Additional data on livestock health in Band-i-Amir

(Update to the report "A Field Mission of the Ecosystem Health Component to Band-e-Amir in May–June 2007")

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Cover photo: Drs Ali Madad Rajabi and Hafizullah Noori visit local shepherds in spring pastures. Band-i-Amir, June 2007.

All photographs: WCS Ecosystem Health Project Team

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INTRODUCTION

In Afghanistan the reduction of veterinary services and vaccination programs during the last twenty years combined with the effect of drought, overgrazing and civil strife have resulted in widespread occurrence of livestock disease outbreaks. Diseases such as Peste des Petits Ruminants (PPR), Foot and Mouth Disease (FMD), sheep pox, anthrax, and enterotoxaemia are endemic in the country and often occur as annual epizootics. PPR, anthrax and enterotoxaemia are remarkably effective at killing livestock whereas FMD and sheep pox have a direct effect on food security; they reduce milk production in dairy cows and yaks, decrease fertility and incapacitate breeding bulls and oxen. Although all these diseases are common in Afghanistan, it is not precisely documented to which extent they also affect livestock in Band-i-Amir a naturally created group of lakes in the province of Bamyian, and one of the few candidate areas in Afghanistan for the status of protected area. In addition, other diseases commonly found in sheep and goats in west Asia, such as brucellosis, Q fever, chlamydiophilosis, toxoplasmosis or blue tongue have rarely or never been recorded in Afghanistan because of the lack of epidemiological surveillance.

The assessment of health status of sheep and goats in Band-i-Amir is done with the goal to evaluate qualitatively the risk of disease transmission from livestock to wild herbivores occurring in the area. Horizontal inter-species transmission is a central mechanism in the emergence of diseases in wild-living populations (Ostherhaus, 2001; Richomme et al., 2006). 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 (Cleaveland et al., 2001; Woolhouse et al., 2001).

In mountainous areas, the abundance of summer grazing drives domestic animals to utilize them intensively and leads often to forced cohabitation with the autochthonous fauna. The spillover of contagious diseases from domestic to wild-living ungulates has been largely

reported during the last 25 years (Foreyt and Jessup, 1982; Frölich et al., 2002; Hudson et al., 2002) with sometimes detrimental effects at population level in rare wild ungulates (Callan et al., 1991; Dagleish et al., 2007). 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 (Habibi, 2003). Yet, most of them have been destroyed or suffer serious habitat degradation and over-hunting. Bamiyan province still hosts populations of Siberian ibex (*Capra sibirica*) and urials (*Ovis orientalis*) (Shank, 2008), yet these species are under threat of disappearance due to uncontrolled hunting and alleged competition with livestock for suitable habitat. Although in theory cross-species transmission of diseases between livestock and wild ungulates could create havoc in populations of wild herbivore, in Band-i-Amir the risk of population extinction due to overhunting seems to far overstep the anecdotic likelihood of livestock-born epidemics in the scant populations of wild ungulates still occurring in the area (Ostrowski et al., 2007). The purposes of the present report are 1/ to compile the pending results of our scientific investigations related to health issues in the sympatric populations of domestic sheep (*Ovis aries*) and goats (*Capra hircus*) in Band-i-Amir, in Afghanistan, and 2/ to provide scientific foundation for the future development of policies aimed at reducing the risk of disease spillover from livestock to wild ungulates.

BACKGROUND

This document has been written as an addendum to our 2007 report (Ostrowski et al., 2007). To summarize our earlier investigations, between 27 May and 6 June 2007, we undertook a field mission in the northeast of Band-i-Amir. The survey main goal was to collect data on livestock health and possible interactions of livestock with wildlife. We reported that people living in Band-i-Amir are mostly sedentary farmers who live in small villages located around lakes. Only a minority of them is involved in herding and uses the surrounding mountains as seasonal pastures, potentially bringing their livestock into contact with wildlife. We interviewed 27 of them about their livestock. They herded 876 sheep, 235 goats, 167 cattle heads, 18 horses and 90 donkeys. Livestock suffered from disorders including diarrhea, abscesses, skin problems, lameness, coughing, heavy tick burdens and genital myiasis (a lesion caused by dipterous fly larvae feeding on the host's necrotic or living tissues). We sampled several ectoparasite specimens in an attempt to identify them. Shepherds also reported clinical symptoms compatible with those observed in foot-and-mouth disease (FMD), contagious caprine pleuropneumonia, and glanders, all diseases that affected their livestock in the recent past. We collected 228 blood samples on sheep and goats and forwarded them to the Central Veterinary Laboratory (CVL) in Kabul for FMD, Peste des Petits Ruminants and brucellosis serological testing.. Eventually we investigated the use of traditional medicine by herders and particularly plants. Fifteen (55.5%) of the interviewed shepherds in 2007 (Ostrowski et al., 2007) used herbalism, a traditional folk medicine practice based on the use of plants, to treat livestock disorders.

Typically they prepare leaf decoctions of selected local plants and administer them orally to sick animals. A great variety of plant species is used in local herbalism but four species predominate for veterinary usage: *buzbash*, *joli gao, pasha kushak* and *gandabaghal* (all names in Dari). They seem to be mainly used for digestive tract impairments, such as bloating, colic, flatulence and diarrhea. Yet, as often reported in studies of folk medicine, there was great inconsistency among respondents about the diseases and symptoms these plants are supposed to treat. We sampled a specimen of the four plant species for identification. The present report provides results of serological investigations, and clarifies the identity of collected ectoparasites and medicinal plants.

MATERIALS AND METHODS

Sample collections

Randomly selected livestock in grazing areas were blood-sampled in the field (Plate 1) or the evening, upon their return to the night corrals of mountain settlements (see sampling locations in Ostrowski et al., 2007). Between 5 and 10 ml of blood were drawn aseptically in plain vacutainers (Terrumo®, USA) via jugular venipucture, allowed to clot at 15–22°C for 3–4 hours and centrifuged for 4–5 minutes with a manual centrifuge (Hettich, Germany). Sera (c. 1.5 ml) were pipetted and stored in cryovials at –196°C in liquid nitrogen dry shippers (Taylor–Wharton, USA). The dry shippers were moved by car to Kabul at the end of the mission where samples were stored at –20°C until processed.

We collected tick specimens in 2007 and immediately immersed them in ethanol 70%. We shipped them to the reference laboratory in the original ethanol solution. Also, in May 2008 we provided to Mr Muhammad Ayub Alavai, WCS conservation specialist for Hazarajat, vials with 70% ethanol and asked him to coordinate with local shepherds the collection of larvae and adult flies responsible of vulvar myiasis in sheep. Four specimens of adult flies and 11 larvae at various stages of maturation were sampled and forwarded to us in summer 2008.

Plant specimens reportedly used in local herbalism were located in the field with the help of knowledgeable herders. Specimens with flowers and roots were carefully collected by Mr Muhammad Ayub Alavai and stored flat between absorbent papers and ventilators in a standard plant press before being shipped to WCS Kabul.

Serological investigations

In May and June 2007 we collected 228 blood samples on sheep and goats in Band-i-Amir and forwarded them to the Central Veterinary Laboratory in Kabul (CVLK) for serological testing against Foot and Mouth Disease, Peste des Petits Ruminants, and brucellosis. These three major diseases may result in economic losses and pose a threat to wild herbivores as well. As of January 2009 CVLK tested 146 of these samples but only against brucellosis. In 2007 and 2008 we purchased and provided to CVLK serological kits to evaluate exposure level of sampled livestock to *Coxiella burnetti*, *Chlamydia abortus*, *Toxoplasma gondii* and Blue Tongue virus (BTV), respectively the agents of Q fever, chlamydiophilosis,

toxoplasmosis and BTV infection. 104 samples were tested in duplicates for Q fever and BTV and 39 for chlamydiophilosis and toxoplasmosis.

Toxoplasmosis, chlamydiophilosis and Q fever — Sera were analyzed with semi-quantitative competitive enzyme-linked immunosorbent assays (ELISA) (CHEKIT® Tests, Idexx laboratories, USA). All laboratory work at CVL–Kabul was supervised by Drs S. Yingst and M. Habib. Earlier we asked the Central Institute for Animal Disease Control of Lelystad, The Netherlands (CIDC–Lelystad), to re-test 55 samples collected in Wakhan/Pamir for Q fever (CHEKIT® Tests, Idexx laboratories, USA) under ISO/IEC 17025 research standards. Qualitative results of both laboratories matched rigorously (Ostrowski et al., 2009).

Brucellosis — Serological tests for brucellosis suffer lack of specificity (false positive results) and cannot always distinguish reactions due to *B. melitensis* from cross-reactions to other bacteria, particularly *Yersinia enterocolitica* O:9. One way to discriminate false positive from true positive reactions is to apply different tests with different specificity levels (Godfroid, 2002). We used the buffered *Brucella* antigen tests or Rose Bengal (RB) plate agglutination tests (Bengatest®, Synbiotics, France) as primary investigation. Then, all doubtful or positive samples to RB test were re-analyzed with complement fixation test (in-house procedure) and a competitive ELISA (Prionics AG, Switzerland). RB screening was either performed directly by us or by the CVL–Kabul. Confirmation tests were all done at the CIDC–Lelystad.

Bluetongue — Sera were tested for the presence of antibodies against the VP7 protein of BTV with competitive ELISA following manufacturer recommendations and provided standards (Pourquier® ELISA bluetongue competition, Institut Pourquier, France). According to producers, these assays were not cross-reacting with closely related Epizootic Hemorrhagic Disease (EHD) orbiviruses. Because of the relatively high prevalence detected at CVL–Kabul, 10 positive samples were re-checked by CIDC–Lelystad (ID–VET bluetongue competitive ELISA, ID–VET, France; ISO/IEC 17025 accredited research). Results were matching at 100%.

Parasite identification

We sent collected ticks to the US Naval Military Research Unit 3 (NAMRU-3) in Cairo, Egypt, where they were identified by Dr H. Waseef. We shipped specimens of flies to the Natural History Museum in London, UK, where Dr N. Wyatt identified them.

Plant identification

We determined the scientific names of *buzbash* and *joli gao* according to the results of a recent ethno-botanical study carried out in the area (Ali, 2006). In late summer 2008, Dr D. Bedunah, a range ecologist with admittedly incomplete knowledge of Afghan flora, kindly offered to examine *gandabaghal* and *pasha kushak*. He identified *gandabaghal* to species level by discriminating the supposed exhaustive list of plant species of Band-i-Amir (Dieterle, 1973). *Pasha kushak* was only identified to family level.

Plate 1. Drs. Ali Madad Rajabi (bottom left) and Hafizullah Noori (center) collect blood from the jugular vein of an adult sheep, Band-i-Amir, May 2007.

RESULTS AND DISCUSSION

Serological screenings

Q fever — It is a highly contagious zoonotic disease caused by the intracellular pathogen *Coxiella burnetii*. The organism is an obligate intracellular parasite and is currently classified in the Coxiellaceae family and Legionellales order. Many domesticated and wild animals carry C. *burnetii*. Q fever has been found worldwide, in part because C. *burnetii* is extremely persistent in the environment and can be spread over long distances by the wind. In most cases the infection is asymptomatic; however infected domestic ruminants may present abortions near term, stillbirth, retained placenta, infertility, small and weak offspring and sometimes post-parturition complications. In sheep 5–50% of the flock may be affected. C. *burnetii* has also been isolated from wild animals including wild ruminants. Abortive effect in captive wild ruminants has frequently been suspected based on seroconversion events. In Band-i-Amir Pamir, 56.7% of sheep and goats tested positive to C. *burnetii* (Table 1), a significantly higher prevalence than in Wakhan/Pamir (i.e. 12%) (Ostrowski et al., 2009). **This infectious agent seems to be very common in livestock in Band-i-Amir.** Although it is presumably common in Afghanistan at large, these results constitute to our knowledge the second documented case of livestock exposure to C. *burnetii* in Afghanistan after the one we described in Wakhan/Pamir (Ostrowski et al., 2009).

Table 1. Prevalence (95% Confidence Interval) of antibodies to infectious agents in sera of domestic sheep and goats in Band-i-Amir, Bamiyan province, Afghanistan, May–June 2007.

Agent	Sheep P/T[a]	CI[b]	Goat P/T	CI
Toxoplasma gondii	1/34	(0.07 – 15.3)	/5	–
Chlamydiophila abortus	1/34	(0.07 – 15.3)	/5	–
Coxiella burnetii	51/85	(48.8 – 70.5)	8/19	(20.2 – 66.5)
Brucella melitensis I abortus	0/100	(<3%)	0/46	(<6.5%)
Bluetongue virus	45/85	(41.8 – 63.9)	11/19	(33.5 – 79.7)

[a]P/T = number of positive reactors/number of samples tested. [b]CI = 95% Confidence Interval in %

Chlamydiophilosis — Chlamydiophilosis is here restricted to the infection by *Chlamydiophila abortus*, an obligate intracellular bacterium reported from most sheep-raising countries except Australia and New Zealand. *C. abortus* elementary bodies can remain infective in the environment for months if the temperature is freezing or near freezing. The agent is known to cause outbreaks of abortions in sheep and goats, and occasionally in wild ungulates such as deers and llamas. Pregnant ruminants shed large numbers of *C. abortus* in the placenta and uterine discharges when they abort or give birth. Sheep and goats can also be chronic carriers. Serological prevalence in sheep and goats in Band-i-Amir was low with only 2.5% of the tested animals positive to this infectious agent (Table 1). **Results suggest that C. abortus is relatively uncommon in Band-i-Amir, such as in Wakhan/Pamir.**

Toxoplasmosis — Toxoplasmosis is the result of infection by *Toxoplasma gondii*, an obligate intracellular protozoan parasite in the phylum Apicomplexa. It is found worldwide, in part because oocysts are highly resistant to environmental conditions and remain infectious for as long as 18 months in water or warm, moist soils. Yet, they do not survive well in arid, cool climates. Members of the Felidae are the definitive hosts. Most mammals and birds can serve as intermediate hosts and among domestic animals, infections are most common in cats, sheep and goats. In adult sheep and goats toxoplasmosis is usually asymptomatic; however, infection acquired during pregnancy can cause abortion, stillbirths or resorption of the fetus. Congenitally infected lambs have a high mortality rate. Clinical cases of toxoplasmosis in wild ungulates are rarely documented and presumably of rare occurrence. Only 2.5% of the tested sheep and goats were seropositive to *T. gondii* (Table 1). **This infectious agent therefore seems to be relatively uncommon in Band-i-Amir** in contrast to the relatively high prevalence of 14 % observed in livestock in Wakhan/Pamir (Ostrowski et al., 2009). Whether the difference in climatic conditions between the two areas explain in part the different prevalence rate is unknown and would require additional investigations and particularly a significantly larger sample size from Band-i-Amir. Although the parasite is presumably common in Afghanistan at large, these results constitute to our knowledge only the second serological evidence of livestock exposure to *T. gondii* in Afghanistan after the one we described in Wakhan/Pamir (Ostrowski et al., 2009).

Bluetongue — It is an insect-born viral disease of ruminants, transmitted by *Culicoides* sp. hematophagous midges. Direct transmission between animals is not possible and therefore geographical distribution of the disease is limited to areas where *Culicoides* vectors occur, roughly in terrestrial areas extending between latitudes N 40° and S 35°. Among domestic animals, clinical disease occurs most often in sheep, resulting in erosions and ulcers of the mucous membranes, dyspnea or lameness from muscle necrosis and inflammation of the coronary band of the foot. Some strains of virus can result in high mortality rates. But bluetongue infection can also be asymptomatic, presumably when it occurs in populations which have been in contact with the virus for long time. The virus belongs to the order Orbivirus and family Reoviridae and 24 serotypes have been identified worldwide. Bluetongue viruses (BTV) are closely related to the viruses of the epizootic hemorrhagic disease (EHD) which is one of the most important diseases of deers in North America. BTV can also cause severe diseases in wild ungulates, including the white-tailed deer (*Odocoileus virginianus*) and the desert bighorn sheep (*Ovis canadensis*). In Band-i-Amir, 53.8% of the sheep and goats tested positive to the VP7 protein of BTV (Table 1) a higher prevalence than in Pamirs, where 24.9% and 32% of the sheep and yak, respectively, were positive (Ostrowski et al., 2009). In the absence of known cross-reactivity with other viruses (e.g. rotavirus), **it seems that BTV is very common in livestock in Band-i-Amir**. *Culicoides*, the only known vectors of BTV, have colonized a great variety of habitats from sea level to a maximal altitude of 4100 m in Tibet, and although their presence in Band-i-Amir pastures (between 3100 and 3500 m asl on average) remains to be confirmed, these ubiquitous species are very likely to occur owing to the presence of water and warm weather conditions in summer.

Brucellosis — In sheep and goats, brucellosis is mainly caused by *Brucella melitensis*, a Gram-negative coccobacillus which is a facultative intracellular pathogen. Infection in sheep and goats can spill over into wild ruminants; *B. melitensis* infections have been reported in Alpine ibex (*Capra ibex*) in Italy and chamois (*Rupricapra rupricapra*) in the French Alps. However there is no evidence that these animals serve as reservoir hosts for domesticated sheep and goats. *B. melitensis* is very contagious to humans. In animals it is usually transmitted by contact with the placenta, fetus, fetal fluids and vaginal discharges from infected animals. The predominant symptoms in naturally infected sheep and goats are abortions, stillbirths and the birth of weak offspring. In wild chamois, this organism has been linked to orchitis, polyarthritis, blindness and neurological signs, but not abortion. Twelve sheep sera tested were doubtful or weak positive with RB test, but none of them were confirmed positive with ELISA and CF tests. **We indeed found no confirmed positive cases of brucellosis in the 146 animals tested**. Precise information is not available on the situation of brucellosis in Afghanistan. In neighboring Tajikistan a recent cross-sectional serological survey in central and south-eastern provinces, using a method similar to the one we employed in Afghan Pamirs, reported a prevalence ranging between 2.1% in cattle to 5.8% in sheep out of 13626 animals tested (Jackson et al., 2007). Considering the lack of specificity of serological tests for brucellosis these frequencies may constitute maximal values. Overall it seems that brucellosis is of relatively low prevalence in the regions we surveyed since 2006.

Plate 2. *Dermacentor marginatus* ticks infesting a goat. Inserts show a close-up of the ectoparasites, and the successive development stages, larval, unfed adult and engorged adult of this tick species, June 2007, Band-i-Amir, Afghanistan.

Ectoparasites infesting sheep and goats in Band-i-Amir

Two thirds of the 27 interviewed persons during the mission we carried out in May and June 2007 mentioned ectoparasites as a significant problem affecting their ruminant livestock in winter and early spring. At the end of spring —time of the survey— all interviewed people admitted that their sheep, goats and cows were currently infested with ectoparasites. The sheep ked (*Melophagus ovinus*) is one of the most widely distributed external parasites of sheep. We found adult specimens on several animals. As the sheep ked sucks blood on the same spot for a prolonged time, an infestation leads not only to irritations with its consequences —loss of or damage to wool due to rubbing and biting—, but also to direct skin damage.

We also observed on several sheep macroscopic lesions evocative of infestation with *Psoroptes ovis* (psoroptic mange or sheep scab) or *Psorergates ovis* (psorergatic mange) but microscopic examinations of skin scrapings were inconclusive. Mange causes large, scaly lesions developing almost exclusively on the wooly parts of the body, with intense pruritus manifesting by biting and scratching.

Table 2. Data on tick specimens collected in domestic sheep and goats in Band-i-Amir, Bamiyan province, Afghanistan.

Locality	Location (UTM)	Altitude (m)	Host species	Tick species	Qty/sex[1]	Date collection
Kuprok Yakhak	42S 343030 3852692	3343	Sheep	*Dermacentor marginatus*	3 F & 1 M	30/May/07
Kuprok Dandaw	42S 346485 3863545	3309	Goat	*Dermacentor marginatus*	1 F & 6 M	29/May/07
			Goat	*Rhipicephalus microplus*	1 F	
Kuprok Dandaw	42S 346485 3863545	3309	Sheep	*Dermacentor marginatus*	8 M	29/May/07
Abqul Bala Daragak	42S 342491 3863306	3149	Goat	*Dermacentor marginatus*	9 F	01/June/07
Abqul Bala Daragak	42S 342491 3863306	3149	Sheep	*Dermacentor marginatus*	4 F	01/June/07

[1]F=female; M=male

Sheep and goats were also often heavily infested with ticks typically located on their neck, face and ears. Specimens collected on sheep and goats belonged to two species: *Dermacentor marginatus* (Plate 2) and *Rhipicephalus* (*Boophilus*) *microplus*. *D. marginatus* (Ixodida: family Ixodidae) Ixodidae tick (or hard tick) as opposed to Argasidae ticks, such as found in livestock in Wakhan, Badakhshan Province, was the most frequently encountered in sheep and goats (Table 2). In sheep the presence of this tick was often associated with a high prevalence of skin abscesses that could have resulted from bacterial surinfection (e.g. with *Staphylococcus* spp.) following heavy tick infestation. *R. microplus* (Ixodida: family Ixodidae), is considered to be the most important tick parasite of livestock in the world. It occurs worldwide in subtropical and tropical regions. It has been eradicated from the U.S.A., but can be sometimes found in Texas or California, in a buffer quarantine zone along the Mexican border. It can be found in almost any livestock species and in a variety of wild animals including deers and wild sheep. *R. microplus* can transmit babesiosis caused by the protozoal parasites *Babesia bigemina* and *B. ovis* and anaplasmosis, caused by *Anaplasma marginale*. *R. microplus* is a one-host tick; all stages are spent on one animal.

Life cycle (egg/larval/nympheal/adult stages) can be completed in 3–4 weeks; this characteristic can result in a heavy tick burden on animals. In Band-i-Amir, we found this species as a single adult female specimen on only one goat. Because we did not try to estimate tick species prevalence in livestock herds and our sample size was small (20 individuals in three different flocks) it is not possible to conclude on the frequency of occurrence of this tick species in the surveyed area. We did not investigate the presence of *Babesia* or *Anaplasma ovis* in livestock in the area, but their occurrence would be consistent with the known distribution and descriptive epidemiology of these pathogens. Herders also reported the presence of lice-like ectoparasites in their herds but they were unable to show us any, suggesting that lice infestation might be of low prevalence or of seasonal occurrence.

Plate 3. A lesion of vulvar myiasis in a ewe caused by *Wohlfartia magnifica* (Diptera: family Sarcophagidae). Inserts show close up of maggots responsible of the myiasis and a specimen of the adult fly, June 2007, Band-i-Amir, Afghanistan.

Concerning flies responsible of myiasis, two species were identified: *Wohlfahrtia magnifica* (Diptera: family Sarcophagidae) and *Lucilia sericata* (Diptera: family Calliphoridae). The identification of *W. magnifica* was based on seven larvae of different development stages sampled in two ewes with vulvar myiasis (Plate 3). This fly species is widely distributed in the Palaearctic region, its range extending from central and southern Europe and north-west Africa eastwards through the Middle East and Central Asia to northern China and eastern Russia. However it does not appear to have been recorded previously from Afghanistan, probably because of the lack of surveillance, though it is known from surrounding countries such as Iran, Tajikistan, Uzbekistan and Turkmenistan. The larvae are obligate parasites of warm-blooded animals, being a pest of significant veterinary importance in areas where it occurs, especially by causing wound myiasis in farm livestock. In sheep the genital areas are typically one of the worst affected by these larvae. The adult flies are grayish with a striking pattern of bold black spots on the abdomen (Plate 3). In Band-i-Amir genital myiasis are common in sheep shortly after lambing but also sometimes

in summer. Shepherds treat their infested ewes with insecticide sprays and by cleaning necrotic wounds of the vulva with water and soap.

Another species, *Lucilia sericata* was also identified from three adult specimens collected on two ewes with vulvar myiasis. Yet, we believe that this species was not immediately involved in the lesion observed in these animals. *Lucilia sericata* or the common green bottle fly is a very widely distributed species of temperate regions. It is native to the northern hemisphere but has also been accidentally introduced to some temperate areas of the southern hemisphere such as South Africa and Australia. It is 10–15 mm long, and has metallic blue-green or golden coloration (Plate 4). It has black bristle-like hair and three cross-grooves on the thorax. The wings are clear with light brown veins, and the legs and antennae are black. Unlike *W. magnifica* it is not an obligate parasite, as it naturally breeds in carrion, but it is also capable of causing myiasis through a condition called "strike". This condition especially affects sheep, though it also occurs in long-haired breeds of other domestic animals. The condition is caused by bacterial infection arising from soiled wool or hair, in which the flies lay eggs and the resulting maggots may then invade the skin. Large infestations can then result causing tissue damage which can be life-threatening to the host animal. Adult *L. sericata* are often seen around wounds, more so in fact than adult *Wohlfahrtia*, but are much less likely to cause this type of vulvar myiasis. In Band-i-Amir as probably in most regions of Afghanistan the species is very common.

Plate 4. An adult specimen of *Lucilia sericata* (Diptera: family Calliphoridae), showing here a metallic-green coloration.

Medicinal plants for animals used in Band-i-Amir

Buzbash corresponds to *Hymenocrater sessilifolius* Benth, Lamiaceae family, a perennial aromatic plant, while *joli gao* is the black henbane or deadly nightshade, *Hyoscyamus niger* L., Solanaceae family, an annual to biannual herb. This species has a recognized toxicity for humans and animals due to the presence of hyoscyamine, an alkaloid with potent antimuscarinic effects (increased heart rate, mydriasis, decreased secretions, and decreased intestinal motricity). The leaves of *joli gao* are apparently used by people of Band-i-Amir to cure respiratory diseases (Ali, 2006). Similarly to *buzbash*, *gandabaghal* belongs to

Lamiaceae family, and is a perennial aromatic plant, most likely *Teucrium royleanum*. It is well known in the macro-region for its medicinal properties. Recently pharmacological studies have shown that the crude methanolic extract of *T. royleanum* displays significant *in vitro* antibacterial and antifungal activities against *Salmonella typhi*, *Escherichia coli*, *Pseudomonas aeruginosa* and *Microsporum canis* (Bashir et al., 2008). The crude methanolic extract and chloroform, ethyl acetate and n-butanol fractions of this species also display a significant inhibition activity against acetylcholinesterase (Bashir et al., 2007), an enzyme that degrades the neurotransmitter acetylcholine at neuro-muscular junctions and cholinergic synapses of the central nervous system. *Pasha kushak* belongs to Caryophyllaceae family, but could not be identified to species level.

Indigenous knowledge in traditional medicine could benefit future conservation-based development projects by encouraging self-reliance and lessening the dependence of populations on imported goods that must be bought (Davis et al., 1995)

CONCLUSION

In Band-i-Amir, the abundance of domestic animals and the over utilization of forage resources have led to a relative impoverishment of range land and to a poor vegetation recovery rate. Livestock suffer a number of diseases that will not be contained on the long term without resolving overpopulation issues. Because of this intense grazing pressure presumably combined to overhunting practices, recent surveys indicate that wild ungulate populations in Band-i-Amir are severely depleted. Indeed we believe that nowadays wild ungulates are de facto excluded from livestock pasture areas, and cohabitation between these populations is probably a non-issue. In such situation the risk of disease spillover by direct contact between the two populations is very limited. However, a higher likelihood of cohabitation may occur in neighboring areas and we cannot exclude an indirect disease transmission via vectors (eg. ticks, flies, gnats). A disease such as bluetongue exclusively transmitted via *Culicoides* mosquitoes poses a potential risk to wildlife because of its high prevalence in sheep and goats and the known susceptibility of a number of wild ungulates. Foot-and-mouth disease could not be tested serologically but clinical evidence strongly suggested that the disease is endemic in livestock of Band-i-Amir such as in most if not all of Afghanistan. Similarly to bluetongue this disease is also known to affect several species of wild ungulates. Although the improvement of livestock health status is unlikely to benefit immediately the survival of remnant populations of wild ungulates —essentially threatened by overhunting and overgrazing—, we believe that reducing the level of ectoparasite infestation in livestock would both help improve health of livestock and control the risk of transmission of vector-born diseases to wildlife.

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