Observation of Multiple Sarcoptic Mange Related Deaths in Himalayan Serow in Kedarnath Wildlife Sanctuary, India.

Introduction

Sarcoptic mange caused by *Sarcoptes scabiei* is responsible for epizootic disease in populations of various wild canids, wild cats and wild ungulates across the world (Pence & Ueckermann, 2002). Short-term mortality can be high, but doesn't generally alter long-term population dynamics. However, this disease can have drastic implications in fragmented populations, where loss of few individuals can be consequential (Bornstein *et al*., 1995).

This disease has been recorded in several Himalayan ungulates and their predators. However, the remote and inaccessible habitat occupied by many of these species makes it hard to detect outbreaks, much less understand those (Hameed *et al.,* 2016). This is a highly contagious mite infection that is generally found in social species due to ease of transmission as a result of proximity. There is a lack of knowledge and detailed records of this disease found in Himalayan Serow (hereafter referred to as serow), *Capricornis thar*, a species of mountain ungulate that in itself has very restricted scientific knowledge available. All the observations mentioned in this paper were carried out whilst a team of researchers were conducting a project titled "Assessing Health Impact of Livestock Grazing on Two Ungulate Species in Kedarnath Wildlife Sanctuary, Uttarakhand, India: An Ecological Review"

Background

Sarcoptic mange has been recorded in different Himalayan mammals, especially ungulates (Aziz *et al.* 2003; Hameed *et al.,* 2016). In fact, it is a very wide ranging epizootoic disease occurring in 10 orders, 27 families and 104 species of domestic and free-ranging/wild animals (Pence & Ueckermann 2002). Generally cases aren't severe, but examples such as the complete wiping out of Red fox, *Vulpes* on Borrnhold Island in Denmark due to this disease, highlights its potential severity in isolated and fragmented populations (Henriksen *et al.*, 1993). This disease has been documented to be one of the major causes of death and population decline in Southern Europe for Chamois, *Rupicarpa rupicarpa* and Iberian Ibex, *Capra pyrenaica,* species that are ecologically

Himalayan Serow caught foraging on a camera traps placed in the Kedarnath Wildlife Sanctuary. This area had been previously visited by a large herd (~700) of livestock.

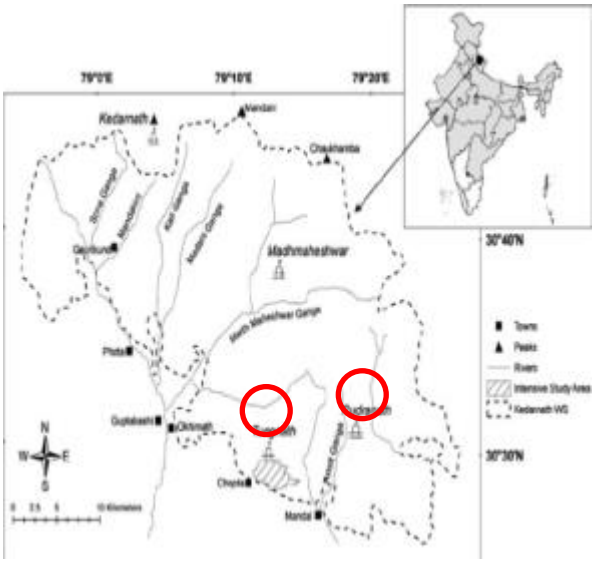
and taxonomically close to the serow (Rossi *et al.*, 1995; Fernandez-Morin *et al,*. 1997).

The disease is caused by a highly infection mites, generally *Sarcoptes scabiei*, though many vagrants do occur and are yet to be identified. Called Scabies in humans, symptoms and reaction to this disease depend on the immune strength of individual animals and species. The disease- causing-organism is a submacroscopic burrowing mite, of which male and female adults, larvae, prontonymphs, tritonymphs, and eggs occur in the epidermis of the affected individual to the level of the stratum granulosum (Arlian, 1988; Arlian, 1989). Symptoms generally are epidermal hyperkeratosis usually without marked alopecia (in some severe cases there is alopecia), but with an underlying chronic dermal inflammation and an abundance of mites in the skin (Arlian, 1988; Arlian *et al.*, 1994).

The mite consumes living cells and tissue fluid. As yet, there is no taxonomic means to distinguish the various strains that manifest a fairly high degree of host specificity for their respective host species. Interestingly, this disease is believed to have arisen in humans, who spread it to their domestic animals, and subsequently the wild ones picked it from the latter (Pence & Ueckermann 2002).

Methods

All sighting of dead serows were based on chance encounters or passing of information from the local villagers or the Forest Department. No active searches for dead serows were conducted. Although, one of the above mentioned project's aims was to quantify habitats used by serow, hence the team inevitably ended being in areas that had chances of witnessing serow mortalities. Also, available data was gathered from the Kedarnath Forest Department wild ungulate death records for 2016.



Map showing the extent of Kedarnath Wildlife Sanctuary, located in Uttarakhand, India. Marked in red are the two sites of the primary study

Whenever a dead animal, including a serow is sighted by any individual, they are mandated to contact the local Forest Department personnel. Upon this, a case is recorded, veterinarians called upon, an autopsy done and a synopsis of causes and symptoms are filed. Apart from the chance encounters and examination of dead individuals, addition information was gained by searching the above mentioned archives in the Kedarnath Forest Department head office for recorded of dead serows diagnosed to be due to sarcoptic mange. Subsequently, 50 individuals from two villages on the Southern boundary of the Wildlife Sanctuary, namely *Siroli* and *Mandal* (N30° 27' 26.22'' E79° 16' 28.47') and 50 individuals from

two villages on the eastern side of the Wildlife Sanctuary, namely *Dummak* and *Kalgot* (N 30° 29' 54.98'' E79o 22' 21.68''), were interviewed to gain local knowledge about this disease's spatial and temporal extent and its historic prevalence in serow and livestock. These four villages were the closest villages to the two primary study sites, hence were deemed chosen to be interviewed.

Observation of serow deaths in the Kedarnath Wildlife Sanctuary due to mange

2 direct observations were recorded across a period of 5 months (May-September 2016) of serow deaths. One was in the *Siroli* village (N30° 27' 26.22'' E79° 16' 28.47') and another one in the *Shokarkh* valley (N30° 29' 25.93'' E079° 10' 46.34'').

In *Siroli*, a male serow was seen falling off a rock cliff onto the ground below, where it was found dead. It was unclear if the individual died due to the fall or before. No sign of bleeding, bruising or predation were seen. The individual had marked alopecia and severe lesions, which were confirmed by the veterinarian to be hyperkeratoic and parakeratoic. This is indicative of a lack of a hypersensitive response due to anergia or malnourishment (Arlian, 1989; Arlian *et al.,* 1994), thus an indication of a severe case of sarcoptic mange. The case was confirmed to be sarcoptic mange, upon examining of deep skin scrapings in 10% potassium hydroxide (KOH), identified by idiosomal denticles and club-shaped setae, by a professional veterinarian (Pence *et al.,* 1975). This site is located at an elevation of

Photos of a freshly deceased Himalayan Serow from the 29th of June 2016 at 0653 hours, found near the Siroli village. Seen clearly on the skin is evidence of sarcoptic mange disease, characterized by hair loss, due to drying and scratching of skin.

1498m, along the village edge. The rock cliffs were a mix of oak, birch and rhododendrons forests with grass patches. The death occurred at 06:58 IST on the 29th of June 2016.

Additionally, a skeleton of a Serow was found in the *Shokarkh* valley, at an elevation of about 3074m. The skeleton seemed at least a month old, upon its discovery on the 26th of September 2016, as the decaying smell wasn't very pungent, all the meat was entirely either eaten or had decayed, and the bones had lick marks on them. Additionally, there seemed to be no sign of predation around the skeleton such as sprint marks, trampled vegetation or blood stains. Had this been a predated kill, we should have expected to see trampled vegetation, as adjacent to the skeleton, the ground was covered primarily with soft stemmed and large leaved plants that were

Photos of a skeleton (skull in picture) of a deceased serow on the 26th of September 2016, found along the main stream of the Shokarkh valley. Seen on the right is the vegetation adjacent to the skeleton. Notice the lack of trapping or other predation related evidences. .

bent easily by the research team's footsteps. This was a riverine habitat, comprising mainly of a thick understory, a stream and patches of oak trees.

Additional records of deaths caused by sarcoptic mange in Serow

Upon checking the forest department archives and conducting interviews, we confirmed at least 12 deaths of serow due to sarcoptic mange in the southern and eastern Kedarnath Wildlife Sanctuary region in 2016, roughly an area of 100km^2(the entire Wildlife Sanctuary is 975km^2). Particularly via interviews, it was confirmed that deaths started in March and continued into September. This is particularly interesting as this disease, anecdotally kills individuals in the colder months, as mainly due to hair loss they can't handle the colder temperatures. It was said that during the summer months (May-July), the individuals get infected by the mites and it generally takes about 2-4 months for them to die.

This mechanism of disease was described by majority of the people interviewed, as a pathway that affects domestic sheep, *Ovis aries* in the region, as well. Interestingly, domestic goats, *Capra aegagrus hircus,* in the region don't suffer from this disease. Additionally, all recorded deaths were of adult serows, but the sexes of individuals

weren't mentioned in the report or identified by the villagers. Most individuals interviewed, suggested that this disease is common in the other ungulates of the area, such as Himalayan Goral, *Naemorhedus goral,* and returns to livestock with intensity every 3-4 years, but does not lead to massive casualties. Over 50% of the people who owned livestock said they did have some medicinal treatment for this disease in needed by their livestock. However, they did acknowledge that this year was particularly drastic for the serow, as they had never before seen so many dying with the same symptoms, across such a long temporal spectrum, as the ones we encountered.

Disease and potential implication in relation to livestock: Steps for the future

During the study, the team installed various camera traps to obtain photographs of the serow. In a particular location, named *Panchaganga* (N 30° 29' 53.36'' E79° 20' 03.80'', elevation 2849 m), we obtained multiple pictures of at least two individuals of the serow from a camera, on the 25th and 26th of September. Additionally, in the exact same location, a livestock herd of about 700 sheep and goat had come foraging, roughly 15 days previously. This confirmed that there is a direct overlap of habitats between livestock and the serow. The literature isn't clear on the role played by livestock in potential transmittance of this disease to wild ungulate populations, though there have been confirmed cases of cross-transmission from other areas and species (McCarthy, 1960; Sweatman, 1971; Perry, 1983). In fact 1 dead serow, with similar symptoms to other sarcoptic mange death victims, was reported roughly 3 km east of this location of overlap between the serows and livestock, in the early days of September 2016. No additional information exists about this particular death.

Therefore, it is of high value to analyse skin samples from sheep and serow infected with sarcoptic mange from the area, to understand if the same mite is infecting both the domestic and the wild ungulates. Additionally, environmental factors such as winter intensity (particularly winter snow depth), rainfall and mean temperatures should be modelled to understand their potential to provide favourable condition for mite's propagation, hence increasing infection intensity and probability. Lastly, the presence and persistence of such mites in the environment should be studied and quantified.

The magnitude of this disease impacting the serow or other species across their range is barely understood, much less being acted upon (Walton *et al.* 2004). From the little that we know of this elusive and "Near Threatened" ungulate, anthropogenic impact such as deforestation causing habitat loss is highly fragmenting their populations, resulting in very little genetic exchange across populations (IUCN red list). This situation thus holds a daunting possibility of sarcoptic mange adversely affecting the populations of this elusive mountain ungulate.

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