Caprinae news

Newsletter of the IUCN/SSC Caprinae Specialist Group

IN THIS ISSUE (1/2018)

EDITORIAL

Dear CSG members,

Here we are with a new issue of our newsletter, under the editorial care of Luca Corlatti, Steve Ross and Gerhard Damm. As you will notice, the look of our newsletter has been greatly renewed and its structure has been improved by adding new sections. We envisage three topics which will require some substantial help from your part, in the near future:

(1) taxonomy is based on subjective standards, which makes it a very slippery terrain to tread on. Yet, as George B. Schaller wrote "*ecological and behavioural analyses require sound systematics. Unfortunately taxonomy is in a state of flux and the problem of what constitutes a species remains unsettled*" (Schaller 1977).

Much more recently, Zachos et al. (2013a) continued Schaller's statement and remarked that "*conservation requires it, too. In fact, conservation oriented agencies, e.g. the IUCN (International Union for Conservation of Nature) and the WWF (Worldwide Fund for Nature), need reliable nomenclature criteria to indicate taxa at risk*".

The "*flux*" mentioned by Schaller in 1977 has evolved into what looks now to many biologists as a kind of "splitting frenzy", thus making some zoologists write "*As well as confusing the functional meaning of a species, taxon splitting could be detrimental to conservation. If threatened species are incorrectly split into several units and managed as such, for example in captive breeding or meta-population management, there could be unnecessary loss of genetic variation and an increased risk of extinction. Such newly designated species call into question the suitability of Red List assessments and the legality of species identified under national laws and international agreements. It is vital to identify true species as conservation units, based on adequate sample sizes and on information pertaining to genetics, morphology and behaviour*" (Zachos et al. 2013b). In the last 12 years, nearly 1100 "new" mammalian species have been described, *e.g.* both deer and Caprinae species have been increased by c. 100% (!) in this time span, which rather calls for some caution.

We will have to make use – possibly a wise use – of taxonomy in the re-assessment of Caprinae *taxa*: a duty to which IUCN calls its specialist groups every now and again.

(2) Nearly all species of Caprinae have been re-assessed on 2008 and several others in the last few years too. 2008 is some ten years ago and IUCN is calling for a re-assessment.

The trouble with re-assessments lies in the fact that sound ones cannot be done by just using Google maps, but first-hand information is required, unless spurious results will be obtained thereby risking to be challenged later on.

We will submit soon a working outline to CSG members and most of you will be asked to coordinate a small group of experts to help with the geographic area and species for which you will be responsible. We have targeted 2020 as the deadline for our re-assessments.

(3) Last, but not least... do contribute with articles to the existence of this newsletter: next issue deadline, MAY 2019. All of us suffer from a chronic shortage of time – we know that – but, to some extent, we have accepted to work for conservation and are expected to keep informed

each other and IUCN on matters relevant to conservation.

Finally, have a look at our new WEB site - which Luca has been caring for: http://iucncaprinaesg.weebly.com We appreciate the simple, effective style Luca has provided. Old issues of Caprinae news can be downloaded from the website, and if you wish to contribute to the newsletter, author guidelines can be also found there. To maintain the website updated with timely information on Caprinae, we need your help! Please send any contribution (pictures, news) to Luca (luca.corlatti@wildlife.uni-freiburg.de).

Let's do it, then!

Sandro Lovari & Juan Herrero

Chairmen IUCN/SSC Caprinae Specialist Group

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Headline news

7th World Conference on Mountain Ungulates

September 10-13, 2019
Bozeman, Montana, USA

Hosted by:

Endorsed by the Caprinae Specialist Group, IUCN Species Survival Commission

The World Mountain Ungulate Conference will convene in North America for the first time. Bozeman, Montana is located about 1 hour from Yellowstone National Park and near other internationally known natural protected areas which support large populations of mountain ungulates amidst the spectacular landscapes of the Northern Rocky Mountains.

The Conference will provide a venue where interested persons may learn, network, and engage professionally in the exchange of current knowledge of mountain ungulate research, conservation and management.

We welcome the international participation of professors, students, researchers, wildlife managers, private and communal landowners, government agencies, and all others with an interest in mountain ungulates.

Conference Schedule — First call for presentations and posters, January 2019; registration to begin in Spring 2019; Conference program finalized in Summer 2019.

Conference planning committee — Kurt Alt, Conservation Director, Wild Sheep Foundation; Sandro Lovari and Juan Herrero, Chairmen of the Caprinae Specialist Group; Raul Valdez, Member, Caprinae Specialist Group.

Major Financial Sponsors — Wild Sheep Foundation & Safari Club International Foundation.

Conference website is forthcoming

Conservation and Management

Trophy hunting and artificial selection for small horns in mountain ungulates

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Many mountain ungulates are much sought-after hunting trophies, and the IUCN Caprinae Specialist Group has long supported the inclusion of hunting in conservation programs. About 20 years ago, we produced a statement that was later used as a basis for the IUCN Guiding Principles on Trophy Hunting: https://cmsdata.iucn.org/downloads/iucn_ssc_guiding_principles_on_trophy_hunting_ver1_09aug2012.pdf

We recognize that sustainable hunting, in accordance to biological principles and including respect for local communities, can have many positive contributions to the conservation of mountain ungulates and their habitat. Members of our group have also produced evidence that in some cases, excessive harvest based on horn size can favor the evolution of smaller horns. The initial paper showing a genetic change in heavily-hunted bighorn sheep on Ram Mountain, Alberta (Coltman et al. 2003) was confirmed by a re-analysis (Pigeon et al. 2016) that accounted for some valid statistical criticisms, and showed that the evolutionary trend towards smaller horns stopped when the trophy hunt was suspended. Long-term, broad-scale analyses of harvest record suggest that evolutionary change is to be expected when harvests are intense (Garel et al. 2007, Hengeveld & Festa-Bianchet 2011, Pérez et al. 2011, Festa-Bianchet et al. 2014) but can be avoided when regulations limit the selective impact (Büntgen et al. *in press*) or when harvest is limited by access (Douhard et al. 2016).

This is not a difficult concept to grasp: about 30-40% of variability in sheep horn size is inheritable. Intense artificial selective pressure will cause evolution, especially when, as is the case for wild sheep, ram horns grow to 'trophy' size a few years before large horns confer high mating success (Martin et al. 2016). Evolutionary changes can be avoided by regulations that ensure that some large-horned males survive to reproduce. The effectiveness of those regulations can be gauged by analysis of long-term data on the age and horn size of harvested males. For example, when bighorn sheep ram horn size was declining in Alberta, up to a quarter of the harvest was made up of rams aged 4 or 5 years, while in parts of British Columbia where the horn size of Stone's ram has not declined, about 70% of the harvest is made up of rams aged 8 years and older. Many other factors affect the probability that trophy hunting will have an evolutionary impact, including the age-specific role of horn size on mating success, the degree of mate monopolization by large-horned males, the availability of effective sources of non-selected immigrants and gregariousness (Festa-Bianchet 2017). The overriding factors, however, are the selectivity and the rate of the harvest.

Unfortunately, these results have been received with hostility by some in the trophy hunting community, partly because they have been used by anti-use groups to suggest that any kind of trophy hunting will have undesirable evolutionary consequences. That is not the case. Instead, I have argued that the specific biology of mountain sheep, combined with very heavy selective hunting, sets up a perfect storm that is very likely to lead to an evolutionary response. I have encouraged researchers and managers to consider when selective harvest may lead to evolution, and how to ensure that harvests are evolutionarily sustainable. Managers are instead increasingly confronted with manufactured uncertainty (Boan et al. 2018) that makes it more difficult to use the best science to develop harvest plans. A good example is the recent attempt by wildlife biologists in Alberta to change bighorn sheep hunting regulations based on strong evidence that the current harvest scheme selects for small horns. That recommendation was refused by the provincial government and the report supporting it remains in 'draft' stage after 3 years: http://aep.alberta.ca/fish-wildlife/wildlife-management/documents/BighornSheepMgmtPlan-Draft-Jun25-2015A.pdf

The latest manifestation of hostility towards the idea that intense, quota-free selective hunting may lead to evolution is found in three papers recently published in a 'Special Issue' on mountain sheep in the Journal of Wildlife Management, including an Editorial comment (Boyce & Krausman 2018) to which I have written a reply (Festa-Bianchet 2018). Another paper in this issue, questioning the idea that selective hunting can lead to evolution, contained several basic errors and a reply (Kardos, Luikart & Allendorf 2018) led the author to admit that bighorn sheep hunting regulations in Alberta may in fact have caused an evolutionary response (Heffelfinger 2018). I trust that most wildlife managers and conservationists will consider the evidence for evolutionary effects of selective hunting and neither attempt to simply obstruct it, nor abuse it by applying it out of context.

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New strategy for the conservation of the barbary sheep in Tunisia: a common framework for action

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The barbary sheep *Ammotragus lervia* is an ungulate endemic to northern Africa whose numbers are decreasing in the region. Faced with this situation, the Directorate-General of Forests in Tunisia in collaboration with the International Union for Conservation of Nature (IUCN), the Ministry of local business and the environment of Tunisia, and several Tunisian civil society organizations, published a strategy and an action plan for the conservation of this emblematic species, which deserve to be implemented urgently.

The barbary sheep is the mountain ungulate best adapted to arid and hot environments. It is an important element of North Africa and Tunisia's biodiversity, and it is currently classified as Vulnerable in the IUCN Red List of Threatened Species. Over the last century, the presence and distribution of the barbary sheep on the African continent has dramatically decreased, mainly due to the combined effect of poaching and habitat degradation. In Tunisia, only a few populations remain, especially in protected areas and they face a number of threats.

In the medium term, the ultimate goal of this strategy is to ensure the survival of at least four populations of free-ranging barbary sheep in Tunisia, occupying their natural ranges in the regions of the Sahara, Dahar-Ouara, Orbata-Bou Hedma and on the Tunisian Dorsale. To achieve this goal, five intervention strategies have been identified: (i) habitat conservation, (ii) elimination of poaching, (iii) monitoring and data collection, (iv) awareness and valorisation of the species, and (v) identification of funding mechanisms. For each of these strategies, a long-term objective and strategic objectives have been defined and priority actions have been prescribed for the period 2018-2027, with indications in terms of responsibility and budget.

Through implementation of management plans and progressive reduction of poaching until its elimination, the strategy should guarantee conservation and restoration of habitat to ensure the protection of at least 90% of the population of barbary sheep in Tunisia. To support these management actions, an awareness programme for societies living around the barbary sheep was included, with actions to promote ecotourism within and around important sites.

In this perspective, the strategy aims to see viable populations of barbary sheep in their potential range in Tunisia by 2050, so that they symbolize the North African mountains and constitute an important element of sustainable development. The successful implementation of this strategy will be closely linked to the work of several actors at the national level and each one will need to coordinate with various institutions to effectively achieve these objectives.

The development of this action plan was also made possible thanks to the involvement and active collaboration of a number of experts, including IUCN SSC Caprinae SG members, who have spent time and shared their knowledge and experience during all stages of the elaboration of this strategy. Financial support was received from the MAVA Foundation and the Biodiversity Foundation (Fundación Biodiversidad) of the Spanish Ministry of Agriculture and Fisheries, Food and Environment.

The strategy document is available in French at this link: https://portals.iucn.org/library/node/47645

For more information or if you wish to receive a print copy of the strategy, please contact Violeta Barrios.

Markhor and Siberian ibex occurrence and conservation in northern Afghanistan

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Abstract — In Asia, markhor *Capra falconeri* and Siberian ibex *Capra sibirica* occur in six and eleven countries respectively, and both species have been reported in Afghanistan. However, few wildlife studies in Afghanistan have been made in recent years and the current distribution of markhor and ibex is largely unknown. We conducted field surveys in northern Badakhshan Province, Afghanistan in July-October 2011, and documented the presence of markhor and ibex there for the first time. We made direct observations of markhor in Shahr-e Buzurg District and the Darwaz region, and collected indirect field evidence and community reports of markhor and ibex. The strip of land along the Amu Darya River from

western Darwaz to Shahr-e Buzurg district through Khawahan and Raghistan districts should be a priority site for future markhor and ibex conservation in Afghanistan. If protection measures are taken, this area along with the adjacent protected area in Tajikistan, could act as valuable and viable refuge for sustaining markhor and other wild species that inhabit the region.

Keywords: Shahr-e Buzurg, Darwaz, *Capra falconeri,* markhor, *Capra sibirica,* ibex, conservation.

Introduction

Few wildlife studies have been made in recent years in Afghanistan and thus the current distribution of many wild ungulates, including markhor *Capra falconeri* and Siberian ibex *Capra sibirica*, remain largely unknown in most of the country. This is important because future conservation actions depend on up-to-date data on species distribution and population status. Markhor are listed as protected in Afghanistan, and hunting of the species is prohibited throughout its range (Zaher 2010). Siberian ibex are nominally protected from human harvest by a nationwide presidential ban on hunting. However, both species are most likely hunted throughout their range by local tribesmen (Reading & Shank 2008).

Markhor are among the rarest wild ungulates in Central Asia (Michel 2010). The species is listed as Near Threatened by the IUCN, and three subspecies *C. f. falconeri, C. f. heptneri, and C. f. megaceros* have been recognized globally (Michel & Michel 2015). Markhor distribution extends over six countries, including Tajikistan west of the Amu Darya River and in northern Afghanistan (Michel 2010; Michel et al. 2015). It is thought that all three subspecies of markhor occur in Afghanistan, distributed in the north and north-eastern parts of the country (Petocz 1972; Hassinger 1973; Habibi 2003; Michel & Michel 2015). Although markhor distribution is claimed to cover northern Badakhshan Province and western Darwaz region (Hassinger 1973; Habibi 2003; Michel 2010), we were only able to find two documented records of markhor in Afghanistan, both in the northeast (Hassinger 1973; Stevens et al. 2011), indicating that the distribution of markhor in Afghanistan is still unclear.

Siberian ibex have a wide distribution that extends over eleven countries from northern India in the south to Russia in the north, and Afghanistan in the west to Mongolia in the east. In Afghanistan, Ibex distribution covers the Hindu Kush, Pamir, Koh-e Baba ranges from the Wakhan National Park in north-east to Badghis in the west (Hassinger 1973; Schaller 2007) and from Darwaz in the north to Kabul in the south (Habibi 1977).

Here we report the results of two field surveys conducted in the Shahr-e Buzurg District and in the Darwaz region (60 km apart) in northern Badakhshan Province, Afghanistan to evaluate the current presence of markhor and ibex there.

In addition, we aimed to gather information relevant to establishing conservation areas in northern Badakhshan.

Study area

We surveyed a strip of land along the Amu Darya River that falls under four districts of northern Badakhshan Province: Shahr-e Buzurg district, and Kof Ab, Shukai, and Nusai districts, all in the Darwaz region. The Darwaz region is the northernmost part of Afghanistan and it shares a border with Tajikistan (Fig. 1). The Amu Darya River serves as the international border between the study site and Tajikistan.

Figure 1: Map showing the study area in Northern Afghanistan and markhor distribution in the region.

We visited 46 villages and four field sites, most of which were located in valleys that drain into the Amu Darya River. The study covered 300 km^2 of Shahr-e Buzurg district, and 1,997 km^2 of the Darwaz region. Darwaz is among the most remote areas of Afghanistan, due to poor road connections, and its wildlife remains largely unsurveyed. Topography of the area varies from steep slopes and cliffs to undulating terrain and flat areas. The steep slopes and cliffs become more dominant in the landscape the further along the Amu Darya river one travels from east to west. The vegetation of the area is largely scrubland, occupied by a variety of shrub and tree species.

Methods

Surveys were carried out from July to October 2011, and included interviewing local people, gathering observations and identifying specimens of markhor, ibex and other wildlife species. We focused our interviews on village headmen, hunters and shepherds, as they were believed to be the most knowledgeable concerning the status of local wildlife. For more accurate identification of animal species, we showed photographs of large mammals, including ibex and markhor, that were known or suspected to be distributed in the area, based on the “Mammals of Afghanistan” by Habibi (2003).

Based on our survey experience in adjacent areas where villagers were unreceptive to formal interviews and the recording of their responses, we conducted informal interviews where we discussed and inquired about wildlife without immediately recording the responses. We feel it was the best approach to use under the circumstances, and are confident in our recall of responses.

Following interviews, we visited potential markhor and ibex habitats suggested by the interviewees, using experienced hunters from the local communities as field guides, and aiming to confirm the presence of the species in the area.

Results

Shahr-e Buzurg — Of 67 respondents, 41 (61%) from northern Shahr-e Buzurg stated that markhor were present and once abundant in their area. However, respondents thought that populations have declined, and few remain in northern Shahr-e Buzurg. During our field surveys we observed four markhor (Fig. 2) in the Payan-e Moor area, close to the border with Tajikistan. Experienced hunters from Payan-e Moor believed that there were roughly 20 markhor remaining in the area, other respondents also concurred with this view.

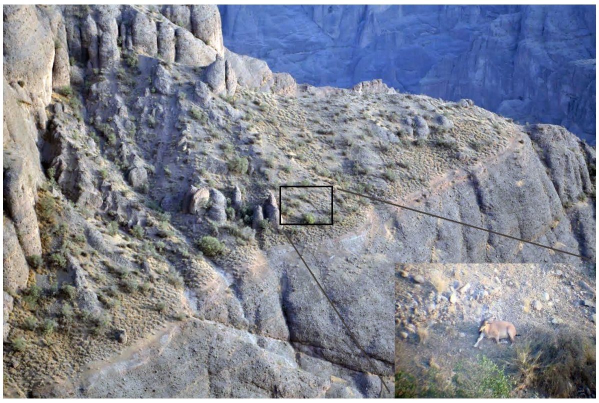

Figure 2: One of the four markhor observed in Payan-e Moor area of Shahr-e Buzurg District, Afghanistan.

In addition to our direct sighting of markhor in Payan-e Moor area of Shahr-e Buzurg, horns of a five-year-old male markhor and a skin of a female, said to be local to the area, were shown to us during the survey (Fig. 3). Also, a young markhor had reportedly been captured from the area, about three months prior to our survey, and smuggled elsewhere, where it was kept as an exhibit by a wealthy person.

During our survey we did not record reports suggesting the presence of ibex in northern Shahr-e Buzurg, nor did interviewees recall presence of the species in the past.

Darwaz — Of 40 respondents from Kof Ab District, 15 (37%) indicated that markhor existed in the western part of the district. This assessment was further supported by our sighting of six markhor in the area between Dahan-e Ab Kof and Leiwgard village in Gandamargh Valley. We also observed four pairs of markhor horns in Leiwgard

Figure 3: (left) A skin and a pair of horns showed to us in Payan-e Moor Village in Shahr-e Buzurg and (right) one of four sets of markhor horns photographed in Leiwgard Village of Kof Ab in Darwaz Region.

village that were from the local area (Fig. 3). Three pairs were old, but one pair was relatively recent with presence of old blood around the horns.

Seventy-four out of 131 respondents (56%) stated that ibex occurs in some parts of Darwaz. One of the informants showed us a skin and horns of two individual ibex in Nusai District, about 60 km northeast of where we sighted markhor. In addition, we found ibex horns in Gandamargh Valley where we saw six markhor. According to interviewees, Ibex are present in the survey area, yet distributed sparsely due to unsustainable hunting. Ibex populations in Shukai and Nusai districts were thought to be on the brink of extirpation due to poaching. The distribution of Ibex and markhor in western Darwaz overlaps, but is thought to be segregated due to ibex preference for higher elevations.

Discussion

Our sighting of one markhor in Shahr-e Buzurg and six in Leiwgard, Darwaz region confirmed the presence of markhor on the Afghan side of the Amu Darya River for the first time. Interviewees also stated that western Darwaz and Shahr-e Buzurg support markhor populations. However, markhor populations in Shahr-e Buzurg are thought to be small and may only survive due to immigration from larger source populations in nearby Tajikistan. Markhor populations in Leiwgard appear larger and more stable, though this population is also connected to neighboring Tajik populations. The Leiwgard area is the most remote part of Kof Ab District and is lacking road connections with other parts of Badakhshan. The Amu Darya River separates Leiwgard from Tajikistan and the M-Sayod Conservancy which is known to harbor Markhor populations (Fig. 1). We suspect that when water level drops in the river during winter, markhor could move between both areas. The remoteness of Leiwgard is likely the primary reason that markhor and ibex still exist in this area.

According to the interviewees, Leiwgard is home to about 80 markhor, as well as numerous ibex, brown bear *Ursus arctos*, leopard (probably snow leopard, *Panthera uncia*) and other mammalian species. Respondents from Leiwgard village stated that markhor and ibex utilize the same area with different altitudinal preferences. Markhor are said to inhabit the lower elevations and prefer steep cliffs, while ibex utilize the higher elevations in the upper valleys with colder environments. This if true is one of the very few areas where these two caprid species overlap.

We believe the Leiwgard area represents the easternmost occurrence of markhor in Badakhshan, as we failed to record any evidence of the presence of markhor in Nusai and Shukai, the two northeastern districts of Darwaz (Figure 1). The western part of Kof Ab district, mainly the mountains section surrounding Leiwgard that runs along the Amu Darya River, seemed to offer suitable habitat for markhor. It contains rugged mountains with steep cliffs and areas that were free of livestock and human disturbance. The vegetation cover was open woodland with sparse juniper trees, pistachio trees, wild almond, and many shrub species. According to respondents, the markhor distribution continues towards Khawahan and Raghistan districts in the western side that has the same habitat type.

Several conservation management actions to promote persistence of Markhor and other biodiversity in the Leiwgard area are required. A priority is the protection of the area along the Amu Darya River starting from Leiwgard and continuing through Khawahan and Raghistan districts to Payan-e Moor and beyond into the Shahr-e Buzurg district. This area is a priority for future markhor conservation and for other endangered wildlife such as snow leopard. The area has the advantage of being connected to the M-Sayod Conservancy on the Tajik side of the border, and so efforts could be combined between Afghanistan and Tajikistan to promote conservation in the larger area. By coordination of conservation efforts, an important area with unique habitats and endangered wildlife could be preserved.

Acknowledgements

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Highest penalty handed down for poaching Sumatran serow in Malaysia

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Malaysia is home to only one species of the Caprinae family, the Sumatran serow *Capricornis sumatraensis*. Listed as Vulnerable in the IUCN Red List (Duckworth et al. 2008), this species is increasingly threatened by commercial poaching and habitat loss (Duckworth et al. 2008; Shepherd & Krishnasamy 2014). Like all serow species in Southeast Asia, its body parts are highly prized in the illegal wildlife trade for their purported medicinal values, and the meat is a popular dish (Rahman 1997, Shepherd & Krishnasamy 2014).

The Sumatran serow is legally protected in Peninsular Malaysia by the Wildlife Conservation Act 2010 and under this Act, anyone found guilty of hunting, taking or keeping serow parts or derivatives is liable to a minimum fine of MYR 100,000 (USD 33,300) and a maximum of MYR 500,000 (USD 166,670) and faces a imprisonment of up to five years.

The hunting of, taking or keeping female serow can lead to a fine of between MYR 200,000 (USD 66,670) and MYR 500,000 (USD 166,670), and a jail term of up to five years. Anyone convicted of illegally hunting, taking or keeping a juvenile serow is liable to be fined between MYR 150,000 (USD 50,000) and MYR 500,000 (USD 166,670) and imprisoned for up to five years. Yet few have been prosecuted for serow related offences and fewer still have received penalties that would serve as a deterrent (Shepherd & Krishnasamy 2014). Recently, however, a judge in Malaysia meted out a landmark penalty in a serow case.

On March 27th, 2017, two men were arrested by the Department of Wildlife and National Parks Peninsular Malaysia (locally known as Perhilitan) enforcement officers with the head and other parts of a Sumatran serow in their four-wheel drive vehicle at the Tekai Tembeling Forest Reserve near Jerantut, in the state of Pahang. Jerantut leads to the Kuala Tahan, which is headquairters of the country's premier national park, Taman Negara. The men were each charged with two counts of keeping parts of an endangered animal without a permit under Section 68(2)(c) of the Wildlife Conservation Act. The Temerloh Sessions Court judge fined them each MYR 300,000 (USD 70,320) or six months' imprisonment, or, in default, two years' jail for each offence. The men were not able to pay this amount and were therefore sent to the Bentong prison, also in Pahang, to serve the time there. Perhilitan's Director General, Abdul Kadir Abu Hashim was quoted in The Star Online (2 June 2017) as saying that the punishment meted out under the Act was the highest fine ever recorded by the department in Peninsular Malaysia (Joibi 2017).

The penalty imposed on these wildlife criminals underscores the seriousness of the crime, and puts the spotlight on a species that is easily overlooked. An enlightened Malaysian judiciary which supports conservation efforts will make a significant difference in deterring poaching and trade of serow, and other threatened species in Malaysia.

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Research

Recent advances in climate change research related to the Caprinae

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Climate change is a primary threat to species persistence and biodiversity at a global scale (Urban 2015). Alpine environments across the world provide habitats for a great diversity of cold-adapted biota that are intrinsically sensitive to global warming and associated phenomena (Gentili et al. 2015). As the Caprinae are largely alpine species, it is reasonable to expect that climate change poses a real threat to their conservation, and consequently is a concern of Caprinae researchers. Here I make a short overview of climate change research published in the last 5-years and related to the Caprinae. My objective is to review evidence of the consequences of climate change to the behaviour and conservation of Caprinae, and to summarize the direction such research is leading. The review is based on a Google scholar search, based on the last five years, entering the words 'climate change' and either 'mountain ungulate' or 'alpine ungulate' or 'Caprinae'. As a result, the review is intended to be brief rather than comprehensive; I take examples of major research themes but miss many relevant publications.

Considering the fast pace of climatic change, genetic adaptation is unlikely to aid the Caprinae's resilience in the short term. Rather Caprinae are likely to respond by moving or changing habitat to evade unfavourable climates, and through altered phenotypic expression, by adapting their physiology, development and behaviour to the new conditions (Hetem et al. 2014, Fuller et al. 2016). I have grouped research into these potential responses to climate change into three broad research themes: (a) predicting the long-term demographic consequences of climate change (b) adaptive movements and escape from climatic extremes; and (c) use of phenotypic plasticity to adapt to climate change. I have selected three to four studies in each of these themes to illustrate recent research.

Predicting the demographic consequences of climate change — The effects of climate change on population survival and demographics is a key research area providing insight into the mechanisms and expected changes in populations under new climatic conditions. Several studies have used long term monitoring datasets to forecast and track demographic changes in relation to climate. The effects of climate on demography have been investigated in mountain goats *Oreamnos americanus*, Northern chamois *Rupicapra rupicapra* and bighorn sheep *Ovis canadensis.*

Using 37-years of monitoring data from 10 coastal Alaskan mountain goat populations, White et al. (2017) predicted the likely fate of Mountain goats in Alaska under 10 IPCC global climate change scenarios. They found that reduced survival associated with increasing summer temperatures was the main threatening process. The higher temperatures resulted in heat stress and led to decreased foraging effort, and use of habitats with lower productivity (White et al. 2011). This negative effect was not compensated for by improved survival due to milder winters and decreased snow depth. In the populations studied there was also little scope for upward migration to escape the increasing summer temperatures. Under the most realistic climate change scenarios, the net effect was extinction over a 70-year time frame (2015–2085). Consequently, the future of mountain goat populations in Southern Alaska was thought to be tenuous at best.

A similar study was conducted on Alpine chamois in Gran Paradiso National Park, Italy, by Imperio et al. (2014). The study modelled the influence of density dependence and climatic forcing on chamois demography using 51 years of monitoring data. The long-term demographic projections suggested an overall positive effect of lower winter snow depth on survival rates, but similar to what was found in Alaskan mountain goats, higher spring-summer temperatures exerted a negative effect on population dynamics, in particular on females and younger age classes. Overall the positive and negative effects of changing climatic conditions largely balanced out, and predictions using more realistic structured models suggested only a slight reduction in population abundance due to climate change.

Due to extremes of temperature, snow, forage availability and quality, the Caprinae's ability to forage and maintain body mass varies throughout the year. Maintaining body mass is an important factor affecting Caprinae survival and demographics in seasonal environments. To understand this phenomenon, Douhard et al. (2018) looked at the intrinsic mechanisms behind the effects of climate on demographic traits of bighorn sheep in Canada. They found mean spring (April–May) temperature was the main driver of relative seasonal mass changes, as warm springs reduced relative winter mass loss but also reduced summer mass gain of both sexes, possibly due to a trade-off between growth rate of plants and duration of access to high-quality forage. Despite no net effect on adult body mass across the year, mothers that lost more mass during the winter had lambs that gained less mass during summer, and these lambs were less likely to survive the winter (Douhard et al. 2018). Considering Canada is expected to warm by 2-3 degrees, the results suggest that the effects on bighorn sheep survival and population should be positive.

Although different species will respond differently depending on climate and habitat conditions, the demographic consequences of climate change, and the mechanisms of seasonal mass changes found in the above studies may apply to other Caprinae. These studies show the strength of long term monitoring datasets in providing insight into how climate can affect Caprinae at a population level.

Adaptive movements and range shifts — Changing climatic conditions are likely to change the suitability and availability of habitat. To adapt to changing habitats it is expected that Caprinae will shift their ranges to maintain access to suitable resource conditions. To track or predict climate induced range shifts, researchers have employed long-term monitoring, habitat modelling, and short term spatial monitoring techniques in relation to temperature.

Long term positional data is rare for the caprinae, making tracking of climate induced shifts challenging, however Büntgen et al. (2017) used 230,565 harvest / hunting locations between 1991 and 2013 to track range shifts of 4 ungulates in the European Alps. Harvest data were available for Alpine ibex *Capra ibex*, Alpine chamois *Rupicapra r. rupicapra*, red deer *Cervus elaphus*, and roe deer *Capreolus capreolus*. The study found small but significant increases in the elevation at which both Caprinae species were hunted. The new areas of activity coincided with relatively warmer, snow-free, and thus more favourable autumn conditions, suggesting a link between the range shifts and climate change.

Where long term datasets are lacking, predictive habitat modelling is a useful option. This technique was employed by Salas et al. (2018) to measure current habitat suitability of Marco Polo argali sheep *Ovis ammon polii* in Tajikistan, and predict future habitat availability based on two climate trajectories. Based on changes in annual mean temperature, precipitation of the warmest quarter, and temperature seasonality, models suggested argali would lose 6,928 km^2 of suitable habitat by 2050 and 7,219 km^2 by 2070, particularly at lower altitudes (3,300–4,300 m). However, counteracting the losses, over the studies time frame 6,106 km^2 of new habitat became suitable at elevations between 4500–6900 m. Importantly, the authors predicted that areas forecast to become suitable in the future were likely to be accessible by dispersing argali.

A similar modelling method was used to predict present and future ungulate distributions on the Tibetan plateau, including five Caprinae species, under future climate scenarios (Luo et al. 2015). The study predicted most species would see 30–50% reductions in distributions and an increase in threat, mostly due to changes in annual precipitation, annual mean temperature, land cover type, and temperature seasonality. However, assuming the region remained intact and species dispersal was possible, some species were predicted to make distributional gains, including three of the Caprinae species, the

Chinese goral *Naemorhedus caudatus*, bharal *Pseudois nayaur*, and dwarf bharal *Pseudois nayaur schaeferi.*

One weakness of distribution modelling methods as used above, are the many untestable assumptions made about species' habitat selection, and the state of the future environment. For example, while the Himalayan tahr should select higher altitude habitats in the summer to circumvent heat stress, the higher altitude habitats are avoided to help tahr reduce encounters and predation by snow leopard (Ferretti & Lovari 2016). Predation risk is one of many influential variables that are rarely used in habitat modelling. Yet despite the theoretical nature of most distribution models, their value lies in the demonstration of future scenarios and threats. Models draw attention to expected conservation issues and allow landscape management and connectivity strategies to be formulated in time to conserve species that are at risk from climate change.

Behavioural plasticity — Perhaps the main means of adaptation to climate change for many Caprinae will be their behavioural and physiological plasticity. This will be essential for species living in isolated populations where range shifts to counter climate change are impossible. Behavioural modifications such as a shift to nocturnal foraging or selection of a cool microclimate may buffer free-living mammals against thermal and water stress, but may carry a cost, for example by reducing foraging time or increasing predation risk (Fuller et al. 2016).

Due to the highly seasonal nature of most Caprinae habitats, maintaining energy supplies is a challenge and has proven extremely important for caprinae productivity and survival (Douhard et al. 2018). The Caprinae often must deal with seasonally low food availability due to plant phenology and snow cover, and restrictions in the time and areas they can actively forage during the summer due to heat stress. For example, Mason et al. (2017) found that Alpine ibex *Capra ibex* thermoregulated during hot summer days by foraging at higher altitude. As a result, they used less productive habitats and consumed lower quality forage, as indicated by lower levels of fecal crude protein. Ibex did not behaviourally compensate by increasing the time spent foraging, and so in theory ibex could suffer negative impacts due to their reduced access to quality forage.

A similar approach was taken to study Alpine chamois (Mason et al. 2014a). In contrast to ibex, chamois did not respond to warmer temperatures by moving upslope, but rather reduced foraging activity when it was hotter. It was predicted that chamois would forage 10% less in a 5 °C warmer climate. Although ibex and chamois adapted to hotter temperatures in different ways, the outcome was similar, with both potentially experiencing a nutritional deficit.

In the face of climate change, it is likely that other heat sensitive Caprinae will alter their foraging activity patterns, which could affect their ability to acquire sufficient resources. In support of this theory, long-term body mass declines (1979 to 2010) were detected in three nearby populations of alpine chamois (Mason et al. 2014b). Across the study period, juvenile chamois body mass declines were most strongly associated with increases in growing season temperatures, which may decrease time spent foraging due to heat stress, and secondly to increasing population density due to stricter hunting controls, which may have increased resource competition between chamois.

One aspect of ibex and chamois foraging behaviour that can influence the ability to acquire sufficient resources, but not monitored by the above studies, was the foraging rate itself. Puorger et al. (2017) investigated the foraging behaviour of alpine chamois in Switzerland based on bite and step rates, indicating food intake rate and searching activity, respectively. They found chamois increased their bite rate with decreasing forage nitrogen content, decreasing slope and increasing temperature. Step rates were higher at high temperatures and decreased with increasing relative plant cover. The increase in bite rate with temperature and lower forage nitrogen content may therefore represent a plastic adaptation by chamois that compensates for lower nutritional quality, and shorter foraging times when temperatures are high.

Considering that only few studies have conducted behavioural research in relation to climate change, as research accumulates it is likely the diversity of behavioural flexibility in relation to climate will be revealed. These insights will add to our understanding of adaptability and resilience of caprinae to a changing climate.

Concluding remarks — The amount of climate change research already completed on caprinae is encouraging. Predictive research is particularly relevant to caprinae conservation, as predictions will allow us to plan our responses, prioritise conservation actions and test our ideas, in time for when they are most needed.

This review highlighted the usefulness of comprehensive monitoring datasets in providing accurate predictions. Monitoring datasets can assess the effects of environmental conditions on population dynamics, phenotypic plasticity, and evolutionary potential (Festa-Bianchet et al. 2017). More long-term monitoring projects would be helpful, and as the rate of environmental change is increasing, should be initiated as soon as possible (IPCC 2014).

Predictive distribution modelling is also a very useful approach. Thus far distribution models related to climate change have mainly used coarse scale climate data and simple habitat variables. Although these models are very useful, particularly in the sense of planning, they lack the realism required to understand the details of species responses.

Incorporating variables such as predation risk, expected changes in vegetation distribution, and behaviour into models will increase complexity, but will also improve realism. Another area of distribution modelling that is lacking is the use of modelling methods to help identify corridors of Caprinae species; a better understanding of how to maintain connections between Caprinae habitats is needed to facilitate better landscape management and conservation planning.

It is apparent that more research is required to understand the potential effects of climate change, particularly since ecological responses to climate can vary between species and populations. As climate change is expected to have major impacts on species living in extreme environments (Parmesan 2006), more research is needed in areas experiencing extreme climates, including the Arctic, North Africa and the Middle-East. In addition, as highly threatened Caprinae are already exposed to impacts other than climate change, understanding how threats interact with climate change would provide important insight into the future status of many Caprinae species.

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Red deer, weather and survival of a threatened mountain ungulate: all that's reintroduced ain't gold!

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Reintroductions have become widespread operations to restore the local biological diversity and/or preserve threatened *taxa*. Yet, we may expect that reintroductions will affect the biology of *taxa* already present. In Abruzzo, Lazio and Molise National Park (Central Apennines, Italy), the only area where the Vulnerable (*sensu* IUCN) Apennine chamois *Rupicapra pyrenaica ornata* survived up to the 1980s of the last Century, this *taxon* has suffered a 30% decline from the 2000s on (2005: *c.* 650 individuals, 2010: *c.* 450 individuals), whereas red deer (*Cervus elaphus*, reintroduced in 1972–1987: 81 individuals) have greatly increased (2010: > 2500 individuals). In a study area within the historic core range of chamois (upper Val di Rose), in 2010–2011, we found out: (1) a great space (> 75%) and diet (> 90%) overlap between deer and chamois; (2) a significant increase of unpalatable plant species and a decreasing trend of the nutritious, most grazed species by chamois, in respect to when deer were absent; (3) irrespective from vegetation type, a significantly reduced bite rate of adult female chamois in patches used also by deer, compared with areas without deer (Lovari et al. 2014).

Our results have suggested a negative effect of red deer on the availability of nutritious plant species in summer–autumn, because of grazing and physical damage to the grassland caused by trampling. Within the same study area, we have also assessed sexual differences in the foraging behaviour of adult chamois (Ferretti et al. 2014). In particular, we observed that, although both sexes used preferentially nutritious food patches, females showed a lower feeding intensity (indexed through the bite rate) and a greater step rate than males. This result suggests that females prioritise a fine-scale selection of vegetation and, in turn, are expected to be more vulnerable than males to the negative effects of resource depletion. Environmental conditions and access to high -quality forage in the warm season influence the winter survival of offspring of mountain ungulates. Our results have indicated that interspecific overlap in resource use with an increasing, reintroduced population can threaten rare *taxa* such as the Apennine chamois.

Species, which have coevolved, have learned to avoid competition through resource partitioning. Nonetheless, human-induced alteration of plant/animal communities can enhance the occurrence of competitive interactions. As remarked earlier, amongst herbivores, access to high-quality forage in the warm months, *i.e*. during nursing and weaning, influences growth and survival of offspring. In turn, resource exploitation by a reintroduced, superior competitor can be expected to affect offspring survival of the inferior one, by decreasing foraging efficiency and diet quality of mothers and young. Thus, following the preceding study, we concentrated our attention on 3 study areas (*A/B/C*), differing in deer densities (great/intermediate/extremely low), and nutritional quality of pasture. In particular, areas *A-B* ('poor' areas) showed a reduced availability of nutritious forage, hence a lower diet quality for female chamois and kids, whereas area *C* (a 'rich' area) had a much greater availability of nutritious forage (Ferretti et al. 2015). We assessed the negative effects of reintroduced red deer on Alpine grassland, on foraging behaviour of female Apennine chamois (July–October 2012–2013) and on winter survival of chamois kids (Ferretti et al. 2015). Patch size of bare soil was directly associated to local deer density and, in areas with deer, it increased throughout the summer and the autumn months. Between summer and autumn, the volume of nutritious plants (i.e., forbs) in the diet of female chamois decreased and did it faster in the areas with deer (*A* and *B*) than in area *C*, where deer were near-absent. Thus, in the poor areas, pasture quality had been reduced by the presence of an herbivore competitor (the red deer), although other factors may have also played a role (Lovari et al. 2014; Ferretti et al. 2015). Feeding intensity (indexed through bite rate) of female chamois was significantly lower and their food searching (assessed by step rate) was greater in the areas with deer. Kids showed a significantly greater winter mortality, with a smaller proportion of younger individuals in the areas with deer than in area *C.* Unpredictable consequences can follow interspecific interactions within restored animal communities, especially in human-altered ecosystems, with an increase of the potential for competitive interactions.

We also wished to look at the physiologic, behavioural and demographic effects of resource depletion. In fact, access to high-quality forage during nursing and weaning is crucial for reproductive success to mountain ungulates, as lactation determines heavy energetic and physiological costs to mothers, while influencing early growth and survival of offspring. Thus, we compared the effects of pasture quality on suckling behaviour and winter survival of chamois kids, in three areas of different forage quality (Scornavacca et al. 2016). In the poor areas, we could assess a significantly (1) lower suckling success of chamois kids (number of suckling bouts/number of suck attempts); (2) lower frequency of suckling bouts (n. suckling bouts/kid/h); (3) lower suckling intensity (suck duration/kid/h) in respect to the rich area. On the contrary, frequencies of suckling rejections and those of suckling attempts (n. events/kid/h) were the lowest in the rich area. The winter survival of chamois kids was c. 2 times greater in the rich area (45%) than in the poor areas (20–26%). In the poor areas, resource scarcity induced adult female chamois to decrease maternal cares, ultimately affecting population dynamics through kid winter mortality. There are two alternative ways by which competitive interactions could vary in response to different levels of food abundance. Aggression should be greater when resource availability is lower, to access food. Alternatively, energy allocated to aggressive interactions may increase when the available spectrum of food resources becomes wider, in turn allowing a greater selection. We compared grouping, aggressive and vigilance behaviour, as well as relevant endocrine correlates, across our three study areas (Fattorini et al. *in press*-a).

In the richer area, we recorded (*i*) the largest group size/greatest proportion of young individuals in groups; (*ii*) the lowest rate/intensity of aggression between individuals, at feeding; (*iii*) the lowest duration of vigilance and proportion of "costly" vigilance, *i.e*. without chewing grass; (*iv*) the lowest levels of testosterone and cortisol metabolites, suggesting a lower endogenous aggressiveness/stress response. Food depletion appears to play a role in increasing aggression between feeding individuals, with cascading effects on group phenology, vigilance and stress. Furthermore, also intrinsic and environmental stressors, such as age and seasonality, can influence social behaviour and endocrine levels in gregarious foragers, but little is known about how season and age affect both behaviour and physiological responses. We evaluated seasonal/age variations of aggression and vigilance, and seasonal/age variations of endocrine levels (faecal cortisol and testosterone metabolites, Fattorini et al. *in press*-b). For our study, we selected a period of decreasing resource abundance and maternal care from July to October, a key period for nursing, weaning and early growth of offspring. Aggression rate, vigilance and cortisol levels decreased all throughout, while aggression intensity showed the reverse trend. Aggression peaked when chamois were on the most nutritious vegetation patches. Dominance increased with age, and prime-aged females (4-8 years old) showed higher cortisol and testosterone levels, and were involved in aggressive interactions more often than subadult or older females. On early summer, when nursing effort was the greatest, the selection of nutritious food patches led to frequent encounters between female chamois, increasing aggression rate, vigilance and endogenous stress response. The progressive decrease in food abundance from July to October triggered competition for food resources and increased intensity of aggression. Most likely, the energetic demands of lactation and offspring guarding, were key determinants of behavioral and physiological stress in female chamois. Our results have suggested a multi-factorial compromise between reproductive state and stress levels, in this group-living species.

Finally, weather variations have the potential to influence species interactions, although effects on competitive interactions between species are poorly known. Both weather and competition can influence foraging behaviour and survival of herbivores during nursing/weaning, a critical period in the herbivore life cycle. We assessed the combined effects of weather and competition with red deer on the feeding behaviour of adult female Apennine chamois in summer, as well as on winter survival of chamois kids (Ferretti et al. 2018). High temperatures and low rainfalls during the growing season of vegetation had a negative effect on bite rate. The effects of weather appeared greater in forb patches, with cold-adapted nutritious plants important to chamois, than in graminoid ones. Our results have shown that exceedingly warm weather conditions and competition with deer had additive, negative roles on the foraging behaviour and survival of chamois (Ferretti et al. 2018). Higher temperatures are likely to negatively influence distribution, growth and/or nutritional quality of plants, while competition would reduce pasture quality and availability through resource depletion. Both factors should limit food/energy intake rates on the warm months, reducing survival of the young in winter. Thus, interspecific competition can be an important additive factor to the effects of weather changes on behaviour and demography and it can act as a “catalyst” to accelerate the negative effects of these changes on important food resources, in turn on distribution and population size of mountain ungulates.

These effects can be particularly undesirable when the superior competitor is an abundant, ecologically competitive species, while the inferior one is a threatened taxon, which may suggest caution before operating local reintroductions.

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SPOTLIGHTS

First confirmation on the occurrence of threatened Tibetan Argali in Gangotri National Park, Uttarakhand, India

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Argali *Ovis ammon*, the largest wild sheep of the world, has undergone a significant decline in population numbers (Harris & Reading 2008) and it is currently considered Near Threatened by the IUCN red list. In India, Argali is known to occur in the Trans-Himalayan habitats in Ladakh (Fox et al. 1991) and, rarely, in Lahual and Spiti and Sikkim (Chanchani et al. 2010, Harris & Reading 2008, Fox & Johnsingh 1997) (Fig.1A). Here we report the first occurrence of Tibetan argali *Ovis ammon* in the Trans-Himalayan habitats of Nelang valley in Gangotri National Park (GNP), Uttarakhand State, India (Fig. 1B-C).

The northern limits of Nelang valley form the international border with the Tibetan region of China. The area is characterized by alpine scrub vegetation comprising *Eurotia* sp. *Caragana* sp. *Lonicera* sp. and *Rhamnus* sp.

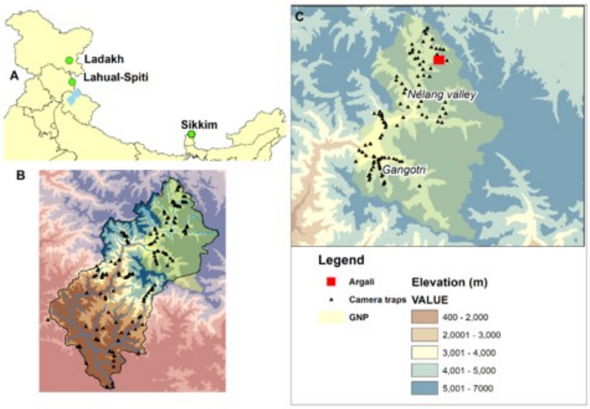

Figure 1: (A) Indian Himalayan Region with Bhagirathi basin (highlighted in blue) and previous location of Argali reports. (B) Bhagirathi basin, Gangotri National Park (GNP) and camera trap locations. (C) Location where Argali was photo-captured in Nelang valley of GNP by camera traps.

Argali was photo-captured (Fig. 2) by two camera traps (deployed at two different sites) on four occasions in the month of April and May of 2017. At one site, photo-captures occurred on April 26 (4 individuals), May 4 (4 individuals) and May 6 (1 individual). At the other site (adjacent grid) in the same valley, 10 individuals (8 sub adult males and 2 females) were photo-captured on the 7^{th} of May.

Figure 2: Threatened argali was photo-captured twice in Nelang valley, Trans-Himalaya landscape of Gangotri National Park, Uttarakhand.

The Gangotri NP was established in 1989, for conservation of habitats of blue sheep. The Park has a distinction of being the only National Park in India encompassing continuous zone of both the Greater and Trans-Himalayan regions. Very few research studies or surveys have been conducted in the Trans-Himalayan landscape of Uttarakhand (Nelang valley). The Gangotri NP was taken up as one of the intensive monitoring sites for the long-term monitoring project: “Assessment and Monitoring of Climate Change Effects on Wildlife Species and Ecosystems for Developing Adaptation and Mitigation Strategies in the Indian Himalayan Region” that has been initiated under the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) Programme funded by the Department of Science and Technology, Government of India. The surveys which started in October 2015 have so far led to the discovery of four new distribution records including Argali, Sand fox *Vulpes ferrilata,* Woolly hare *Lepus oiostolus* and Eurasian Lynx *Lynx lynx*. The Park was founded as an area of conservation significance for the vulnerable snow leopard *Panthera uncia*, the endangered Himalayan brown bear *Ursus arctos isabellinus* and the endangered musk deer *Moschus* spp.

In India, survival of Argali is threatened by livestock grazing because of competition, displacement, possible disease transmission and habitat loss. The distribution range of the Tibetan argali comprises the Tibetan Plateau and its surrounding mountains, covering about 2.5 million km^2 (Shackleton 1997). Despite the vast distribution range, Argali populations are highly fragmented throughout (Fox et al. 1991, Schaller 1998). The only stronghold of argali population in India is Ladakh, where it is mostly limited to the eastern areas bordering China (Fox et al. 1991), though its exact range is unknown. Ladakh is believed to have 10,988 km^2 of potential habitat for argali (Chundawat & Qureshi 1999) but the species is only present in isolated parts in this area (Bhatnagar & Wangchuk 2001).

Our discovery opens new opportunities for the conservation of this species in India, as Gangotri NP is a Protected Area that can favour survival of this species. Nelang valley, where argali was photographed, has similar habitat types and species composition as Ladakh, where argali already occurs. Nonetheless, despite being a National Park, livestock grazing during summer and presence of feral dog populations can represent major hurdles to Argali conservation. Studies on the interaction between livestock and argali have shown that livestock grazing not only deplete resources but also physically displaces argali from pasturelands (Namgail et al. 2007). We thus recommend creating inviolate areas for this species and removal of dogs from the valley. Construction and maintenance of border roads for the paramilitary forces is another challenge for the conservation of threatened species in the area. Argali are extremely sensitive to human disturbance and grazing pressures (Harris & Bedunah 2001, Maroney 2005, Namgail et al. 2007), thus the only opportunity for their survival depends upon the creation and maintenance of intact, disturbance-free areas. We also believe the current information on distribution of this species might underestimate the actual range of occurrence. Kumar et al. (2017) recently proposed recognition of the Trans-Himalayan biogeographic zone in Himachal Pradesh and Uttarakhand States (Fig. 3).

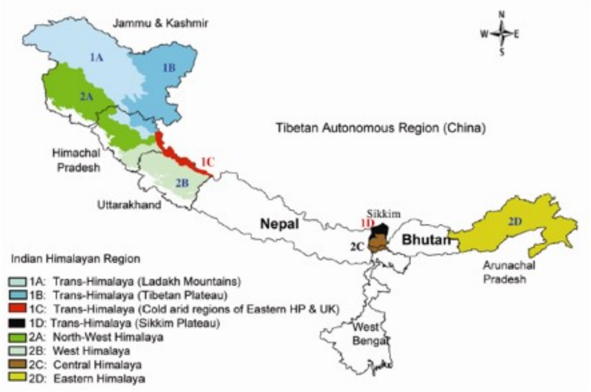

Figure 3: Map showing the proposed areas under the new Trans-Himalayan Biogeographic Province (1C: Tran-Himalaya – in red) (source: Kumar et al. 2017).

There is a need for conducting intensive surveys in these Trans-Himalayan regions to understand the distribution and status of trans-Himalayan mountain ungulates such as argali, blue sheep and other wildlife species, so that they could be monitored for long-term conservation and management.

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Rare sighting of Tibetan Argali in the Spiti Valley, Himachal Pradesh

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Argali *Ovis ammon*, the largest extant species of wild sheep, live over a large geographic range in the high mountains of Central Asia. Nonetheless, they are separated into rather disjunct populations, of which some are morphologically independent. Wilson & Reader (2005) and Fedosenko & Blank (2005) identify nine subspecies, *O. a. ammon*, *O. a. collium*, *O. a. comosa* (= *jubata*), *O. a. darwini*, *O. a. hodgsoni*, *O. a. karelini*, *O. a. nigrimontana*, *O. a. polii*, and *O. a. severtzovi*. Geist (1991) recognized all of these except *collium* and *severtzovi*, which he argues are sub-species of Urial *Ovis orientalis*.

Furthermore, India solely has small populations of the sub-species Tibetan Argali *O. a. hodgsoni* (hereafter referred to as Argali), which is restricted to the eastern plateau of Ladakh and northern Sikkim, adjacent to Tibet (Fox and Johnsingh 1997, Bhatnagar 2003, Ul-Haq 2003, Namgail et al. 2004). There are anecdotal reports of them being spotted occasionally in Spiti valley (near eastern Ladakh), Upper Himachal Pradesh, however evidence is lacking (Pandey 2002). Around 200 Argali were said to roam Ladakh by Fox & Johnsingh (1997). Namgail (2004) put their numbers to be slightly higher than 200, sighting 127 individuals in the near 500km^2 Gya-Miru Wildlife Sanctuary and the additional near 120-140 Argali recorded in unpublished reports from other areas in Ladakh. Argali still remain very rare in Sikkim according to Sharma and Lachungpa (2003). With decreasing population trends of this already thin population of Argalis in India, mainly due to habitat loss and competition with livestock (Namgail et al. 2007), this globally near threatened species can be considered nothing less than endangered across its Indian range. In fact, it is provided the highest protection status under the Indian Wildlife Protection Act (Schedule I) (Anonymous 2002).

With this background, we report sightings two individuals of Argali (Fig. 1) near the Gete Village (32^o 18' 22.34'' N, 78^o 01' 58.02'' E, 4467m) of Spiti Valley (Fig. 2) on 30th May 2017. Both individuals were adult females (characterised by their thinner horns in comparison to the more roundish, thicker and corkscrew horns of males). They were spotted grazing with a group of ca. 10 Dzos (cow-yak hybrids) and cows. Nearby there was a herd of c.120 free-ranging yaks as well. Anecdotally, this area can be characterized as an undulating dry alpine meadow (Schweinfurth 1957). This area's geography hence is in compliance with Argali habitat preference, which primarily includes gently sloped steppe valleys and alpine grasslands (Schaller 1998).

Figure 1: Image of the two female Argali spotted near Gete village in Spiti Valley. The rufous-brown ting on their neck and back is symbolic of their summer coat. Also notice the relatively thin parallel horns that are characteristic of the females.

Upon conversation with ca. 25 local herders and villagers, living in Gete, Tashigang (32° 17' 42.37'' N, 78° 03' 26.23'' E, 4413 m) and Kibber (32° 20' 00.18'' N, 78° 00' 39.56'' E, 4158m) villages (all three villages are the closest settlements from the area the Argali were spotted), it was confirmed that the female pair, locally known by the name 'Nyanmo' had been first spotted around August 2016 near grazing yak herds in the same region. Periodically, as these villagers would take turns to check on their grazing yaks, they would also spot the two Argali sometimes. This suggests that the Argali perhaps reached this area, nearly a year ago and in fact spent the entire winter in this region of the Spiti valley. Pandey (2002) and some locals suggest that few Argali come into Spiti valley from the adjoining Changthang region of eastern Ladakh via the Parang La pass (32° 27' 0''N, 78° 3' 0''E, 5744m), occasionally along with sheep and goats.

Though, no resident population of the Tibetan Argali have been recorded with the Himachal Pradesh territories, this general region(Upper Spiti Landscape) merits thorough investigation for the same.

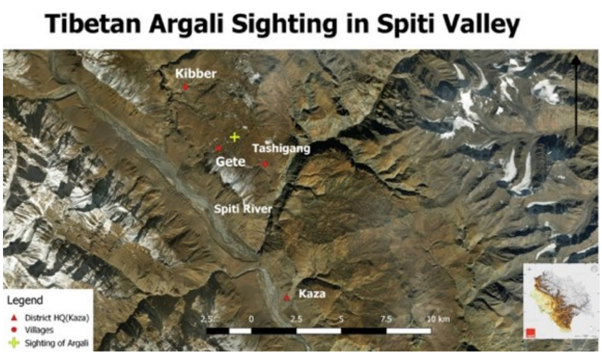

Figure 2: Map displaying the location of the two Argalis. Notice their proximity to the villages of Gete and Tashigang in the Upper Spiti Landscape. Kibber is perhaps the largest village in the region and most of the livestock that the Argalis were feeding near, belong to residents from Kibber.

Perhaps with a focus in the winters, as Tibetan Argali are known to migrate(mostly vertically) between their summer and wintering grounds (Chundawat 1992). It would be of merit to monitor the seasonal movements of these two female Argali to confirm if in fact they are over wintering in Spiti. If this is true, perhaps recolonization and persistence in Spiti valley of Argali is possible.

Studies have shown that most livestock herds in the Spiti valley are overstocked, which is associated with overgrazing and pasture degradation (Prins 1989; Mishra et al. 2001). Forage competition with livestock and the collateral effects of pastoralism have presumably caused local extinctions of at least four wild herbivores (including the Argali) from Spiti (Mishra et al. 2002). In fact, Namgail et al. (2007) have shown that due to livestock presence, Argali get displaced from their favoured habitat to less favourable locations. Considering this scenario, this sighting of two Argali gives up a platform to perhaps initiate their monitoring, whilst also considering undertaking a Himachal Pradesh wide survey in summer and winter to demarcate any extant yet unreported Argali population in these regions. This natural history data can then be the basis upon which potential conservation initiatives can be based, for this rare mountain ungulate of the Himalayas.

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