (Fig. 1). Despite some freeze/thaw damage from storage in the glacier, histologic examination showed hyperkeratotic and parakeratotic hyperkeratosis of the epidermis. A severe exudative dermatosis was present as denoted by a large infiltration of polymorphonuclear neutrophils, many of which appeared degenerate (Fig. 2) and were frequently associated with multiple gram-positive cocci. Interstitial serum, mononuclear inflammatory cells, and nuclear debris were also present. A similar mixed inflammatory cell response was present in the dermis along with nuclear debris. Multiple parasite profiles were present deep within the hyperplastic epidermis in pockets lined with parakeratotic stratum corneum. The parasite profiles were of variable shape due to differing planes of section, yet the prominent triangular scales characteristic of *Sarcoptes scabiei* were visible on one aspect of most profiles (Fig. 2). A diagnosis of scabies was made on the basis of these findings.

We believe this is the first reported incidence of scabies in blue sheep. The distribution and severity of the skin lesions in this case were extreme and not typical of that described in domestic sheep, in which primarily the lips, nostrils, external surfaces of the pinnae, and occasionally the legs are involved; in this case, the face appeared to have been spared, yet the whole antebrachium and a large area of the brisket were affected (Yager and Scott, 1993). In a severe scabies outbreak affecting the free-ranging Barbary sheep (*Ammotragus lervia*, a wild

FIGURE 1. Forelegs and brisket of the affected blue sheep. Note alopecia, marked lichenification and grey scaling crust present on the surfaces of both forelegs from the elbows to the carpi, both axillae, and the brisket. Insert: mite recovered from plucked hair preparation with morphology typical of *Sarcoptes scabiei*.

sheep adapted to mountain terrain in North Africa) following their introduction to the Sierra Espuña Regional Park in Spain, there was a total absence of lesions on the forelegs and brisket and only one sheep had lesions on a hind limb (Gonzalez-Candela et al., 2004). However, generalized scabies lesions have been reported in

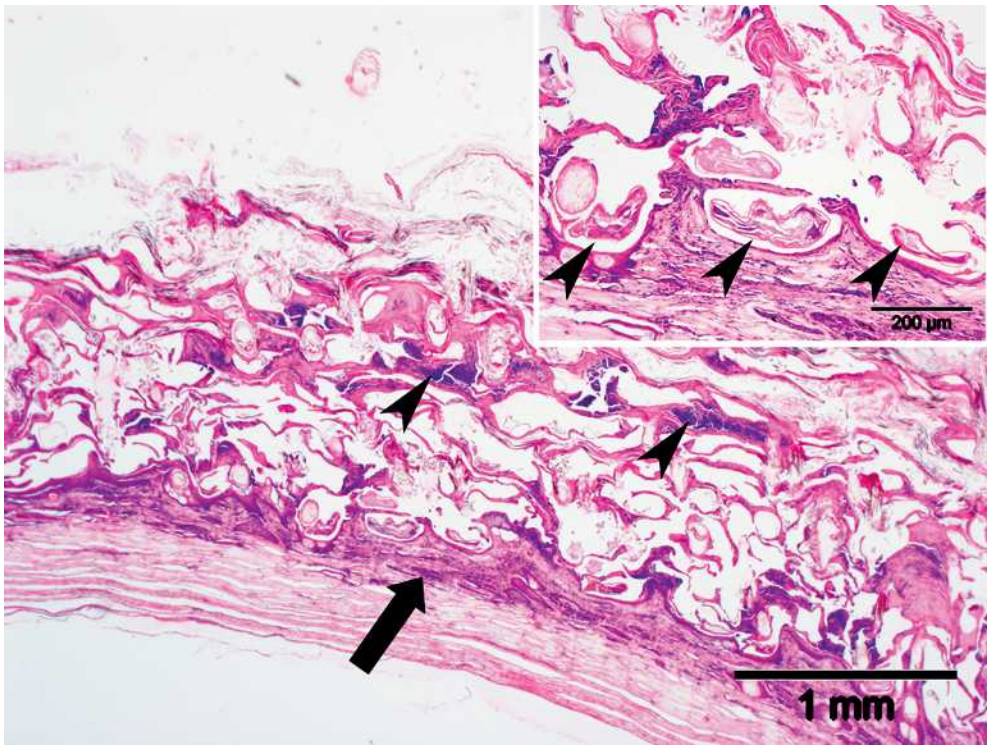

FIGURE 2. Severe scabies infestation in the skin. Note the disruption to the normal architecture of the epidermis and the inflammatory infiltrate in both the epidermis (arrow heads) and scattered throughout the dermis (arrow). Insert: higher magnification of same field showing parasite profiles (arrow heads) deep within the hyperplastic epidermis in pockets. Hematoxylin and eosin.

the more hairy desert sheep of the Sudan (Ibrahim and Abu-Samra, 1987) and also in goats, although the head is still the preferred site (Yager and Scott, 1993). This apparent anomaly in lesion distribution might partly be due to the evolutionary misclassification of blue sheep. Most recent studies, including behavioral, genetic, and biochemical evidence, now consider the blue sheep is probably a primitive goat with some convergent sheep-like characteristics (Schaller, 1977).

The presence of large numbers of mites in the skin scrapings and plucked hair samples, the severe crusting dermatosis, deep fissures, extent of the lesions, and absence of any eosinophils in the tissue samples suggests the possibility of a weak or nonexistent hypersensitivity response to the parasite. In domestic animals this form of scabies is characteristic of the poorly nourished or those with debilitating coexisting disease (Yager and Scott, 1993). However, because this species has not been thoroughly studied, there might be differences in the patterns of cellular infiltration compared with domestic sheep and goats. In addition, the bacterial infection and the presence of neutrophils might represent a time frame dominated by the bacterial aspect of the complex.

We were unable to find any apparent concurrent disease in the animal available for study to explain the pattern of the lesions, although introduction of a novel disease into any naïve population might result in severe lesions and a high mortality rate similar to that of the scabies outbreak in the Barbary sheep (Gonzalez-Candela et al., 2004). Furthermore, free-living animals in an extreme climate, such as the high Tibetan plateau, where

food is sparse might be in constant threat of nutritional deficit. Protein/calorie malnutrition has been repeatedly shown to adversely affect how sheep react to parasite challenge (Coop and Kyriazakis, 1999) and could be a significant factor in the clinical presentation of scabies in blue sheep. To compound this, as intense pruritus develops, animals spend less time feeding, which can further exacerbate any nutritional shortfall. From an evolutionary perspective it is unlikely that herbivorous animals, adapted to an extreme cold environment with very low relative humidity such as that of the rock- and snow-covered high Tibetan plateau, would have been exposed to the common ecto- and endoparasites we associate with domestic ruminants in temperate and tropical climates. As such, they might not have evolved immunologic or other strategies, such as partitioning of limited nutritional resources (Coop and Kyriazakis, 1999), to effectively deal with such a challenge.

The source of the initial infection in the blue sheep remains uncertain because no clinical signs of scabies were observed in local domestic animals at the time of this investigation. More recent observations of local domestic stock suggests the presence of low-grade scabies, and detailed questioning of the older shepherds suggests this might have been present prior to 1996 when affected blue sheep were first noticed (M. H. Woodford and R. K. Powell, pers. obs.). However, the gregarious social behavior of blue sheep, with individuals and groups constantly varying between two to 400 animals (Wang and Hoffman, 1987) moving across the Tibetan Plateau irrespective of national boundaries, is likely to be significant in the spread of the disease. We believe the most likely source of the infection would have been from domestic livestock from any one of the several countries having territory within the Tibetan Plateau. This might be a similar situation to the scabies epidemic in free-ranging Barbary sheep where the infection was from local domestic goats in which the former suffered a population decrease of 86% over a 5-yr period (Gonzalez-Candela et al., 2004). In this case it is perhaps pertinent that the sheep had been introduced into a foreign habitat within a fenced nature reserve with a limited food supply. Prior to the scabies epidemic, the Barbary sheep population had increased steadily over a 17-yr period to a level that was probably unsustainable.

Whatever the original source of the scabies infection in the blue sheep 10 yr after the initial reports of dead animals, the consequences appear to be severe, not only for the survival of the species itself but potentially also for other species such as the snow leopard, which relies on them as their primary food source. Treatment options for the blue sheep are somewhat limited due to their shy nature, dispersal over a huge range which crosses several international boundaries, and lack of any effective vaccine against *Sarcoptes scabiei* (Tarigan and Huntley, 2004). There appears to have been little, if any, obvious host adaptation to the parasite over the period of the outbreak or selection of animals that are more tolerant, but further investigation is required to confirm this and the extent of the change in the population plus its intra- and interspecies dynamics.

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LITERATURE CITED

COOP, R. L., AND I. KYRIAZAKIS. 1999. Nutrition-parasite interaction. Veterinary Parasitology 84: 187–204.

FAIN, A. 1968. Etude de la variabilite de Sarcoptes scabiei avec une revision des Sarcoptidae. Acta Zoology Pathology Antverpen 47: 1–196.

———. 1978. Epidemiological problems of scabies. International Journal of Dermatology 17: 20–30.

FOX, J. L., S. P. SINHA, R. S. CHUNDAWAT, AND P. K. DAS. 1991. Status of the snow leopard *Panthera uncia* in northwest India. Biolological Conservation 55: 283–298.

GONZALEZ-CANDELA, M., L. LEON-VIZCAINO, AND M. J. CUBERO-PABLO. 2004. Population effects of sarcoptic mange in Barbary sheep (*Ammotragus lervia*) from Sierra Espuna Regional Park, Spain. Journal of Wildlife Diseases 40: 456–465.

HARRIS, R. B. 2003. *Pseudois nayaur*. *In* IUCN 2004. *2004 IUCN Red List of Threatened Species*. www.iucnredlist.org. Accessed 30 January 2006.

IBRAHIM, K. E. E., AND M. T. ABU-SAMRA. 1987. Experimental transmission of a goat strain of *Sarcoptes scabiei* to desert sheep and its treatment with Ivermectin. Veterinary Parasitology 26: 157–164.

MISHRA, C., S. E. VAN WIEREN, P. KETNER, I. M. A. HEITKONIG, AND H. H. T. PRINS. 2004. Competition between domestic livestock and wild bharal *Pseudois nayaur* in the Indian Trans-Himalaya. Journal of Applied Ecolology 41: 344–354.

SAKAI, A., T. MATSUMOTO, M. SAITOH, T. MATSUZAKI, T. KOIZUMI, T. ISHIZAKI, Z. H. RUAN, Z. G. WANG, Q. H. CHEN, AND X. Q. WANT. 2003. Cardiopulmonary hemodynamics of blue-sheep, *Pseudois nayaur*, as high-altitude adapted mammals. Japanese Journal of Physiology 53: 377–384.

SCHALLER, G. B. 1977. Mountain monarchs: Wild sheep and goats of the Himalaya. University of Chicago Press, Chicago, Illinois, 425 pp.

SOULSBY, E. J. L. 1986. Helminths, arthropods and protozoa of domesticated animals, 7th Edition. Baillière Tindall, London, UK, 809 pp.

TARIGAN, S., AND J. F. HUNTLEY. 2004. Failure to protect goats following vaccination with soluble proteins of *Sarcoptes scabiei*: Evidence for a role for IgE antibody in protection. Veterinary Parasitology 133: 101–109.

WANG, X., AND R. S. HOFFMAN. 1987. Pseudois nayaur and Pseudois schaeferi. Mammalian Species 278: 1–6.

YAGER, J. A., AND D. W. SCOTT. 1993. The skin and appendages. *In* Pathology of domestic animals, 4th Edition, K. V. F. Jubb, P. C. Kennedy and N. Palmer (eds.). Academic Press, San Diego, California, pp. 681–683.

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