Livestock and urial interactions in Wakhan and the risk of disease propagation between them

A progress report

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Broader scopes of the project

Horizontal inter-species transmission is a central mechanism in the emergence of diseases in wild-living populations. The probability for a pathogen to cross the species barrier from a 'source' to a 'receptor' species depends on the type of pathogen, on the susceptibility of the receptor and on the rate of efficient direct (from animal to animal) or indirect (via environmental contamination or vector transmission) contacts between the species. The contact rate between the source and the receptor is intimately linked to the relationship between these species and the likelihood of sharing the same habitat.

In mountainous areas, the abundance of domestic animals leads to forced cohabitation between them and their wild counterparts. The spillover of contagious diseases from domestic to wild-living ungulates has been largely reported during the last 25 years with sometimes detrimental effects at population level in rare wild ungulates. Domestic and wild-living ungulates are competitors for food, which results in pasture sharing and, thus, in the transmission of infectious agents, especially indirectly transmitted ones.

Afghanistan is a mountainous country that supported in the recent past large populations of free-living mountain ungulates. Yet, most of these populations have been destroyed or suffer serious habitat degradation and over-hunting. In Wakhan District, Badakhshan Province, Pamir and eastern Hindu Kush mountains still host populations of Marco Polo sheep (*Ovis ammon polii*), Himalayan ibex (*Capra sibirica*) and urial sheep (*Ovis orientalis*), yet they are under threat of disappearance due to uncontrolled hunting and competition with livestock for suitable habitat. Although in theory cross-species transmission of diseases between livestock and wild ungulates could operate in both ways, in Afghan Pamirs the risk of population collapse for wild ungulates seems to far overstep the anecdotic likelihood of livestock being impacted by a pathogen indigenous to wild ruminants. Indeed livestock in Afghan Pamirs are a renewable human resource, quickly replaced in the event of massive mortality such as affecting them during harsh winters, whereas wildlife currently suffers overutilization and competition for food resources, allowing only limited productivity. Any relevant contagious pathogen introduced into such pressurized population could have a quick disastrous impact. Therefore, within the proposed plan to protect remnant populations of wild ungulates in Afghan Pamirs, one may legitimately question whether

livestock pose a significant health risk to wild ungulates and especially to those, such as urial, sharing their grazing areas with livestock. The purposes of the present study are 1/ to ascertain the level of sympatric relationship between livestock and urial in the Hindu Kush mountains of Wakhan and, 2/ to evaluate the presence of infectious agents of potential threat to urials in the livestock population potentially in contact with urials.

Preliminary results of landscape use investigations

In April and May 2011 five teams from the WCS project in Wakhan associated with local rangers conducted a longitudinal west-to-east survey of urial sheep and Himalayan ibex in the southern slopes of the Hindu Kush mountain range, between Fitr vilalge at the entrance of the Wakhan corridor, and Sarhad-e Broghil village where the car track ends. The WCS veterinary team was asked to participate in this large-scale survey. In addition to documenting numbers and distribution of large wildlife species, the vets use the opportunity of this longitudinal large-scale investigation to record the presence of livestock in surveyed habitats. Livestock pose a risk of disease transmission to wild herbivores through direct contacts, and their presence in Wakhan is considered a risk factor to wild ungulates.

The present report offers a preliminary assessment on the existence of pastures shared by urials and livestock, and hence the risk of pathogen transmission through direct contacts between them.

The two ranger teams led by WCS vets traveled by car from Qila-e Panja to Fitr villages located at the entrance of the Wakhan corridor. Their surveys started on April 15th and ended on May 3rd. Each team had a pre-determined number of valleys and mountain ranges to investigate during this period of time.

The methodology of the survey has been described in greater details in another report (Zalmai Moheb *et al.*, 2012) and we provide here only a brief overview of it. Surveys were carried out on foot, starting every day in the early morning and ending at sunset (Plate 1). Valley slopes were thoroughly scanned with binoculars and spotting scope from vantage points. Observations of wild ungulates and livestock were recorded on standardized data sheets, including group size and composition, behavior, habitat and vegetation coverage, spotting location, and compass bearing combined with map plotting. The presence of livestock was assessed based on visual contacts, on the occurrence of fecal material or footprints, on the presence of occupied or unoccupied settlements, and according to interviews of local inhabitants.

The team led by Dr. Ali Madad "Rajabi" surveyed in Lower Wakhan Fitr and Wergund Payan valleys, part of Regijurm barren area, mountains between Paghish and Yamit villages, and mountains around Khandud, Yazuk, and Pak villages.

Plate 1. The ungulate survey team led by Dr. Ali Madad "Rajabi" at work in the Hindu Kush, April 2011, Wakhan District, Badakhshan Province, Afghanistan.

In Upper Wakhan this team surveyed Hindu Kush drainage valleys ending in Pikut, Sast, Kret, and Deghulaman villages, and mountains between Sast and Qila-e Wust villages and around Nirs Payan Village. The team led by Dr. Hafizullah "Noori" surveyed in Lower Wakhan Ojdaragh, the mountains between Fitr and Qazideh villages, the valley ending at Shkhawar Village, the mountains around Wergund Payan and Wergund Bala villages, part of the barren area of Regijurm, and mountains around Pakuy Village. Then in Upper Wakhan it surveyed the west side of Pikut Village valley, mountains between Sast and Avgarch villages, the valleys of Kuzget and Kandkhun villages, and mountains around Korkut and Suikunj villages.

Cumulated observations of large wildlife species near livestock settlements totalized 403 animals, including 41 urial sheep, and 362 Himalayan ibexes (Plate 2). These observations were incorporated into the dataset of global survey results for the vet teams. Whereas Himalayan ibexes were present in 11 out of the 16 surveyed areas, urials were seen only in five of these localities (Table 1). Except in Shkhawar (Lakhsh), areas with urials also had ibexes.

Plate 2. A large herd of Himalayan ibexes on the southern slopes of the Hindu Kush mountain range, April 2011, Wakhan District, Badakhshan Province, Afghanistan.

However, the habitat used by ibexes and urials differed markedly. While ibexes used steep rocky habitat, in general difficult to access for livestock, urials used "smoother" hilly landscapes, and were often observed in rolling hills surrounding those relatively flat areas favored by livestock. This habitat preference renders urials potentially more exposed to direct contacts with livestock and their pathogens than ibexes. We therefore focused on the urial distribution to determine areas of highest risk of disease spill-over from livestock.

Except in Wergund Payan and Avgarch the only livestock species observed during the survey was the domestic yak, as also confirmed by interview reports. In general sheep and goat use this mountain range later in the season and another survey later in the year will have to be carried to assess the level of occupancy of the mountain range in summer Yak were seen in Ish Murg, Avgarch, Kuzget, Korkut and Suikunj areas. It is not known, as it is the case for Marco Polo sheep in Pamirs, whether domestic yak intermingle with urial sheep in pastures of the Hindu Kush. If it is the case it would render virtually all the Hindu Kush range, which is extensively used by yak in winter, an area of potential disease spillover to urials. In Wakhan, yaks are known to host contagious diseases potentially dangerous to wildlife such as foot-and-mouth disease. However,

domestic sheep and goats, as the closest domestic relatives to urials and ibexes, respectively, may pose a far greater risk of disease transmission to wild ungulates than free-ranging domestic yak.

Table 1. List of livestock settlements visited by WCS veterinary teams during the wild ungulate survey with information on livestock/wildlife concomitant presence. In bold the area with concomitant presence of sheep/goats and urial in April, Wakhan District, Badakhshan Province, Afghanistan.

Date	Settlement name	Evidence of livestock presence	Livestock in spring	Livestock in summer	Ibex observed	Urial observed
15/04/2011	Qazideh	Foot prints and feces	(Yak?)	Sheep, goats & cattle	29	2
15/04/2011	Fitr Valley (Wenkharaw)	Foot prints and feces	(Yak?)	Cattle	40	0
16/04/2011	Fitr Valley (Khan Sang)	Foot prints and feces	(Yak?)	Catlle	25	0
16/04/2011	Shkhawar (Lakhsh)	No	(Yak?)	Sheep, goats & cattle	0	7
17/04/2011	Shkhawar Valley	Foot prints and feces	(Yak?)	Cattle & yak	22	0
18/04/2011	**Wergund Payan (Sabzposh)**	**Sheep and goats present**	**Sheep & goats**	**Sheep, goats & cattle**	**82**	**27**
22/04/2011	Pagish Valley	Foot prints and feces	(Yak?)	Sheep, goats, cattle & yak	39	0
25/04/2011	Pakuy 2	Foot prints and feces	(Yak?)	Sheep, goats, cattle & yak	7	0
25/04/2011	Pakuy 1	Foot prints and feces	(Yak?)	Sheep, goats, cattle & yak	0	0
25/04/2011	Ish Murg	Yak present	Yak			
27/04/2011	Pikut Valley (new)	Foot prints and feces	(Yak?)	Sheep, goats, cattle & yak	37	4
27/04/2011	Pikut Valley (old)	Foot prints and feces	(Yak?)	Sheep, goats, cattle & yak	41	1
29/04/2011	Sast	Foot prints and feces	(Yak?)	Sheep, goats, cattle & yak	32	0
29/04/2011	Avgarch	Foot prints and feces	Sheep, goats, yak	Sheep, goats, cattle & yak	0	0
01/05/2011	Kuzget	Yak present	Yak	Sheep, goats, cattle & yak	8	0
04/05/2011	Suikunj	Foot prints and feces	(Yak?)	Sheep, goats, cattle & yak	0	0
04/05/2011	Korkut and Suikunj	Yak present	Yak	Sheep, goats, cattle & yak	0	0

Although in Pamirs sheep and goats come very rarely into contact with Marco Polo sheep, this situation seems to differ for urials in the Hindu Kush where domestic sheep and goats have been seen at relatively close distances from them (Stefan Michel, pers. comm.). We therefore considered the presence of domestic sheep in areas used by urials indicative of a high level of disease transmission risk.

Based on these assumptions, our observations and investigations support that Wergund Payan is an area of increase risk of close contact between shoats and urials and potentially an area of disease transmission between herbivores in April. Should we consider yak a health risk to urials, then the area of Pikut would also qualify as an area of spring disease risk.

Our approach is evidently constrained by several limitations. First the two teams surveyed only 30-40% of the urial spring habitat in Wakhan Valley and results of the three other teams have not been compiled in the present report. For example the area of Dehqankhana / Sarhad-e Boroghil in Upper Wakhan, not surveyed by the vets, hosts large numbers of livestock in winter and spring, including sheep, cohabiting with urials (Zalmai Moheb pers.comm.). Also, because urials are gregarious and highly mobile species, the fact that they were not observed during the survey in areas that hosted domestic sheep, such as in Avgarch area, does not mean that they never use the area in spring. Also there are reports of urials coming in winter and spring within a distance of less than half a kilometer from villages in Lower Wakhan Valley, a behavior that could expose them to a higher risk of disease transmission from livestock. Finally although the results of this preliminary assessment could probably be extrapolated to the range utilization situation in late autumn and winter, they say nothing about the risk of disease spill-over during summer, when almost all the Hindu Kush range hosts large numbers of livestock of different species, and the distribution of urials is unknown.

Preliminary results on serological investigations of livestock

Infectious diseases can leave serological tracks of their current or past presence. Testing blood samples of exposed individuals for the presence of specific markers may therefore tell a lot on the history of the presence of infectious agents in a range of species. We decided to use this method to evaluate the level of exposure of livestock in Wakhan Valley and the neighboring Hindu Kush range to a number of infectious agents[1].

[1]In summer 2011, 793 sheep and goats were blood-sampled in Wakhan Valley and tested for the presence of antibodies against brucellosis and contagious caprine pleuropneumonia (CCPP) by the CVDRL, as part of a transboundary (with Tajikistan and Pakistan) collaborative study sponsored by AAAS. Willy Schauwers supervised the serological work at CVDRL and reported for brucellosis a prevalence of 0/793 (CI95%, 0.0-0.5) with RBT, and 1/395 (CI95%, 0.0-1.4) with cELISA, and for CCPP in goats a prevalence of 3/375 (CI95%, 0.2-2.3) with latex agglutination test (LAT). Subsequently CIRAD, one of the reference laboratories for CCPP, tested 359 of the 375 samples,

We assumed that targeted infectious agents have a homogenous distribution across the largely intermingling sheep population of Wakhan. Thirteen locations were picked randomly among c.45 possible sampling locations in the area. We aimed to sample c. 250-400 animals from these 13 locations. This target sample size was selected in order to detect, with a probability of c. 95%, at least one positive individual, assuming a minimal prevalence rate of 1% in the sampled population.

In October 2012 we collected blood samples from 309 healthy adult sheep across Wakhan Valley (between the villages of Shkhawr Bala in the west and of Dehqan khana/Sarhad-e Broghil in the east) (Tab. 2) to evaluate the exposure level to brucellosis, PPR and Q fever in the area.

Samples were collected from animals gathered in corrals or barns, and sometimes, in open fields with the help of community herders. For each animal we took 5-8 ml of blood in vacutainer vials (Terumo, USA) via jugular vein puncture. Blood samples were kept between 15-22°C for 3-4 hours to allow for clotting. We extracted two to three ml of serum with a micropipette or plastic 'one-use' pipette after clotting and centrifugation for 5-10 minutes (Manual centrifuge, (Hettich, Germany). Sera were transferred into labeled cryovials (date, location, access number) and stored in liquid nitrogen dry shippers (at -196°C) in Wakhan Valley. All samples were eventually transferred in the liquid nitrogen container and shipped by car to WCS office in Kabul where they were stored in a freezer (-20°C) for 1.5 month before being sent to CVDRL for serological analyses. Serological kits were provided to CVDRL at the same occasion.

including the three positive samples with LAT, with a more specific cELISA and found no positive samples, supporting clinical evidences that the three samples reacting with LAT were likely false positive.

Table 2. Location and number of adult sheep blood-sampled in Wakhan Valley, Badakhshan Province, Afghanistan, in October 2012.

Date	Settlement name	Number of sheep sampled	Number of males	Number of females
14/10/2012	Avgarch	82	18	64
10/10/2012	Dehqan Khana	25	7	18
07/10/2012	Digargund	14	1	13
10/10/2012	Kansir karkat	24	0	24
11/10/2012	Mulbar Deh Sarhad	9	0	9
11/10/2012	Pokor Deh Sarhad	18	3	15
13/10/2012	Sast	30	7	23
07/10/2012	Shkhawar Bala	10	3	7
07/10/2012	Shkhawar Payen	18	3	15
08/10/2012	Wergund Bala	25	5	20
08/10/2012	Wergund Payen	22	1	21
11/10/2012	Zargtilqa	13	2	11
11/10/2012	Zartgar	19	1	18

Conclusions

Preliminary investigation on the cohabitation of livestock and urials in the Hindu Kush have provided interesting indications and will be relayed by a GIS-based landscape-scale modeling exercise that should provide us with probabilities and preferred areas of interactions within the next two years.

Regarding infectious disease investigations in livestock, pending results from samples collected in Wakhan should add to previous investigations and allow a better understanding of the presence of endemic diseases in livestock of Wakhan and the risk they may pose to the valuable wildlife resource still present in the area.