Caprinae news

Newsletter of the IUCN/SSC Caprinae Specialist Group

IN THIS ISSUE (1/2022)

EDITORIAL

Dear CSG members,

after the pandemic years, 2022 marked a return to a near-normal situation. The easing of restrictions finally allowed mountain ungulate experts from around the world to meet again in person at the 8th World Conference held in Cogne, Italy, organised by the Gran Paradiso National Park. In their contribution, Alice Brambilla and Bruno Bassano, organizers of the event, remind us how this occasion has shown the vitality of research and monitoring of the Caprinae, despite the difficulties of recent years. We are confident that further advances will form the basis for the next World Conference, to be held in Tajikistan in 2024. Under the leadership of Khurshed Shamsuddinov and Najmudinov Najmiddin, this will be an opportunity to discuss the world of Caprinae with an approach that integrates different perspectives. We expect much greater participation from Asia and North Africa, the hub of caprinae. We look forward to seeing you there!

The vitality of mountain ungulate studies is further evidenced by the contributions in this issue of the Caprinae newsletter. Dave Forsyth and colleagues take us to New Zealand to show us how the use of aerial counting methods, in combination with an appropriate sampling design, can be a useful tool for estimating Himalayan tahr *Hemitragus jemlahicus* populations, while Arash Ghoddousi and Corinna Van Cayzeele report on how data from ranger surveys, through an occupancy modeling approach, can be effectively used to improve mountain ungulate conservation in Iran. Staying in Asia, Ranjana Pal and colleagues describe for the first time an outbreak of keratoconjunctivitis in mountain ungulates in that region, an event that warrants further research and monitoring. Another piece of news, this time a positive one, for the Asian region, comes to us from Hana Raza and Peshraw Jamil, who report evidence of mouflon *Ovis gmelini* presence in the Iraqi region of Kurdistan, a presence that will require appropriate strategies to favour the conservation status of this species. Two "linguistic" contributions related to the Caprinae of Europe come from Ricardo García-González and Juan Herrero, who discuss the correct Latin name of the Iberian wild goat *Capra pyrenaica*, and from Mathieu Sarasa, who reports on how the consistency problems in the spelling of the species names is a problem for literature research, in the case of *Capra* and *Rupicapra*.

Unfortunately, 2022 also brought with it the sad news of the passing of an eminent representative of the world of Caprinae research and conservation, Mads Forchhammer, remembered with esteem and affection by his friend and colleague Eric Post.

Luca Corlatti, Juan Herrero & Yash Veer Bhatnagar

IUCN SSC Caprinae Specialist Group

HEADLINE NEWS

Mads Forchhammer Obituary

In March 1991, Mads Cedergreen Forchhammer picked up a copy of Alwyn Pedersen's book

Polardyr ("Polar Animals") in Aarhus, Denmark, and his life was forever changed. Pedersen's chapter on muskoxen inspired Mads's enduring fascination with the species and its ecology. Two years later, as part of his graduate thesis at Aarhus University, Mads published the first analysis of long-term population dynamics of muskoxen in Greenland in relation to weather.

In retrospect, the hallmarks of Mads's many ensuing seminal contributions to large herbivore population ecology are evident in that paper. In it, Mads presented a conceptual and statistical framework for the analysis of population dynamics that incorporated simultaneous density-dependent and density-independent factors and their variation across geographical regions. During his subsequent post-doctoral work at the University of Oslo, Mads next pioneered the application of autoregressive time series models in the analysis of the population dynamics of red deer in Norway. This work was the first to both apply such models to large herbivore dynamics and to incorporate large-scale climate indices into their application. The novelty of this approach lay in its utility in examining interactions between direct- and delayed density dependence (the latter deriving from trophic interactions) and climate in variability in the types of dynamics observed across multiple populations of a species over large spatial scales.

Over the course of his career, Mads would go on to refine and improve the complexity of this approach and in the process launch, and largely define, the field of study concerned with impacts of large scale climatic variation and change on the population dynamics of northern ungulates. His work in this field led to novel insights that shaped our understanding of the dynamics and population ecology not only of muskoxen and red deer but also of Soay sheep, caribou, and Svalbard reindeer, and in the process launched the research trajectories of numerous graduate students and post-docs.

Behind all of this work, and perhaps less evident to the public and professional worlds, was a sensitive and empathetic human being and loving father. Mads was enthralled by the beauty and soothing tranquility of arctic landscapes and shared his appreciation for their subtle nuance and vast nature through his uniquely moving photography. Mads was also unfailingly patient and generous of spirit, as those many who were mentored or taught by him well know.

Mads Cedergreen Forchhammer died in Longyearbyen, Svalbard, June 2022. He will be forever missed by those who knew and loved him.

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The 9th World Conference on Mountain Ungulates: transition to a new integrated and sustainable approach to species conservation

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We are glad to inform you that the 9th World Conference on Mountain Ungulates will be held on October 2024 in Dushanbe, Tajikistan. Registrations will be open by October 2023. The deadline for early registration is 31 May 2024, the deadline for abstract submission is 15th May 2024. For more information on the conference, for registration and abstract submission please contact via email 9wcmutj@gmail.com, the website and twitter link will be launched by end of 2023.

Figure 1: Markhor *Capra falconeri* in Tajikistan. Photo by Khudoydod Mulloyorov.

Scientific research is indispensable for effective management and to foster species and ecosystem conservation. The recent history of some mountain ungulates gives examples on how this can be achieved. In the last decades, as research and technology progress and knowledge accumulates, new questions present exciting and urgent challenges both for researchers and managers. Answering those questions will require an inclusive approach that integrates different perspectives. It is with this aim, that we are delighted to invite you to the 9th Conference on Mountain Ungulates in Tajikistan. As in the spirit of past editions, the goal of the conference is to share the most recent and interesting results of research on mountain ungulates as well as to provide networking opportunities for researchers and wildlife managers. We will cover several topics (see the list below), with the ambitious aim of facilitating the integration of different research fields and connecting them with management and conservation.

Planned sessions

Ecology, Behaviour and Evolution. The interactions between mountain ungulate species, the environment and other species inhabiting it, including humans and livestock, are particularly relevant both for evolutionary biology and for conservation. Rapid changes currently occurring in the mountain environments around the world offer a unique opportunity to investigate the response of wild species to environmental changes, including the return of large predators to many areas of the world, and to shed light on possible changes in selective pressures. Moreover, despite the ecology of some mountain ungulates being relatively well-known, for many others we still lack basic information essential for their conservation. This session aims to share new discoveries on the ecology and behaviour of mountain ungulate species and subspecies. For example, we seek presentations focusing on life history, population dynamics, spatial behaviour, diet, physiology, adaptations to changing environment, within- and between-species interactions, predation and competition.

Genetics. The continuous development of molecular techniques gives new insights on wild species evolution and offers powerful tools to inform conservation. The aim of this section is to present new discoveries on the genetics of mountain ungulates. We encourage presentations on the following topics: development of new molecular tools, conservation genetics, hybridisation, immunogenetics and genomics.

Systematics and Palaeontology. The systematics of wild species is constantly being revised according to new genetic discoveries on mountain ungulates. We call for talks presenting new knowledge on this subject, obtained through an integration of palaeontological and molecular data. Among others, the intended topics covered by this session are: revised systematics, functional morphology, palaeontological evidence, phylogenetic reconstructions and ancient DNA.

Health and Diseases. Diseases are important drivers of population dynamics and evolution of wild species as they affect the health status of animals and may result in strong selection, drastic reductions of population size, and local extinction. From a conservation perspective, the spread of zoonotic infections may threaten species conservation through indirect effects, such as calls for the extirpation of wild populations to preserve human health or economic activities. This is particularly relevant for mountain ungulates sympatric with livestock and human activities. The aim of this section is to share knowledge on health and diseases of mountain ungulate populations with particular focus on conservation-relevant discoveries. Possible topics are health status of populations, effects of diseases on population dynamics, emergence of new pathogens, immunogenetics, management of zoonotic and major disease outbreaks and macro parasites as markers of climate change.

Conservation and Management. Most mountain ungulate species interact with humans. Those interactions range from simple coexistence to competition for resources (e.g., with livestock), hunting, introduced species and active conservation actions such as translocations or population supplementation. Often, policy makers must make decisions that should be informed by rigorous scientific knowledge. In this section we encourage the presentation of research covering various aspects of mountain ungulate biology and ecology that have potential applications for conservation and management, as well as case studies where management was beneficial or detrimental to populations, as for example in the case of trophy hunting. In addition, we encourage presentations on the role and use of indigenous and local knowledge for the conservation of mountain ungulates.

Monitoring methods. Several methods have been proposed to properly estimate population size of mountain ungulate populations across a variety of habitats. However, those methods are not yet fully integrated in monitoring practice. We encourage presentations of methodological studies on mountain ungulate monitoring to promote a thorough discussion between researchers and managers in order to find solutions and trade-offs to incorporate good practices into routine monitoring protocols.

Conservation technologies. Methods in wildlife research have changed dramatically in the last decades due to the advent of new technologies. The spread of tools such as, for example, camera traps, sensors tags, drones, remote sensing, image and video interpretation, acoustic monitoring, coupled with machine learning techniques, all allow the collection of large amounts of data that can foster conservation. This session aims to share ideas on the applications of technologies to research and conservation of mountain ungulates.

Poster Session. A poster session is planned for the communication of research on all the abovementioned topic as well as of research of local interest (e.g., results of local population monitoring), work in progress, methods and new ideas.

Field trips. There will be several field trip options available for the conference participants to see the wildlife and enjoy the nature in Tajikistan.

Conservation and Management

Using helicopters to estimate the abundance of non-native Himalayan tahr in New Zealand

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The Himalayan tahr *Hemitragus jemlahicus* was introduced into New Zealand's Southern Alps (Fig. 1) in the early 1900s and now occupies approximately 10,000 km^2 (Forsyth & Tustin 2021). As a non-native species that can form groups >100, there is concern about the impacts of tahr on native ecosystems (Department of Conservation 1993; Cruz *et al.* 2017). In response to these concerns, tahr have been subject to culling for many decades (Tustin & Challies 1978; Forsyth &Tustin 2021).

Figure 1: An example of the steep and remote habitats occupied by non-native Himalayan tahr in the Southern Alps, New Zealand.

The Himalayan Thar Control Plan (HTCP) (Department of Conservation 1993) divides the tahr range according to maximum allowable abundances and densities of tahr in each of seven management units (MUs) (range: <1 to 2.5 tahr per km^2) and two exclusion zones (EZs) (0.0 tahr per km^2), with a total population not to exceed 10,000 tahr. Prior to our study, however, reliable estimates of the abundance and density of tahr in each of these management units were lacking, making enforcement of the HTCP difficult. Previous monitoring had used periodic ground-based vantage point counts (using binoculars and spotting scopes) in a small number of catchments (Tustin & Challies 1978; Department of Conservation 1993). Those ground counts were not corrected for imperfect detection (Forsyth & Hickling 1997), and differences in the areas sampled complicated comparisons of density (Forsyth 2001). Ground-based vantage-point counts are difficult to implement at large spatial scales because many randomly- or systematically-selected sampling locations, which are highly desirable in wildlife abundance estimation, would often be inaccessible. Furthermore, ground-based surveys of mountain ungulates are typically conducted over multiple days, and hence can be disrupted by rapidly-changing mountain weather. Ground counts of Himalayan tahr were discontinued in the 2000s (Forsyth & Tustin 2021).

We were tasked with developing a method to estimate the abundance and density of Himalayan tahr on public conservation land, as defined in the HTCP (7,844 km^2; Department of Conservation 1993). Elevations within the study area ranged from 441–2342 m above sea level, with large areas of permanent snow and ice at higher elevations along the central mountain chain. Given the issues with ground counts outlined above, we decided to use aerial counts, which have been used for many decades to estimate deer abundances in large and remote areas (Forsyth *et al.* 2022). The key advantages of aerial compared to ground counts are that most or all randomly- or systematically-selected sampling locations should be accessible, and that surveys can be conducted quickly during favourable weather. Helicopters were preferred over fixed-wing aircraft because of their slower air speed, lower flying altitude and vertical flight capability.

A systematic random sampling design was used to select monitoring sites, which were located at the vertices of an 8-km grid superimposed over New Zealand's public conservation land within the tahr range. This design resulted in a total of 117 sites across the seven MUs and two EZs. For logistical reasons, monitoring was conducted at a randomly selected subset of sites (without replacement) annually: 16 sites were sampled in 2016, and 22, 28 and 51 were sampled in 2017, 2018 and 2019, respectively. Inferences about the densities and abundances of tahr are therefore averages over this four-year period.

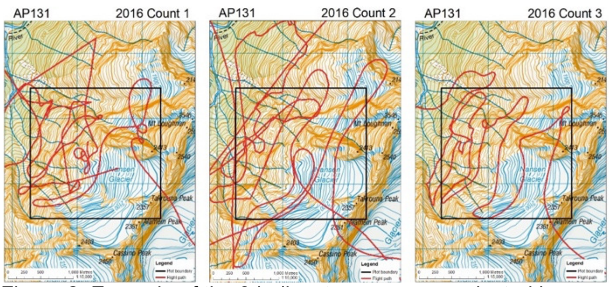

Figure 2: Example of the 3 helicopter surveys conducted in one 2 × 2-km plot (AP131) in 2016. Counts were at least 10 days apart.

At each of the 117 sites, a 2 x 2-km plot (with the centre of each plot the vertex of the 8-km grid) was sampled on three occasions by helicopter (usually a MD 500D or MD 500E). There was a minimum 10-day interval between successive counts at a plot so as to minimise the disturbance effects of the helicopter on tahr in subsequent counts at that plot.

Counts were undertaken during the austral summer and autumn. On each of the three sampling occasions the 4 km^2 plot was overflown by the helicopter flying at about 40–60 knots and at 20–70 m from the ground (Fig. 2). The pilot and one primary observer, seated next to the pilot, searched for tahr (Fig. 3). A person seated in the rear recorded the location (with a GPS) and the sex-age class composition of each group (Fig. 4).

Figure 3: Pilot and observer searching for Himalayan tahr in a 4 km^2 plot in the Southern Alps, New Zealand.

The total number of tahr counted within each plot, at each of the three sampling occasions, were used to estimate abundance corrected for imperfect detection using a generalized N-mixture model for open populations (Dail & Madsen 2011). We assumed that the tahr population on each plot was potentially open to movement-related changes in abundance between the three sampling occasions and modelled these changes using survival and recruitment' processes. The total population of tahr in the sampling frame was estimated using both design-based, finite sampling methods and model-based inference procedures.

Figure 4: Male Himalayan tahr observed on a glacier during a helicopter count in the Southern Alps, New Zealand. Note the steep terrain in the background and the cloud forming, hazards that make estimating the abundance of mountain ungulates difficult.

The mean estimated density of tahr on each plot varied from 0.0 to 31.7 tahr per km^2. Mean densities of tahr varied among management units, ranging from 0.3 to 10.7 tahr per km^2 and exceeded specified intervention densities in six of the seven management units. The total design-based estimate of tahr abundance in the sampling frame was 34,500 (95% CI: 27,750–42,900), with a coefficient of variation (CV) of 0.11. The corresponding model-based estimate of total abundance was similar (34,550, 95% CrI: 30,250–38,700) but was substantially more precise (CV of 0.06) than the design-based estimate. The precision of the estimates for the individual management units were also better than the design-based estimates, with CVs <0.20 for all but one management unit. For further details on our methods and results, see Ramsey *et al.* (2022).

Our estimates of Himalayan tahr abundance on public conservation land (62% of the total range defined in Department of Conservation 1993) indicate that the tahr population during 2016–2019 greatly exceeded 10,000, with the lower 95% confidence and credible limits for the design- and model-based estimates more than double that value. Furthermore, average tahr densities exceeded the thresholds defined in the HTCP in both exclusion zones and in all but one management unit. It is now recognised that more control effort is needed to reduce tahr abundances and densities below the threshold values stipulated in the Himalayan Tahr Control Plan (Department of Conservation 2022). More generally, our study shows that robust estimation of the abundance and density of mountain ungulates is possible by combining aerial surveys and open population models with an objective, probabilistic sampling design.

References

Cruz J., C. Thomson, J.P. Parkes, I. Gruner, D.M. Forsyth – 2017. Long-term impacts of an introduced ungulate in native grasslands: Himalayan tahr (*Hemitragus jemlahicus*) in New Zealand's Southern Alps. *Biological Invasions* 19: 339–349.

Dail D., L. Madsen – 2011. Models for estimating abundance from repeated counts of an open metapopulation. *Biometrics* 67: 577–587.

Department of Conservation – 1993. Himalayan Thar Control Plan. *Canterbury Conservancy Conservation Management Series* No. 3, Department of Conservation, Christchurch, New Zealand.

Department of Conservation – 2022. Previous Tahr Control Operational Plans. https://www.doc.govt.nz/parks-and-recreation/things-to-do/hunting/what-to-hunt/tahr/tahr-control-operations/previous-tahr-control-operational-plans/#plan-21-22, accessed 21 October 2022.

Forsyth D.M. – 2001. Measuring the abundance of Himalayan tahr in New Zealand: Problems and potential solutions. Pages 308–311 in: 'Wildlife, Land, and People: Priorities for the 21st Century. Proceedings of the Second International Wildlife Management Congress' (Eds. R. Field, R.J. Warren, H. Okarma, and P.R. Sievert). The Wildlife Society, Bethesda, Maryland, USA.

Forsyth D.M., G.J. Hickling – 1997. An improved technique for indexing abundance of Himalayan thar. *New Zealand Journal of Ecology* 21: 97–101.

Forsyth D.M., K.G. Tustin – 2021. *Hemitragus jemlahicus*. Pages 393–445 in: 'The Handbook of New Zealand Mammals, Third Edition' (Eds C.M. King and D.M. Forsyth) Family Bovidae. CSIRO Publishing, Melbourne.

Forsyth D.M., S. Comte, N.E. Davis, A.J. Bengsen, S.D. Côté, D.G. Hewitt, et al. – 2022. Methodology matters when estimating deer abundance: A global systematic review and recommendations for improvements. *Journal of Wildlife Management* 86: e22207

Ramsey D.S.L., D.M. Forsyth, M. Perry, P. Thomas, M. McKay, E.F. Wright – 2022. Using helicopter counts to estimate the abundance of Himalayan tahr in New Zealand's Southern Alps. *Journal of Wildlife Management* 86: e22252.

Tustin K.G., C.N. Challies – 1978. The effects of hunting on the numbers and group sizes of Himalayan thar (*Hemitragus jemlahicus*) in Carneys Creek, Rangitata catchment. *New Zealand Journal of Ecology* 1: 153–157.

Harnessing a wealth of analogue ranger-based monitoring data for the conservation of mountain ungulates – a case study from Golestan National Park, Iran

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Poaching is driving many large mammals toward extinction, and large herbivores such as mountain ungulates are particularly at risk (Ripple *et al.* 2015). This is mainly due to a range of context-specific incentives motivating poaching such as subsistence hunting or supplying local or urban meat markets (Challender & MacMillan 2014). Despite ever-increasing conservation efforts worldwide to combat poaching, it continues to contribute to the decline of many threatened species and more effective interventions are needed (Travers *et al.* 2019). One of the main requirements for effective conservation measures against poaching is robust and repeated monitoring data on threatened species (Critchlow *et al.* 2017). However, this information is often scarce due to inconsistent or complex data collection approaches.

One of the often-untapped sources of wildlife sighting data is ranger-based monitoring. In many protected areas, rangers are tasked with patrolling areas of higher poaching probability as well as with guarding areas of target species distributions. Rangers are often required to note down their sightings of non-compliances and wildlife either in an analogue format in forms and logbooks or using handheld GPS units. However, in most cases these data are left unanalyzed, failing to support adaptive management and decision-making processes in protected areas. One of the main reasons for not benefitting from this wealth of repeated, widespread and detailed datasets is the absence of straightforward workflows for the analysis, especially if they were collected in an analogue format.

In this study, we aimed to address this issue and develop a workflow for analyzing data on mountain ungulate distributions from analogue logbooks in an occupancy modelling framework to inform adaptive management. We used Golestan National Park (874km^2) as the case study, which is the oldest protected area of Iran and is home to six ungulate species, two of which are Caprinae: bezoar goat *Capra aegagrus* and urial *Ovis vignei* (Fig.1). The ungulate populations of the park have suffered from a massive poaching crisis after Iran's Islamic Revolution in 1979, but since then are slowly recovering (Ghoddousi *et al.* 2019). However, populations of both bezoar goat (-88%) and urial (-66%) are still significantly lower than in the 1970s. Poaching is mainly performed by local residents to sell at local meat markets, for cultural reasons, for pleasure, and finally due to conflicts with conservation bodies (Ghoddousi *et al.* 2019). Bezoar and urial are highly preferred by poachers and urial was hunted in ca. 69% of all poacher seizures in the park (Ghoddousi *et al.* 2017).

Figure 1: A herd of urials in the Golestan National Park, Iran. Photo: Hamed Tizrooyan.

We obtained logbook data from nine ranger stations from 2014-2016. We then geolocated 552 landmarks and 754km of patrol trails mentioned in these logbooks and created a reference map to facilitate the digitization of the patrols. We superimposed a 3 x 3 km^2 grid system (hereafter cells) over the study area as the unit of our analysis (96 cells). Benefitting from the reference map, we then digitized 4800 day-entries (i.e., daily patrols) by allocating them to relevant cells. From each day-entry, we recorded the cells patrolled and the sighted ungulate species. We only used direct sightings of wildlife, as there is a higher chance of misidentification of indirect signs (e.g., tracks, dung).

We used an occupancy modelling framework using the *unmarked* package in R Statistical Software to assess the distribution of bezoar goat and urial (MacKenzie *et al.* 2017). This modelling approach consists of two components: detection probability (p) and occupancy state (ψ). We treated each cell as a site and each month as an occasion to build the detection history table. For detection or survey covariates, we used patrolling intensity and landscape openness (i.e., a combination of the average ruggedness and forest cover in each cell), and as site covariates, we used ruggedness, NDVI, distance from ranger stations, and distance to roads or borders (Ghoddousi *et al.* 2016).

We conducted a single-species, single-season occupancy for every 12 months of data and then calculated the mean ψ of each species at each site (Marescot *et al.* 2020). We built the models with different combinations and interactions of variables. We use the Akaike information criterion (AIC) for model ranking, considering models with Δ AIC < 2 as structurally similar, and models with the lowest AIC as the best model(s). We predicted ψ for each species and each year in each cell given the parameters of the best model(s).

Figure 2: A ranger on patrol in Golestan National Park, Iran. Photo: Amirhossein Khaleghi Hamidi.

We obtained 1180 sightings of bezoar goat and 5704 sightings of urial from logbooks. Over the study period (2014-2016), all cells were patrolled at least once but there was high variation in patrolling intensity across sites and months. The median number of patrols per year across all cells was 42 (0-331). The best model of the bezoar goat showed a positive impact of ruggedness and a negative impact of distance from ranger stations. The best urial model showed the importance of NDVI as the indicator of vegetative greenness. Both survey covariates of patrolling intensity and visibility were present in the best models of both species. The detailed methods description of this study is reported in a published paper (Ghoddousi *et al. 2022*).

Here, we showed the wealth of data that could be provided from ranger-based monitoring to improve the conservation of threatened species. Our model predictions correctly described the distribution of bezoar goat and urial in the park, which for the case of bezoar goat was mostly in safer areas near ranger stations. Importantly, we showed how often unused data from analogue logbooks could be used to draw inferences on wildlife status and poaching prevalence (Ghoddousi *et al. 2022*). The dire situation of many mountain ungulates in combination with lack of sufficient resources, urges conservationists to use the best available data in conservation planning.

References

Challender D.W.S., D.C. MacMillan – 2014. Poaching is more than an Enforcement Problem. *Conservation Letters* 7: 484–494.

Critchlow R., A.J. Plumptre, B. Alidria, M. Nsubuga, M. Driciru, A. Rwetsiba, et al. – 2017. Improving law-enforcement effectiveness and efficiency in protected areas using ranger-collected monitoring data. *Conservation Letters* 10: 572–580.

Ghoddousi A., A. Kh. Hamidi, M. Soofi, I. Khorozyan, B.H. Kiabi, M. Waltert – 2016. Effects of ranger stations on predator and prey distribution and abundance in an Iranian steppe landscape. *Animal Conservation* 19: 273–280.

Ghoddousi A., M. Soofi, A.K. Hamidi, S. Ashayeri, L. Egli, S. Ghoddousi, et al. – 2019. The decline of ungulate populations in Iranian protected areas calls for urgent action against poaching. *Oryx* 53: 151–158.

Ghoddousi A., M. Soofi, A. Kh. Hamidi, T. Lumetsberger, L. Egli, S. Ashayeri, et al. – 2017. When pork is not on the menu: Assessing trophic competition between large carnivores and poachers. *Biological Conservation* 209: 223–229.

Ghoddousi A., C. Van Cayzeele, P. Negahdar, M. Soofi, A. Kh Hamidi, B. Bleyhl, et al. – 2022. Understanding spatial patterns of poaching pressure using ranger logbook data to optimize future patrolling strategies. *Ecological Applications* 32: e2601.

MacKenzie D.I., J.D. Nichols, J.A. Royle, K. Pollock, L.L. Bailey, J.E. Hines – 2017. Occupancy estimation and modeling - inferring patterns and dynamics of species occurrence. Academic Press.

Marescot L., A. Lyet, R. Singh, N. Carter, O. Gimenez – 2020. Inferring wildlife poaching in southeast Asia with multispecies dynamic occupancy models. *Ecography* 43: 239–250.

Ripple W.J., T.M. Newsome, C. Wolf, R. Dirzo, K.T. Everatt, M. Galetti, et al. – 2015. Collapse of the world's largest herbivores. *Science Advances* 1: e1400103.

Travers H., L.J. Archer, G. Mwedde, D. Roe, J. Baker, A.J. Plumptre et al. – 2019. Understanding complex drivers of wildlife crime to design effective conservation interventions. *Conservation Biology* 33: 1296–1306.

RESEARCH

Infectious keratoconjunctivitis in Asian Mountain ungulates

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IKC in wild ungulates

Infectious Keratoconjuctivis (IKC) is a contagious ocular disease affecting a wide variety of ruminants characterized by redness of the conjunctiva, corneal opacity, serous and purulent lachrymation, increased blinking and blepharospasm (Egwu 1989; Giacometti *et al.* 2002a), and in the more severe cases, the perforation of the eyes (Mayer *et al.* 1997; Degiorgis *et al.* 2000). These clinical signs may result in transitory or permanent blindness, impairing movements and feeding

(Giacometti *et al.* 2002a). The disease has long been known to affect Caprinae in Europe, mostly *Rupicapra* spp. and *Capra* spp., but has also been documented in bighorn sheep *Ovis canadensis* in North America (Jansen *et al.* 2006) and in the introduced Caprinae species (Alpine chamois *Rupicapra r. rupicapra* and Himalayan tahr *Hemitragus jemlahicus*) in New Zealand (Daniel & Christie 1963; https://www.nztf.org.nz/project-pinkeye).

The impact of IKC outbreaks in wild Caprinae varies and can range from low (1-5%) to considerable (locally up to 30%) mortality (Giacometti *et al.* 2002a; Arnal et al. 2013;). Demographic effects may include cohort effects due to lower reproductive indices, that can delay population recovery in the absence of other stressors (Arnal *et al.* 2013; Loison *et al.*1996). IKC may also become endemic in some wild Caprinae populations (Mavrot *et al.* 2012; Fernández-Aguilar *et al.* 2017b), but the actual impact of the disease in these circumstances has been poorly investigated.

Here, we describe an outbreak and a potential instance of IKC in Asian mountain ungulates. To our knowledge, these are the first reported cases of this disease in free-ranging mountain ungulates of Asia.

Bharal in Gangotri National Park, Western Himalaya, India

Between September and December 2017, multiple records of Himalayan blue sheep or bharal *Pseudois nayaur* with severe ocular disease were documented in Gangotri National Park (NP), located in the Upper Bhagirathi basin, Uttarakhand. The first evidence of IKC in bharal was reported in September 2017 by a trekking group in the Kedar valley of Gangotri NP. The affected animals had severe signs of ocular disease manifested by listlessness, serosanguineous lachrymation and blindness (Fig. 1a). These observations were complemented by images from camera traps deployed in the park for research purposes by the Wildlife Institute of India under the National Mission for Sustaining the Himalayan Ecosystem project (details can be found at https://wii.gov.in/nmshe_about). The camera traps were active seasonally (summer and winter) from October 2015 to May 2019 aimed at collecting information on species in different valleys of Gangotri NP and adjacent valleys outside the park (Fig.2). The first record of a bharal with ocular clinical signs were reported on 2nd September in Kedar valley, followed by six more cases in the same month and valley (Fig. 1 (c), (d)). On 26th November 2017, the research team also encountered a similar case in Kedar valley with one female bharal showing listlessness, inactivity (sitting in the same spot the entire day), blepharospasm with dried lachrymal discharges (Fig. 1b). The following day, four bharal (2 males and two kids) were spotted grazing with lachrymal discharges. Attempts to capture the bharal for detailed examinations were unsuccessful due to the terrain and remoteness of the area. Further cases were recorded during the winter camera-trap session in Kedar valley (one each in November and December 2017) and Rudragyra valley (one in November and two in December 2017). Bharal spotted (N=404) during the seasonal trail surveys in the surrounding valleys from Gangotri NP (Nelang and Gaumukh), or outside the park (Srikanth and Gidara) showed no evident signs of ocular disease. No cases of bharal with ocular signs of infection were recorded in camera traps after December 2017, and no dead animals were encountered during seasonal trail surveys.

Figure 1: Cases of infectious keratoconjunctivitis in bharal detected in Gangotri National Park between September and December 2017, Western Himalaya, India. a) two cases of a kid and an adult female with emaciation and ocular perforation (photo credit: https://timesofindia.indiatimes.com/); b) bharal female with blepharospasm and dried lachrymal discharges; c) and d) bharal with ocular discharge detected by camera traps.

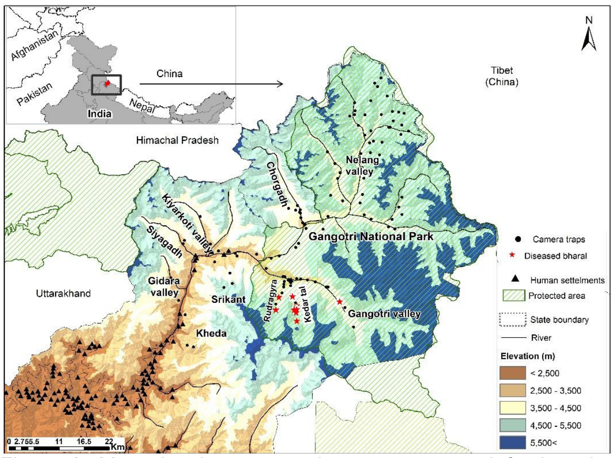

Figure 2: Map showing areas where severe eye infections in bharal were documented between September and December 2017 in Gangotri National Park, Western Himalaya, India.

The Kedar valley and the adjacent Gangotri valley support a high density of bharal with observed aggregations of up to 200 animals. Other Caprinae species found in the area (>3500m) include goral *Naemorhedus goral*, Himalayan tahr *Hemitragus jemlahicus* and Himalayan serow *Capricornis sumatraensis*. No incidents were recorded in these species.

Most human habitation in the region is restricted to lower areas (<2700m). Seasonal grazing is practiced in alpine and subalpine zones by livestock between June and September in all valleys, with the exception of Kedar and Gangotri valleys. Although grazing is not allowed in the Kedar valley since 2006, livestock grazing in the adjacent Rudragyra valley is one potential source of the infection.

Markhor in Darvaz-Hazaritshoh Range, Tajikistan

In Tajikistan, markhor *Capra falconeri* are almost exclusively found within trophy hunting conservancies, except for the Dastijhum Strict Nature Reserve (Michel *et al.* 2015). The markhor populations are monitored in conservancies annually. For the annual markhor census in March 2022, the IUCN Caprinae Specialist Group (CSG) was invited by the Committee for Environmental Protection (CEP) of the Government of Tajikistan. The census was conducted by members of CSG, researchers from the Tajik Academy of Sciences, members of the CEP and conservancy managers and rangers (Herrero *et al.* 2022).

Figure 3: Left: Conservancies dedicated to markhor and wildlife conservation and the Dashtjum Strict Nature Reserve in Tajikistan. The black dot in the map indicates the location where the blind female markhor was detected (Right). Photo by Munib Khanyari

During the survey, in March 2022, an adult female markhor was spotted moving in circles in ankle-deep snow by a surveying team in the higher reaches of the M-Bukhori Conservancy (38.0030ºN, 70.0950ºE) (Fig. 3). The adult female seemed to have impaired vision and was weak, which allowed the survey team to capture and handle it for a quick examination. The animal had a severe keratoconjunctivitis, including corneal opacity and infraorbital alopecia (Fig. 3). These disease signs are consistent with IKC described in other wild Caprinae species (Arnal, *et al*., 2013; Fernández-Aguilar *et al*., 2017c). The team counted a minimum of 6,588 individuals across the known species distribution covering nearly 1,777 km^2 (Fig. 3), but no other markhor were seen with similar symptoms. Most of the markhor were observed from long distances using spotting scopes and signs of ocular disease may have been overlooked. Signs of IKC in markhor had not been previously documented in the area according to some conservancy managers and rangers, although an in-depth study of local knowledge of the disease has not been performed.

Discussions with 10 conservancy owners and 8 community rangers, many of whose families have livestock, revealed that local livestock had shown similar signs in the past. More work needs to be done to understand the potential overlap between Markhor and livestock through their range, and possible transmission of diseases (Woodford *et al.* 2004; Ostrowski *et al.* 2011).

Common understandings from both case studies

Infectious keratoconjunctivitis is a highly contagious disease transmitted through direct contact with contaminated excretions and aerosols and by insect vectors that feed on ocular and nasal discharges (Degiorgis *et al.* 1999; Fernández-Aguilar *et al.* 2019;). IKC typically causes outbreaks of disease in wild Caprinae and native livestock (Náglic *et al.* 2000; Arnal *et al.* 2013), yet it can also cause sporadic disease in endemic situations (Mavrot *et al.* 2012; Fernández-Aguilar *et al.* 2017b). Both scenarios are consistent with the cases reported in this work. Although an etiological diagnosis could not be made, symptoms such as ocular discharge, severe keratoconjunctivitis, and perforated eyes were consistent with reports on IKC in other wild Caprinae (Mayer *et al.* 1997; Fernández-Aguilar *et al.* 2017b). The circling behavior of the markhor has also been described in severely IKC-affected individuals (Degiorgis *et al.* 2000).

In Caprinae, diverse infectious agents including *Mycoplasma conjunctivae, Chlamydia* spp., *Moraxella (Branhamella) ovis* or *Listeria monocytogenes* have been detected and associated with ocular disease in both wild and domestic ruminants (Egwu 1989; Giacometti *et al.* 2002b; Åkerstedt & Hofshagen 2004). Among all infectious agents, *M. conjunctivae* is consistently associated with outbreaks of IKC and is typically considered the primary agent in wild Caprinae (Giacometti *et al.* 2002b). However, the importance of other microorganisms possibly involved as secondary invaders remains unknown. A recent study reported endemic infections of *Mycoplasma conjunctivae* and *Chlamydiaceae* in domestic sheep and goats from the Kharakoram, in remote mountain ranges in the Gilgit-Baltistan district of Pakistan (Fernández-Aguilar *et al.* 2017a). Other mycoplasmas can also cause ocular disease, together with other signs of disease (e.g., respiratory signs), and it is important to note that *M. capricolum* subsp. *capricolum* has been documented in Markhor populations from Tajikistan (Ostrowski *et al.* 2011).

Interactions among domestic and wild Caprinae may occur in alpine and subalpine meadows (Ryser-Degiorgis *et al.* 2002), and spill-over pathogen transmission across species, leading to IKC outbreaks, has been demonstrated by molecular epidemiological studies (Belloy *et al.* 2003; Fernández-Aguilar *et al.* 2017b). Whether the cases described here have originated from local domestic sheep and goats is unknown but highly probable.

Looking forward: Recommendations

These anecdotal reports of eye infection disease in Asian Caprinae need additional research on the etiology, impact to populations and epidemiological links to domestic livestock. IKC may be underreported in wild Caprinae from the Himalaya and other Asian mountain ranges because of the remoteness and ruggedness of these regions, making observations and eye swab sampling for etiological studies difficult. Although interventions are difficult once outbreaks are in progress, the conservation-oriented management should be pointed towards minimizing interactions with livestock and implementing an effective syndromic surveillance of IKC (and other diseases) in livestock that share grazing areas with wild Caprinae. This could improve the early detection of new health threats and allow to develop mitigation strategies to disease spread at the livestock/wildlife interface.

References

Åkerstedt J., M. Hofshagen – 2004. Bacteriological investigation of infectious keratoconjunctivitis in Norwegian sheep. *Acta Veterinaria Scandinavica* 45: 1–8.

Arnal M.C., J. Herrero, C. de la Fe, M. Revilla, C. Prada, D. Martínez-Durán et al. – 2013. Dynamics of an infectious keratoconjunctivitis outbreak by *Mycoplasma conjunctivae* on Pyrenean Chamois *Rupicapra p. pyrenaica*. *PLoS One* 8: p.e61887.

Belloy L., M. Janovsky, E.M. Vilei, P. Pilo, M. Giacometti, J. Frey – 2003. Molecular epidemiology of Mycoplasma conjunctivae in Caprinae: transmission across species in natural outbreaks. *Applied and environmental microbiology* 69: 1913–1919.

Daniel M.J., A.H.C Christie – 1963. Untersuchungen über Krankheiten der Gemse (*Rupicapra rupicapra L.*) und des Thars (*Hemitragus jemlaicus Smith*) in den Südalpen von Neuseeland. *Schweiz Arch Tierh* 105: 399–411.

Degiorgis M.P., J. Frey, J. Nicolet, E.M. Abdo, R. Fatzer, Y. Schlatter et al. – 2000. An outbreak of infectious keratoconjunctivitis in Alpine chamois (*Rupicapra R. rupicapra*) in Simmental-Gruyères. *Schweiz Arch Tierheilkd* 142: 520–527.

Degiorgis M.P., E. Obrecht, A. Ryser, M. Giacometti – 1999. The possible role of eye-frequenting flies in the transmission of *Mycoplasma conjunctivae*. *Mitteilungen der Schweizerischen Entomol. Gesellschaft* 72: 189–194.

Egwu G.O. – 1989. Ovine infectious keratoconjunctivitis: some studies on the role of *Mycoplasma conjunctivae*, PhD., University of Liverpool.

Fernández-Aguilar X., Ó. Cabezón, J. Frey, R. Velarde, E. Serrano, A. Colom-Cadena, et al. – 2017b. Long-term dynamics of *Mycoplasma conjunctivae* at the livestock-wildlife interface in the Pyrenees. *Plos One* 12: e0186069.

Fernández-Aguilar X., J. López-Olvera, M. Ribas, M. Begovoeva, V. Roser, J. Cardells, O. Cabezón 2019. *Mycoplasma conjunctivae* in insect vectors and anatomic locations related to transmission and persistence. *Veterinary Microbiology* 228: 7–11.

Fernández-Aguilar X., L. Rossi, Ó. Cabezón, A. Giorgino, I. Victoriano Llopis, J. Frey, et al. – 2017a. Infectious keratoconjunctivitis and occurrence of *Mycoplasma conjunctivae* and *Chlamydiaceae* in small domestic ruminants from Central Karakoram, Pakistan. *Veterinary Record* 181: 237–237.

Fernández-Aguilar X., O. Cabezón, J.E. Granados, J. Frey, E. Serrano, R. Velarde, F.J. Cano-Manuel, et al. – 2017c. Post epizootic persistence of asymptomatic Mycoplasma conjunctivae infections in Iberian ibex. *Applied and Environmental Microbiology* 83: e00690-17.

Giacometti M., M. Janovsky, L. Belloy, J. Frey – 2002a. Infectious keratoconjunctivitis of ibex, chamois and other Caprinae. *Revue scientifique et technique (International Office of Epizootics)* 21: 335–345.

Giacometti M., M. Janovsky, H. Jenny, J. Nicolet, L. Belloy, E. Goldschmidt-Clermont, et al. – 2002b. *Mycoplasma conjunctivae* infection is not maintained in alpine chamois in eastern Switzerland. *Journal of Wildlife Diseases* 38: 297–304.

Herrero J., Y.V. Bhatnagar, A. Ghoddousi, M. Khanyari, Z. Moheb, P. Sepahvand – 2022. Advise for the survey markhor *Capra falconeri* in Tajikistan – 2022. Caprinae Specialist Group of IUCN.

Jansen B.D., J.R. Heffelfinger, T.H. Noon, P.R. Krausman, J.C. deVos Jr – 2006. Infectious keratoconjunctivitis in bighorn sheep, Silver Bell Mountains, Arizona, USA. *Journal of Wildlife Diseases* 42: 407–411.

Loison A., J.M. Gaillard, J.M Jullien – 1996. Demographic patterns after an epizootic of keratoconjunctivitis in a chamois population. *Journal of Wildlife Management* 60: 517–527.

Mavrot, F., E.M. Vilei, N. Marreros, C. Signer, J. Frey, M.P. Ryser-Degiorgis – 2012. Occurrence, quantification, and genotyping of Mycoplasma conjunctivae in wild Caprinae with and without infectious keratoconjunctivitis. *Journal of Wildlife Diseases* 48: 619–631.

Mayer D., M.P. Degiorgis, W. Meier, J.M. Nicolet, M. Giacometti – 1997. Lesions associated with infectious keratoconjunctivitis in Alpine ibex. *Journal of Wildlife Diseases* 33: 413–419.

Michel S., T.R. Michel, A. Saidov, K. Karimov, M. Alidodov, I. Kholmatov – 2015. Population status of Heptner's markhor *Capra falconeri heptneri* in Tajikistan: challenges for conservation. *Oryx* 49: 506–513.

Naglić T., B. Šeol, D. Hajsig, K. Busch, J. Frey, M. Lojkić – 2000. Epidemiological and microbiological study of an outbreak of infectious keratoconjunctivitis in sheep. *Veterinary Record* 147: 72–75.

Ostrowski S., F. Thiaucourt, M. Amirbekov, A. Mahmadshoev, L. Manso-Silván, V. Dupuy, et al. – 2011. Fatal outbreak of *Mycoplasma capricolum* pneumonia in endangered markhors. *Emerging Infectious Diseases* 17: 2338–2341.

Ryser-Degiorgis, M.P., P. Ingold, H. Tenhu, A.M.T. Less, A. Ryser, M. Giacometti – 2002. Encounters between Alpine ibex, Alpine chamois and domestic sheep in the Swiss Alps. Hystrix 13: 1–2.

Woodford, M.H., M.R. Frisina, G.A. Awan –2004. The Torghar conservation project: management of the livestock, Suleiman markhor (Capra falconeri) and Afghan urial (*Ovis orientalis*) in the Torghar Hills, Pakistan. *Game and Wildlife Science* 21: 177–187.

SPOTLIGHTS

The first conclusive evidence of mouflon *Ovis gmelini* in the Kurdistan Region of Iraq

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The Zagros Mountain Forest is a typical ecosystem in the Kurdistan Region in Iraq where many rare and threatened species can still be found. Extensive logging has degraded wide swaths of the region's oak *Quercus* sp. dominated deciduous forests and pistachio *Pistacio* sp. almond *Prunus* sp. forests, causing the further decline of many already threatened large mammals including the mouflon. Michel & Ghoddousi (2020) assigned the extant subspecies of mouflon in Iraq as the Armenian mouflon *Ovis gmelini gmelini*. The subspecies is known to inhabit the northern Zagros Mountains (Harrison

1964; Turnbull & Reed 1974; Yusefi *et al.* 2019; Michel and Ghoddousi 2020) and in Iraq it occurs in mountainous landscapes (Fig. 1), arid hills and undulating terrain. Nevertheless, the present distribution of the mouflon is largely unknown. While this species was once distributed throughout the Fertile Crescent (Yeomans *et al.* 2017) today it is only rarely seen in Iraq. Although border regions in Halabja, Khurmal, Maidan, Wasit and Salah Al-Din areas have had occasional anecdotal and poaching reports of mouflon, no live image of the species has been obtained before.

On December 2020, a male mouflon was observed and filmed near Hana Nawa village of Khurmal District in Halabja Governorate, located at N 35.297639° E 46.145913° (Fig. 2). This record is the country's northernmost confirmed record of the mouflon. This new confirmation is important as according to the latest version of the IUCN Red List, the mouflon is classified as "Near Threatened". Mouflon are distributed over six countries of Armenia, southern Azerbaijan, Cyprus, northern Iraq, southern and western Iran, and eastern Turkey, with Iran holding the main population (Michel & Ghoddousi 2020). Mouflon populations are severely fragmented due to threats such as poaching (Ghoddousi *et al.* 2016, 2019) and competition with livestock for space and forage (Bleyhl *et al.* 2019).

Figure 1: An example of habitat where the Mouflon was captured along the Iraq-Iran border (Peshraw M. Jamil, March, 2021).

Figure 2: First photographic record of a live mouflon from Iraq-schreenshot from a video (Peshraw M. Jamil, December 2020)

Figure 3: Mouflon poached in Badra, Wasit (August 2017)

Historical records (Hatt 1959; Shackleton 1997) and Neolithic and Epipaleolithic bone excavations of "wild sheep" reported from Palegawra Cave, Jarmo, and Bestansur in the Sharizor plains, dating back to 15000 cal BP and 7100 BC, are previous reliable sources that prove mouflon was extant in Iraq (Hatt 1959; Mathews *et al.* 2019; Asouti *et al.* 2020). Less reliable reports have been posted on social media with photographs of poached mouflon, but one social media record with details on the date and locality has been recorded (Fig. 3). Alsheikhly (2012) also reported the killing of an adult male from Himreen foothills in 2009 and an adult female near Badra in Wasit province in 2011, but without providing photographic evidence. More recently reputable local reports were obtained by the first author during research using interviews, in 2016 and 2018 (H. Raza unpublished data). On one occasion footage of a herd of over 15 individuals were shown to the first author (2016) near the Iran-Iraq border, however it was not possible to obtain the footage and therefore the record was lost.

The mouflon is protected by the Kurdistan Region's Decree No. 1 of 2021 from Hunting, a fine of 10 million Iraqi Dinars (equivalent to ~6850 USD) is given for poaching one mouflon. However, due to a lack of regular implementation of the laws and monitoring and patrolling by the forest wardens in the region, they are still heavily poached. Poaching has resulted in the species becoming very shy and consequently they are rarely observed. The existence of the photographed male on the Iraq-Iran border could suggest that they are vagrants coming from Iran. However, the existence of historical and anecdotal records of the animal indicates its presence or potentially a recolonization of the species (Michel S. 2021 Pers. comm.).

Mouflons are one of the main prey species for the endangered Persian leopard *Panthera pardus saxicolor*/*tulliana* in areas where both species occur together in Iraq. The establishment and proper maintenance of protected areas is key to the conservation of the mouflon population and its habitats and to ensure a future for leopards. More work is required to better understand the status of Mouflon in Iraq. Establishing population monitoring and developing a strategic transboundary framework to ensure the survival of this rare and globally threatened ungulate is needed.

References

Alsheikhly O. – 2012. The hunting of endangered mammals in Iraq. *Wildlife Middle East* 6: 2–3.

Asouti E., D. Baird, C. Kabukcu, K. Swinson, L. Martin, A. García-Suárez et al. – 2020. The Zagros Epipalaeolithic revisited: New excavations and 14C dates from Palegawra cave in Iraqi Kurdistan. *PLoS ONE* 15: e0239564.

Bleyhl B., M. Arakelyan, E. Askerov et al. – 2019. Assessing niche overlap between domestic and threatened wild sheep to identify conservation priority areas. *Diversity and Distribution* 25: 129–141.

Ghoddousi A., A. Kh. Hamidi, M. Soofi, I. Khorozyan, B.H. Kiabi, M. Waltert – 2016. Effects of ranger stations on predator and prey distribution and abundance in an Iranian steppe landscape. *Animal Conservation* 19: 273–280.

Ghoddousi A., M. Soofi, A. Hamidi, S. Ashayeri, L. Egli, S. Ghoddousi et al. – 2019. The decline of ungulate populations in Iranian protected areas calls for urgent action against poaching. *Oryx* 53: 151–158.

Harrison D.L. – 1964. The Mammals of Arabia. Insectivora, Chiroptera, Primates. Vol. I. Ernest Benn Ltd., Kent.

Matthews R., W. Matthews, A. Richardson, S. Walsh, I. Iversen, D. Mudd et al. – 2019. The Early Neolithic of Iraqi Kurdistan: Current research at Bestansur, Shahrizor Plain. *Paléorient* 45: 2.

Hatt, R.T. – 1959. The mammals of Iraq. Museum of Zoology, University of Michigan, no. 106.

Michel S., A. Ghoddousi – 2020. *Ovis gmelini*. *The IUCN Red List of Threatened Species* 2020: e.T54940218A22147055. https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T54940218A22147055.en. Accessed on 04 March 2023.

Shackleton D.M. – 1997. Wild Sheep and Goats and Their Relatives: Status Survey and Conservation Action Plan for Caprinae. IUCN/SSC Caprinae Specialist Group, Gland, Switzerland and Cambridge, UK

Turnbull P.F., C.A. Reed – 1974. The fauna from the terminal Pleistocene of Palegawra Cave, a Zarzian occupation site in northeastern Iraq. *Fieldiana Anthropology* 63: 81–146.

Yeomans L., L. Martin, T. Richter – 2017. Expansion of the known distribution of Asiatic mouflon (*Ovis orientalis*) in the Late Pleistocene of the Southern Levant. *Royal Society Open Science* 4: 170409.

Yusefi Gh. H., K. Faizolahi, J. Darvish, K. Safi, J. C. Brito – 2019. The species diversity, distribution, and conservation status of the terrestrial mammals of Iran. *Journal of Mammalogy* 100: 55–71.

Which is the correct Latin name for the Iberian wild goat?

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The Iberian wild goat *Capra pyrenaica* was described in 1838 by the Swiss zoologist Heinrich Schinz using a few specimens from the Pyrenees. Few years later Schimper (1848) described a new species, *Capra hispanica* from Sierra Nevada (Spain) (Fig. 1). Thus, two species of *Capra* were admitted in the Iberian Peninsula (IP): *Capra pyrenaica* Schinz, 1838 in the north and *C. hispanica* Schimper, 1848 in the south and east of the peninsula (García-González *et al.* 2022).

In 1911 the Spanish zoologist Cabrera (1911) proposed a change in the taxonomy of Iberian wild goats. He unified the two described species in a single one, *C. pyrenaica* with four subspecies: the nominal *C. p. pyrenaica* in the Pyrenees, *C. p. hispanica* in the south and east of the IP, *C. p. lusitanica* in the west of the IP (mainly in Serra de Gêrez, Portugal) and *C. p. victoriae* in the Iberian Central Mountain Range (Spain). This is the official classification commonly used and accepted by the IUCN (Herrero *et al.* 2021), although today the existence of subspecies is not accepted by most specialists.

Figure 1: Skull of the type species *Capra hispanica* Schimper, 1848 from the Musée de Zoologie of Strasburg (courtesy of M.-D. Wandhammer).

C. p. lusitanica became extinct at the beginning of the 19th century and the nominal subspecies became extinct in January 2000. The living subspecies (*victoriae* and *hispanica*) are currently undergoing an extraordinary expansion, mainly as a result of natural recovery but also due to reintroductions (García-González *et al.* 2022). In this work we briefly describe the taxonomic status of *C. pyrenaica*, the inconsistencies of current classification and we contend the necessity to change it.

The taxonomic characterization and evolutionary history of Iberian wild goat is still poorly understood. The palaeontologist Crégut-Bonnoure (2006) states that the arrival of *C. pyrenaica* to the IP, took place in the Magdalenian [from 17,000-15,000 years ago (17-15 ky)] and would have evolved from an ancestor related to *C. caucasica* which she named *C. caucasica praepyrenaica*. This species would have arrived in the French Massif Central about 120 ky ago having no contact with the Alpine ibex *C. ibex*, which had established itself in the Alps much earlier. According to Cabrera (1911) *C. pyrenaica* would have spread from the Pyrenees to the rest of the IP occupying its main mountain massifs. Geographical isolation in these massifs and genetic drift would have produced the differentiation of the four known subspecies.

The Crégut-Bonnoure hypothesis has been found to be untrue, as numerous *C. pyrenaica* fossils have been found in the IP prior to the Magdalenian and molecular genetic studies have shown a close relationship between Alpine ibex and *C. pyrenaica* (Manceau *et al.* 1999, Ureña *et al.* 2018). The Crégut-Bonnoure' hypothesis is also known as the "double-way" hypothesis. In contrast, Manceau *et al.* (1999) propose the "single-way hypothesis" whereby *C. pyrenaica* and *C. ibex* would descend from a common ancestor related to *C. camburgensis* (García-González *et al.* 2021). The divergence between both species would have occurred 600 ky ago based on some authors or between 90-50 ky according to Ureña *et al.* (2018).

Figure 2: Comparison of female skulls of *Capra p. pyrenaica* (left) and *C. p. hispanica* (right) (photo M. Maza).

Besides that, there is evidence of the presence of Alpine ibex in the Pyrenees and further south during the Upper Pleistocene and even *Capra* fossils dated between 495 and 241 ky attributed to *C. camburgensis* have been found in south-eastern IP. These findings would lead to a third hypothesis. Ancient goats of the Earlier Pleistocene (*C. baetica*, *C. alba*) found in the south-eastern IP, could have remained there throughout the Pleistocene. These goats could have given rise to the ancestor of *C. hispanica* (*sensu lato, s. l.*[1]) and during the warm interglacial periods they could have migrated northwards coming in contact with the Alpine ibex (or their ancestor) hybridizing and giving rise to *C. pyrenaica* (*sensu stricto, s. str.*) of the Pyrenees (currently *C. p. pyrenaica*). This process has been observed in other species, both in plants and animals [glacial shelters and "suture zones" of Taberlet *et al.* (1998)]. If this was the case, the modern *C. pyrenaica* could then have a hybrid origin.

Cabrera's (1911) classification was based on few specimens and highly variable characters, so it has often been questioned. As an example, two populations belonging to the same subspecies show genetic distances greater than those shown with another population of a different subspecies (Cardoso *et al.* 2021).

The early study of Manceau *et al.* (1999) based on mitochondrial DNA found that the Pyrenean population (*C. p. pyrenaica*) is clearly differentiated from the rest of the Iberian populations, with an equidistant genetic distance between these and the Alpine ibex. Recent molecular genetic studies agree with the same result (Ureña *et al.* 2018, Barros *et al*. 2022) and morphometric works also coincide.

Therefore, the research carried out until now allows us to deduce that the subspecies described by Cabrera (1911) are not valid and that there are two well-differentiated clades separating the extinct Pyrenean goats (*C. pyrenaica s. str.*) and the rest of the Iberian subspecies (Fig. 2). This resembles what was originally described as *C. pyrenaica* and *C. hispanica* by Schinz (1838) and Schimper (1848), respectively. Therefore, it would be reasonable to abandon the present-day single-species classification of *C. pyrenaica* and return to the two earliest species. This means that current living Iberian wild goats should be considered as *Capra hispanica*, and not *Capra pyrenaica*.

If the division of the present *C. pyrenaica* is accepted, should *C. pyrenaica* (*s. str.*) and *C. hispanica* (*s. l.*) have species status? It is difficult to apply a strict species concept (e.g. reproductive isolation) in this particular case (and in the genus *Capra* in general), as there is evidence that *Capra* species can hybridise and their offspring be fertile (Couturier 1962). Cases of genetic introgression of domestic goats *C. hircus* with *C. pyrenaica* have recently been found (Angelone *et al*. 2018, Cardoso *et al.* 2021).

However, other species concepts are possible. In fact there seems to be a continuum from reproductive isolation to panmixia (Zachos 2018). Manceau et al. (1999) proposed to call Evolutionary Significant Units to the different varieties of Iberian goats, but this has the drawback that ESUs are not legally recognised categories (Zachos *et al.* 2014). In any case, the taxonomy of the possible new species *C. pyrenaica* and *C. hispanica* (or the restitution of the old species of Schinz and Schimper) would be an interesting topic of debate, although difficult to solve, given the extinct nature of the pyrenaica and lusitanica varieties.

As for the other current subspecies, Cabrera (1911) considered lusitanica close to C. pyrenaica (s. str.) and in the absence of genetic analysis it could be considered a subspecies of it so its nomenclature would not change (*C. pyrenaica lusitanica*). Regarding the subspecies victoriae and hispanica, although some have observed differences in ecological adaptations (Acevedo & Real 2011), most of the studies point to the lack of differentiating characters between them (Ureña *et al.* 2018, Cardoso et al. 2021, García-González *et al.* 2022).

For these reasons we advocate not considering living subspecies of Iberian wild goat as good subspecies and propose to abandon the use of these subspecific levels. On the other hand, we suggest that a debate should be opened around the eventual separation of the extinct Pyrenean goats from the rest of the Iberian varieties, with the taxonomic implications that this would entail.

[1] Present-day non-Pyrenean subspecies: hispanica, victoriae and lusitanica.

References

Acevedo P., R. Real – 2011. Biogeographical differences between the two *Capra pyrenaica* subspecies, *C. p. victoriae* and *C. p. hispanica*, inhabiting in the Iberian Peninsula: conservation implications. *Ecological Modelling* 222: 814–823.

Angelone S., M.J. Jowers, A.R. Molinar Min, P. Fandos, P. Prieto, M. Pasquetti, et al. – 2018. Hidden MHC genetic diversity in the Iberian ibex (*Capra pyrenaica*). *BMC Genetics* 19: 28.

Barros T., J.M. Fernandes, E. Ferreira, J. Carvalho, M. Valldeperes, S. Lavín et al. – 2022. Genetic signature of blind reintroductions of Iberian ibex (*Capra pyrenaica*) in Catalonia, Northeast Spain. *PLoS ONE* 17: e0269873.

Cabrera A. – 1911. The subspecies of the Spanish ibex. *Proceedings of the Zoological Society of London* 66: 963–977.

Cardoso T.F., M.G. Luigi-Sierra, A. Castelló, B. Cabrera, A. Noce, E. Mármol-Sánchez, et al. – 2021. Assessing the levels of intraspecific admixture and interspecific hybridization in Iberian wild goats (*Capra pyrenaica*). *Evolutionary Applications* 14: 2618–2634.

Couturier M.A.J. – 1962. *Le bouquetin des Alpes* (*Capra aegagrus ibex ibex* L.). Ed. par l'auteur. Grenoble.

Crégut-Bonnoure E. – 2006. European Ovibovini, Ovini and Caprini (Caprinae, Mammalia) from the Plio-Pleistocene: new interpretations. *Cour. Forsch.-Inst. Senckenberg* 256: 139–158.

García-González R., J. Herrero, C. Nores – 2021. The names of southwestern European goats: is Iberian ibex the best common name for *Capra pyrenaica*? *Animal Biodiversity and Conservation* 44: 1–16.

García-González R., J. Herrero, P. Acevedo, M.C. Arnal, D. Fernández de Luco – 2022. Iberian Wild Goat *Capra pyrenaica* Schinz, 1838. In: L. Corlatti, F.E. Zachos (eds) *Terrestrial Cetartiodactyla, Handbook of the Mammals of Europe*. 409-431. Springer International, Cham, Switzerland.

Herrero J., P. Acevedo, M.C. Arnal, D. Fernández de Luco, C. Fonseca, R. García-González, J.M. Pérez, E. Sourp – 2021. *Capra pyrenaica* (amended version of 2020 assessment). The IUCN Red List of Threatened Species 2021: e.T3798A195855497. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T3798A195855497.en

Manceau V., J.P. Crampe, P. Boursot, P. Taberlet –1999. Identification of evolutionary significant units in the Spanish wild goat, *Capra pyrenaica* (Mammalia, Artiodactyla). *Animal Conservation* 2: 33–39.

Schimper W.P. –1848. Note sur une troisième espèce de Bouquetin en Europe (*Capra hispanica*). *Comptes Rendus hebdomadaires séances de l'Académie des Siences* 26: 318–320.

Schinz H.R. – 1838. Bemerkungen über die Arten der wilden Ziegen, besonders mit beziehung auf den Sibirischen Steinbock, den Seinbock der Alpen und den Steinbock der Pyrenaeen. *Neue Denkschriften der allgemeinen Schweizerischen Gesellschaft für die gesammten Naturwissenschaften* 2: 1–26.

Taberlet P., L. Fumagalli, L., A.G. Wust-Saucy, J.F. Cosson – 1998. Comparative phylogeography and postglacial colonization routes in Europe. *Molecular Ecology* 7: 453–464.

Ureña I., E. Ersmark, J.A. Samaniego, M.A. Galindo-Pellicena, E. Crégut-Bonnoure, H. Bolívar, et al. – 2018. Unravelling the genetic history of the European wild goats. *Quaternary Science Reviews* 185: 189–198.

Zachos F.E. – 2018. Mammals and meaningful taxonomic units: the debate about species concepts and conservation. *Mammal Review* 48: 153–159.

Zachos F.E., S. Mattioli, F. Ferretti, R. Lorenzini – 2014. The unique Mesola red deer of Italy: taxonomic recognition (*Cervus elaphus italicus* nova ssp., Cervidae) would endorse conservation. Italian Journal of Zoology 81: 136–143.

Spelling errors in binomial and trinomial names in Caprinae species: *Capra* and *Rupicapra* species as study cases

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Research and reporting documents containing spelling errors in binomial and trinomial names is a potential source of unnecessary synonyms and can lead to misinterpretation and confusion among readers (Raghavan & Dahanukar 2015). This issue has already been explicitly addressed in research on, for example, fish (Raghavan & Dahanukar 2015), plants (Wagner 2016) and arthropods (Guglielmone *et al.* 2009) as correct spelling is a fundamental prerequisite for many steps in data processing. Cases of misspelling have been highlighted for a few ungulate species (e.g., as cited in Groves & Grubb 2011), although, to my knowledge, notes listing the numerous cases of misspelling of mammal names are rare. This brief comment gathers a list of spelling errors of variable occurrence in *Capra* and *Rupicapra* species. These errors were noted during research for manuscripts in preparation for potential further publication. More than 500 spelling errors were found in sources listed by Google Scholar for *Capra* and *Rupicapra* species (Fig. 1 and Table 1) and more than 1200 for the eleven species cited in this note.

Of the *Capra* and *Rupicapra* species, the most common mistakes at the binomial level were for *Capra pyrenaica* followed by *Capra sibirica*, *Capra aegagrus* and *Rupicapra pyrenaica*. At the trinomial level, in these genera, the highest occurrences of spelling errors were detected for *Capra aegagrus blythi* and *Capra falconeri cashmiriensis*. Spelling errors are not exclusive to *Capra* and *Rupicapra* species, as exemplified by mistakes in the names of *Pantholops hodgsonii* and *Ovis nivicola koriakorum*.

These preliminary results are far from being an exhaustive list and rather aim to highlight problems that have up till now received little attention. The avoidance of spelling errors is a challenge all authors face, and their origin may be in part due to typing errors, unintended changes by automatic spell checkers, or associated with the use of grey literature and lower-impact journals that may contain more mistakes (Drake *et al.* 2013). In any event, spelling errors in species' names can propagate taxonomic inaccuracies in the scientific literature (Raghavan and Dahanukar 2015), just as any other misinformation can spread in ecology (Drake *et al.* 2013). The observed occurrences, recurrences and topical nature of spelling errors raise doubts about positive trends in spelling accuracy, just as citation accuracy already does in polar research (McIntyre and Haussmann 2021) and in the various applications of the IUCN Guidelines (Charra & Sarasa 2018).

Figure 1: Examples of screenshots of spelling errors found in references relating to the genus *Capra* and *Rupicapra* detected using Google Scholar.

Spelling errors, notably of names of species, are a challenging issue for all scientists and conservationists seeking to maintain consistency and accuracy in the scientific literature. Spelling errors in names raise questions about other errors in the same references and may complicate searches and reviews that are based on keywords. Greater awareness by all of this issue will help consolidate the perceived trustworthiness of the literature that is the keystone to species conservation.

Table 1: Occurrences of the observed spelling errors in the binomial and trinomial names of *Capra* and *Rupicapra* species estimated using Google Scholar on 10 October 2022.

Binomial or trinomial names	Observed spelling errors	Occurrences
Capra pyrenaica	*Capra pirenaica*	217
Capra pyrenaica hispanica	*Capra pyrenaica hyspanica*	4
Capra pyrenaica victoriae	*Capra pyrenaica victoria*	8
Capra pyrenaica pyrenaica	*Capra pirenaica pirenaica*	2
Capra pyrenaica pyrenaica	*Capra pyrenaica pirenaica*	2
Capra sibirica	*Capra siberica*	91
Capra aegagrus	*Capra aegragrus*	46
Capra aegagrus aegagrus	*Capra aegagrus aegragrus*	5
Capra aegagrus blythi	*Capra aegagrus blithy*	18
Capra walie	*Capra walia*	16
Capra falconeri	*Capra falconieri*	13
Capra falconeri cashmiriensis	*Capra falconeri cashmirensis*	4
Capra falconeri heptneri	*Capra falconeri heptner*	1
Capra ibex	*Capra ibes*	11
Capra cylindricornis	*Capra cilindricornis*	8
Rupicapra pyrenaica	*Rupicapra pirenaica*	47
Rupicapra pyrenaica pyrenaica	*Rupicapra pyrenaica pirenaica*	3
Rupicapra pyrenaica pyrenaica	*Rupicapra pirenaica pirenaica*	4
Rupicapra pyrenaica parva	*Rupicapra pyrenaica prava*	1
Rupicapra pyrenaica parva	*Rupicapra pyrenaica parv*	1
Rupicapra rupicapra	*Rupicapra rupicapa*	7
Rupicapra rupicapra	*Rupicapra rupicarpa*	7
Rupicapra rupicapra rupicapra	*Rupicapra rupicapra rupicarpa*	1
Rupicapra rupicapra cartusiana	*Rupicapra rupicapra cartusana*	1

References

Charra M., M. Sarasa – 2018. Applying IUCN Red List criteria to birds at different geographical scales: similarities and differences. *Animal Biodiversity and Conservation* 41: 75–95.

Drake D., B. Maritz, S. Jacobs, C. Crous, A. Engelbrecht, A. Etale et al. – 2013. The propagation and dispersal of misinformation in ecology: Is there a relationship between citation accuracy and journal impact factor? *Hydrobiologia* 702: 1–4.

Groves C., P. Grubb – 2011. *Ungulate taxonomy*. Johns Hopkins University Press, Baltimore, Maryland.

Guglielmone A.A., R.G. Robbins, D.A. Apanaskevich, T.N. Petney, A. Estrada-Peña, I.G. Horak – 2009. Comments on controversial tick (Acari: Ixodida) species names and species described or resurrected from 2003 to 2008. *Experimental and Applied Acarology* 48: 311–327.

McIntyre T., N. Haussmann – 2021. Declining citation accuracy in polar research. *Polar Record* 57: e43.

Raghavan R., N. Dahanukar – 2015. Taxonomy matters. *Current Science* 108: 1416–1418.

Wagner V. – 2016. A review of software tools for spell-checking taxon names in vegetation databases. *Journal of Vegetation Science* 27: 1323–1327.

8th World Conference on Mountain Ungulates, Cogne (Italy), 27-30 September 2022

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Three years had passed since the last WCMU meeting in Bozeman (Montana, USA), a time during which we all had to deal with the covid-19 pandemic issues, it was fantastic that the community of mountain ungulate researchers could finally meet again.

The 8th World Conference on Mountain Ungulates was held in Cogne (Italy) from 27 to 30

September 2022. More than 160 people from 24 countries gathered in the Italian Alps to present and discuss recent research findings. The aim of the conference was to bring together experts from all over the world to provide an inclusive approach that integrates different perspectives to foster effective mountain ungulate conservation and management.

The conference was organized by the Gran Paradiso National Park, in collaboration with the Abruzzo, Lazio and Molise National Park, in the framework of the joint celebrations for the 100th anniversary of foundation of the two Parks, under the endorsement of the IUCN Caprinae Specialist Group and the GSE-AIESG. The conference was sponsored by the Italian Ministry for the Ecological Transition (MITE) and the Regione Valle d'Aosta. The logistics were supported by Fondation Grand Paradis.

More than 70 oral contributions and 30 posters were proposed and blindly evaluated by the scientific committee, composed of 12 researchers from 9 countries. The final program included 56 oral presentations, 6 invited talks and 36 posters.

After the welcoming and an introduction by Dr. Bruno Bassano, Director of Gran Paradiso National Park, the conference proceedings were opened by Prof. Sandro Lovari with a discussion of advances in understanding of Alpine chamois *Rupicapra r. rupicapra* ecology obtained through long-term research, that had been conducted within Gran Paradiso National Park. The opening talk was followed by another invited talk by Dr. Stefan Michel who opened the "Conservation and Management" session providing an overview of the results and challenges of the IUCN re-assessment of Caprinae species. The other presentations of the session described conservation challenges and status of different species around the world: Markhor *Capra falconeri* in Pakistan, India and Tajikistan, Walia ibex in Ethiopia *Capra walie*, Iberian wild goat *Capra pyrenaica* in the Pyrenees, Alpine and Apennine chamois *Rupicapra pyrenaica parva*, Alpine ibex *Capra ibex* and bighorn sheep *Ovis canadensis* in different parts of their distribution area.

The second day of the conference began with the "Ecology and Evolution" session, opened by Prof. Marco Festa-Bianchet who explained how intense directional selective pressure from trophy hunting can cause evolution of smaller horns in bighorn sheep. The other talks of this diverse session presented different approaches to the study of the ecology of ungulate species and their interactions with the environment and other species. The following session concerned, "Genetics, Systematics and Paleontology", and was opened by Prof. Josephine Pemberton with an introduction on inbreeding depression and its effects on ungulates inhabiting islands. The following presentations covered a broad range of techniques and questions ranging from genetics used to inform reinforcement to ancient DNA.

During the third and last day of the conference, the "Behaviour" session opened with an invited talk by Dr. Luca Corlatti who offered an overview of the patterns and processes shaping mountain ungulate mating systems. This was followed by communications on movement, activity rates and intra and inter specific interactions. In the "Monitoring methods and conservation technologies" session, both field techniques for data collection as well as new data analysis techniques were proposed to advance the study and conservation of mountain ungulates. Finally, the "Health and Diseases" session was opened by Dr. Dominique Gauthier with an invited talk on sanitary issues related to mountain ungulates; presentations on health status and physiology of different species were also given.

The complete program of the conference and the abstract book can be downloaded from here.

The conference also offered opportunities to socialize, very much needed after the last two years of social distancing. The icebreaking aperitif during the poster session on the first evening, and the social dinner in the communal gym in Cogne, offered the participants a taste of the local food and beverages as well as the possibility to interact with each other in a friendly environment. Finally, the last day excursion brought the participants to Levionaz, the study site that hosts a long-term research project on Alpine ibex. The scenery with soft snow falling on the dark winter coats of the ibex that were placidly eating the last dry grass of the autumn and getting ready for winter, gave the participants a glimpse into the life of these majestic ungulates and constituted a worthy closure of four fantastic days.

The organizers of the conference and the scientific committee were very pleased to receive contributions from different parts of the world to extend our effort to facilitate participation of the largest number of researchers, including participants from lower-income countries. Unfortunately, due to visa-related issues, this has not always been possible, and we are sincerely sorry for that. However, we believe that the participation of researchers from 24 countries made the meeting worthy of its name. The presence of a high proportion of young women from different countries was also welcomed. Mountain ungulate research has mostly been conducted by male researchers in the past and seeing more women in this field is a very positive change.

The topics discussed during the conference were numerous and diverse, and it is very difficult to provide an exhaustive summary. However, we would like to highlight what we brought home from the conference. Most mountain ungulates are in some way affected by global change, habitat loss and human-related disturbance, but the effects are not always clear and easy to interpret. In addition, data on many species are lacking, as demonstrated by the re-assessment of the Caprinae species red list. Exchanges between researchers working in different areas are therefore necessary to foster the conservation of mountain ungulates as they often inhabit areas and countries difficult to access. The work of the local researchers, that often work in sub-optimal or even prohibitive conditions, is paramount for the conservation of species and occasions like the WCMU are a unique opportunity to publicise these species, places and people. In countries with the most difficult socio-economic context, where human-wildlife interactions can affect the conservation of endangered mountain ungulates, the involvement of local communities is necessary. Again, the importance of long-term data collection has once more been demonstrated by many presentations that showed that some phenomena can only be understood after many years. Finally, the global challenges of species conservation also require a global approach to scientific research, not only sharing results but also sharing data and promoting large scale collaborations.

We thank the members of the scientific committee, the chairpersons of the different sessions as well as all the authors and the participants for animating a lively and interesting conference. We also want to thank Sandro Lovari and Juan Herrero for their support during the organization of the conference.

The next WCMU is planned to be in Tajikistan in 2024 and with pleasure we pass the baton to the new organizing committee with best wishes for the organization of another successful meeting!

Notice to contributors

Submissions of articles, including research re- ports, conservation news, recent publications, etc., on wild or feral Caprinae, are always welcome from any professional biologist. A potential author does not have to be a member of the Caprinae Specialist Group.

Please send submissions *before September of each year* to the Chief Editor by e-mail attachment (luca.corlatti@wildlife.uni-freiburg.de).

Author guidelines are available for download on the CSG Website: please follow them carefully before submitting your paper!

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