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LETTER FROM THE CONSERVATION FRONT LINE

Human impact and environmental conditions lead to a mass mortality event of David's Myotis (*Myotis davidii*) in Mongolia

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Anthropogenic factors are an important driving force impacting bat populations across the globe. These include habitat loss and alteration, infectious diseases, climate change, and human persecution. Multiple factors typically impact populations simultaneously, which can have severe consequence for biodiversity. Mongolia has a large number of cave systems with over 500 documented in the country, of which only ~300 have been explored (Avirmed, 2020). The lack of exploration in these sites reveals a significant information gap in our understanding of Mongolian bat species and their use of the extensive cave systems throughout the country. Most temperate bat species hibernate in caves (Romero, 2009; Furey & Racey, 2016). Of the 20 species of bats currently recorded in Mongolia, seven are found in caves during hibernation. With harsh and dry climate of Mongolia most of the caves host a low abundance of bats, with just a few sites serving as critical winter sites for these populations.

The Shar khanan cave, located in Undurshil soum of Dundgobi province, in southern Mongolia, is one of the hibernacula sites for David's Myotis (*Myotis davidii*) in the country (Fig. 1). The cave is surrounded by semi-desert (North Desert) with vegetation communities primarily comprised of psammophytic bunchgrass (*Stipa gobica*, *S. glareosa*) Caragana, (*Ceratoides papposa*) and Stipa-Cleistogenes communities growing on brown loose-sandy soils and sands (Gunin & Saandar, 2019). The cave is 25 m deep and 173 m long (Avirmed, 2020). The site is completely dry with no water (Vaks *et al*., 2013). The average air temperature in the cave is 4°C.

Myotis davidii is listed as Least Concern by IUCN (Jiang & Feng, 2019) that primarily occurs in arid habitats (desert and desert-steppe), and is known to use rock crevices, tree hollows, livestock pens, buildings and caves for roosting and hibernation (Batsaikhan *et al*., 2022). It has also been associated with forest habitat in China, where it exclusively uses cave sites for roosting (Jiang & Feng, 2019). This species has been previously confirmed hibernating in several caves in Mongolia's southern and eastern areas (Avirmed, 2020; Hoyt *et al*., 2020).

In April 2024, we conducted cave surveys to study bat hibernation ecology in southern Mongolia. During the study, we visited Shar khanan cave and found the entrance was completely covered by dried grass and sand. We excavated the material to examine the cave entrance. Upon removal of the debris, we found that a mass mortality event of *M. davidii* had occurred inside the cave. We collected 1,208 dead bats from inside the cave and estimated that ~2000 bats had died in total. It appeared that the mortality event had been caused by the obstruction of the entrance. Based on interviews with local herders who live next to the cave, this likely occurred in 2022, 2 years before to our discovery.

Dust events occur frequently in the Gobi Desert zone and across much of the Mongolian grassland area (Lee & Sohn, 2011). Dust storms in the area can have significant negative consequences in the region, including causing a reduction of pasture land for livestock, road closures, settlements and villages can become enshrouded with sand (Natsagdorj, Jugder, & Chung, 2003). There has been an increasing trend in the number of dusty days in southern Mongolia resulting from strong winds. This is on average 2–6 days per year (Amgalan *et al*., 2017) during periods when soil is dry and humidity levels are low. Human activities

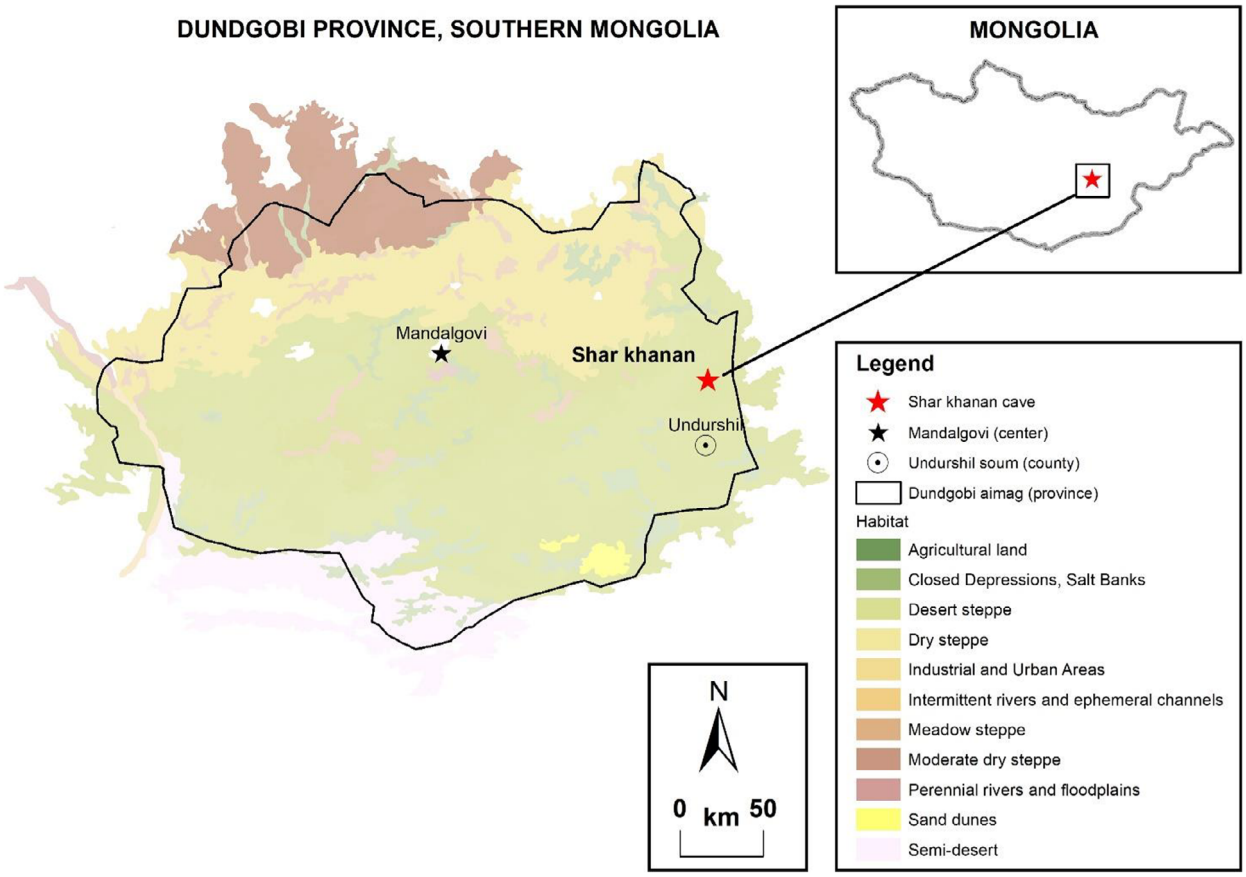

Figure 1 Location of Shar khanan cave in Undurshil, Dundgobi, Mongolia and the surrounding habitat.

may also have important effects in contributing to these significant dust events in some parts of the country (Amgalan *et al*., 2017).

In April 2016, at Shar khanan, we found evidence of a net-like wooden material installed over the cave entrance by local herders, in an attempt to protect their livestock (especially sheep and goats) from falling into the cave. The wooden material completely covered the cave entrance with no openings for bats to escape (Fig. 2f). We believe that human activities may have exacerbated a blockage of the cave entrance and is the primary cause of the mortality of bats in the cave. Human disturbance can cause over-winter mortality in temperate zone bats (Furey & Racey, 2016); however, documentation of die-offs in animals is rare, but particularly in bats who are secretive and even large-scale mortality events may be overlooked (O'Shea *et al*., 2016). Here, we document the first confirmed mass mortality event of this species in Mongolia (Fig. 2). Bat populations are under severe threat in many regions of the world (Voigt & Kingston, 2016), and recent increases in mortality from other anthropogenic sources have put greater pressures on many populations of bats (O'Shea *et al*., 2016). Bats in Mongolia are generally at low abundance and the loss of c. 2000 bats will likely have a significant effect on the bat population in the area. Policies, education, and conservation activities focusing on human-induced mortality are urgently needed in Mongolia to prevent future events like this from occurring. More public awareness, and working with locals to ensure both bats and livestock are safe will provide the most effective conservation measures. Future work will examine the 1,208 bats that were collected to determine age structure. We also deployed temperature and humidity loggers (HOBO Pro v2) to monitor changes in environmental conditions that could also influence bat mortality during hibernation. Finally, bat-friendly gating and fencing will be installed at this site to reduce the risk of this occurring in the future.

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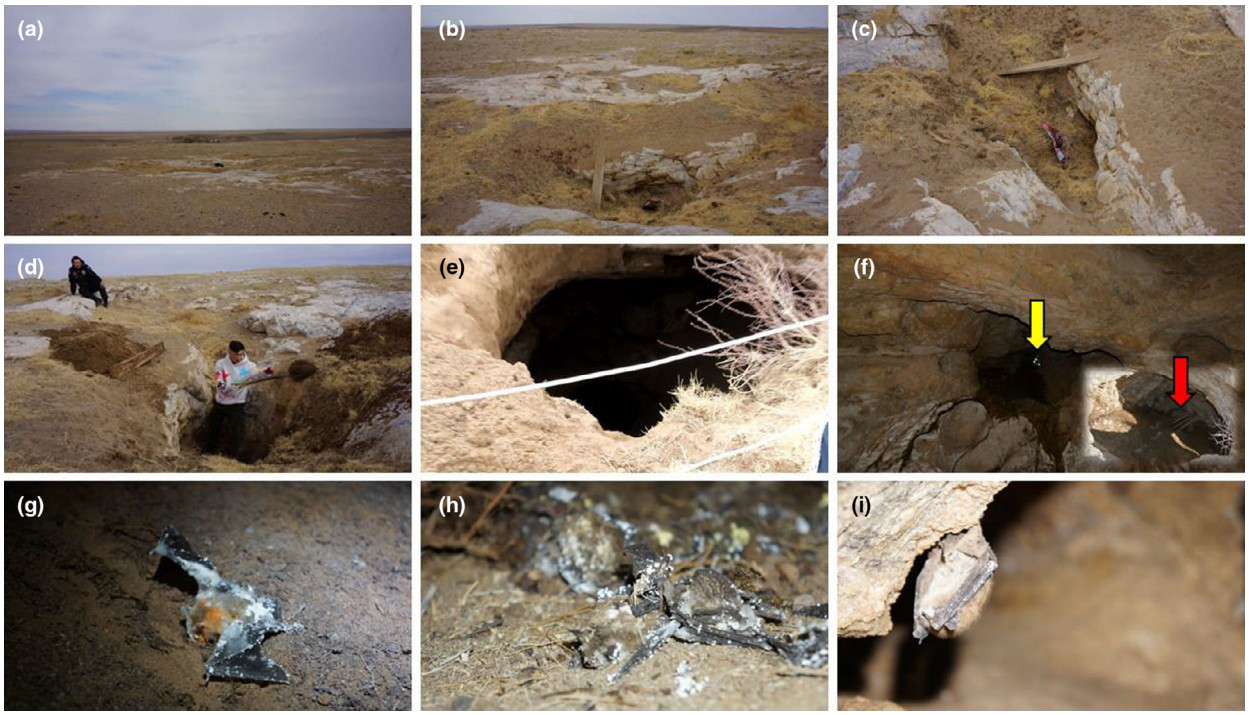

Figure 2 Shar khanan cave. (a) Surroundings of the cave, (b and c) Blocked entrance of the cave, (d) Excavation of the entrance, (e) Opened entrance, (f) Wooden gate of the cave from in (yellow arrow) and outside (red arrow), (g–i) Thousands of mummified bat remains found at the wall, vestibule, and floors of the cave.

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