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## Rabies in a Sand Cat (*Felis margarita*) in Saudi Arabia: One Health Implications

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**ABSTRACT:** We report a case of rabies in a sand cat, *Felis margarita*, from Saudi Arabia. This incident suggests hitherto undocumented spill-over infection in this species. Our report highlights the shortcomings of passive reporting, necessity of wildlife surveillance, and the need for a comprehensive One Health approach to disease prevention and control.

Rabies is an acute, progressive viral zoonosis and one of the oldest known infectious diseases (Tarantola 2017). Rabies surveillance in multiple localities, including the Middle East, remains challenging (Rupprecht et al. 2018). Animal rabies is enzootic throughout the Arabian Peninsula, with the first recorded human case in Saudi Arabia occurring during 1981 (Bales et al. 1982; Kasem et al. 2018). Thousands of animal bites are recorded annually, with sporadic human rabies cases reported (Memish et al. 2015; Dhayhi et al. 2019). The red fox (*Vulpes vulpes arabica*) is considered the primary regional reservoir (Seimenis 2008; Horton et al. 2015). We describe a case of rabies in a sand cat (*Felis margarita*), a small, solitary, desert-adapted felid distributed in northern Africa, the Middle East, and central Asia.

On March 11, 2011, an agitated sand cat launched an unprovoked attack on a 55-yr-old man on his wheat farm in Sharri, a village in Oyoun Al-Jawa, Qassim region. He killed the animal and presented it for medical evaluation at the nearest Primary Healthcare

Center (PHC). He had sustained multiple, deep puncture wounds on his head, hand, and thigh. His wounds were washed thoroughly under flowing water for 15 min, and then infiltrated with equine rabies immune globulin (Vins Bioproducts, Hyderabad, India) at 40 IU/kg body weight. He was given the first of a 5-dose anti-rabies vaccine (ARV; Sanofi Pasteur, Lyon, France) regimen, as per the Ministry of Health (MOH) postexposure prophylaxis guidelines, and received anti-tetanus toxoid (Serum Institute of India, Pune, India). Thereafter, he was transferred to a specialist hospital in Buraydah, the capital of Qassim. The animal's head was sent to the laboratory of the Ministry of Agriculture, Water and Environment (MEWA) in Buraydah. The brain was removed and tested for rabies virus antigens using the direct fluorescent antibody technique (World Health Organization 2018) with fluorescein isothiocyanate anti-rabies virus monoclonal globulin conjugate (Fujirebio Diagnostics Inc., Malvern, Pennsylvania, USA). Impressions from the brainstem, hippocampus, and cerebellum tested positive via the direct fluorescent antibody test; the PHC was notified. The farmer returned to Sharri and was informed of the diagnosis. The PHC staff ensured that he completed the remainder of his ARV regimen. He remains alive.

This case of laboratory-confirmed rabies in a sand cat has public health and wildlife

conservation implications. Given its solitary lifestyle, the sand cat may play a poorly understood role in rabies epizootiology within its geographic distribution. As with other felids, the sand cat was probably infected by a spillover infection from a primary reservoir. This reservoir remains unknown, as the brain sample was not retained, and no cross-species insights were obtained due to the lack of viral characterization.

The Qassim region exemplifies how interactions among farmers, their livestock, and wildlife facilitate such spillover events. Numerous farmlands produce a variety of arable crops, fruits, and vegetables, contributing to the local economy. With wildlife engagement, together with free-ranging dogs and cats, opportunities for human-animal interactions can be expected, with associated sporadic outbreaks. Characteristic of the human-domestic animal-wildlife interface in this ecosystem, fox incursions into human habitations and farmlands with livestock or poultry are not uncommon. For example, fox-mediated rabies virus transmission to camels (*Camerlous dromedarius*) has been documented (Al-Dubaib 2007). In addition, previous studies indicate that multiple bat species are sympatric with foxes, sand cats, and other wildlife in Qassim and nationwide (Memish et al. 2013). Although bats may harbor undetected lyssaviruses, the existing surveillance system is not able to characterize viral variants and infer cross-species transmission events.

The passive surveillance system comprises mainly the submitted animal and exposed human components. Animal testing depends on submission of whole or partial carcasses, predominantly by bite victims and farmers. Domestic animals (mainly dogs and camels) constitute the most frequent samples; wildlife submissions (mainly foxes and wolves) are much less common (Kasem et al. 2018). Data on animal bite victims managed at PHC facilities are submitted monthly in aggregated form. Notably, not all managed cases are documented. For case management, the MOH provides free postexposure prophylaxis to all bite victims. Despite this, the completion of the 5-dose ARV regimen, as recorded

here, is not always achieved due to several factors, including public awareness and the limited mobility of at-risk farm workers. Additionally, outcomes (survival or death) are often unknown. Bite cases are not always reported to MEWA or to the wildlife authorities. Trained animal control officers are lacking. Consequently, the rabies testing status of the biting animals is often unresolved and unlinked to human rabies cases. Currently, despite the size of the country, there are only two laboratories that conduct rabies testing, one each for humans (Saudi Public Health Authority in Riyadh) and animals (in Ahsa under MEWA). The other MEWA laboratory in Buraydah (where the sand cat was tested) ceased testing in late 2014.

Sand cats interact with humans, livestock, and other wildlife within and outside protected areas in Saudi Arabia (Strauss et al. 2007). Poaching of sand cats has been reported (Mallon and Budd 2011), with intense online trading observed during the 2020 COVID-19 pandemic lockdown. Left unchecked, such activities threaten conservation efforts, with possible spillover to other wildlife. Translocation of potentially rabid wildlife may initiate epizootics, as have been reported elsewhere (Rupprecht et al. 2018). Though sand cats are currently considered “not threatened,” continued poaching could precipitate a conservation crisis (Sliwa et al. 2016).

The MOH-MEWA collaboration reported in this case is fundamental to the One Health approach. However, an ideal rabies surveillance system should incorporate wildlife monitoring with real-time reporting and sharing of animal and human data. Rabies control should leverage on the renewed One Health commitments of the G20 leadership during the 2020 COVID-19 pandemic. Additional leverage is provided by the country’s National Transformation Program with its supportive One Health themes (Kingdom of Saudi Arabia 2016). A transformed system should include animal control officers who facilitate multisectoral response and testing. Most importantly, and given the country’s size, nationwide testing capacity should be established strategically, with animal and

human laboratories linked. A central laboratory should coordinate rabies virus variant characterization.

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