



Letter to the Editor

A collective statement in support of saving pangolins**Keywords:**

Pangolin
Conservation
Ecology
Captive breeding
Immunology

We are an international group of biological scientists, conservationists, and environmentalists who have been closely following the plight and conservation of pangolins over a number of years. Pangolins comprise the mammalian Order Pholidota, which contains eight living species found in diverse habitats in Africa (4 species) and Asia (4 species), which provide important ecosystem services, including providing “pest” control and improving soil quality (Chao et al., 2020). They remain the most threatened and trafficked mammal species in the world (Gaubert et al., 2018; Sarah Heinrich et al., 2016). For over a century, there have been numerous attempts to rescue and maintain these animals in captivity, but with very few examples of success, chiefly because they usually die of infection (Hua et al., 2015; Lihua et al., 2010). In 2016, the genomes of the *Critically Endangered* Chinese and Malayan pangolins (Fig. 1) were sequenced and revealed two important findings (Choo et al., 2016). First, to the best of our knowledge, pangolins are the only mammals known to lack the *IFNE* (Interferon epsilon) gene (important for mucosal immunity), suggesting that their resistance to pathogens may be reduced. Moreover, we found that pangolins have a reduced number of the heat shock protein (HSP) gene family members, suggesting stress susceptibility inducing immunosuppression, more so than other mammalian lineages. These findings may help explain why captive pangolins frequently succumb to infection.

Leveraging upon the genome-driven biological insights, researchers have successfully established a captive Malayan pangolin population up to the third filial generation, by keeping the environment, food and water as hygienic as possible (Yan et al., 2021) under proper husbandry conditions. These pangolins may serve as genetic stocks for re-establishing dwindling natural populations and bolstering populations of wild pangolins, and helping to maintain genetic diversity. Notably, successful reintroduction of captive breeding populations have prevented the extinction of many species including the Arabian Oryx (*Oryx leucoryx*) (Ostrowski et al., 1998), the Yellow-shouldered Amazon Parrots (*Amazona barbadensis*) (Sanz and Grajal, 1998), the European bison (*Bison bonasus*) (Schmitz et al., 2015), the Alpine ibex (*Capra ibex ibex*) (Stüwe and Nievergelt, 1991), and the Bearded vulture (*Gypaetus barbatus*) (Hirzel et al., 2004).

However, without cooperation from all key stakeholders (including governments, researchers, and the public), successful protection of pangolins could still be far away (Heighton and Gaubert, 2021). New techniques must be developed and utilized to ensure pangolin populations are protected. Furthermore, significant efforts are needed to reduce demand

globally, since the slow reproductive rate of pangolins mean that demand will always outstrip sustainable supply if trade continues. Accordingly, we are signing (Appendix 1) and writing this Letter to voice the following suggestions and concerns:

- 1) There are an insufficient number of rescue centres that can provide adequate care for confiscated pangolins, which is a challenge to their protection. Furthermore, there is a lack of standardized guidelines for maintaining pangolins in captivity besides the fact that many veterinarians may not be trained to treat these unique animals. These undoubtedly contributed to the challenges of many institutions and zoos to maintain them in captivity. As such, capacity building in terms of manpower and expertise is definitely crucial to ensure the proper treatment and maintenance of pangolins in captivity, and hopefully the successful reintroduction into the wild. In addition, collaboration on knowledge exchange and developing standardized operating procedures to reduce unnecessary mortality should be a priority. To facilitate the management of pangolins, we recommend maintaining pangolins in specific pathogen-free (SPF) houses, similar to how we usually treat other immunocompromised animals in order to minimize the risk of infections.
- 2) With time running out for these highly endangered species, it is time to act promptly by reviewing respective laws and policies that encumber conservation of pangolins. For example, living non-native pangolins rescued from smugglers cannot be released into the wild due to legal restrictions, and they often end up dying in captivity due to improper care. Additionally, once a case is successfully filed, pangolins can be released immediately without adequate care, or whilst in too poor condition to be able to survive. Thus, the relevant authorities worldwide must work together to address these issues immediately, and to facilitate the responsible release of such animals back into their natural habitats following rehabilitation. In addition to adequate care following a seizure, for non-native species, repatriation of endangered species is essential to the long-term survival of these species. In addition, Chinese scientists have techniques to breed and maintain captive pangolins, but face challenges to obtain Chinese pangolins for breeding and re-establishing wild populations in China, while other countries have Chinese pangolins, but lack the required techniques and expertise. Clearly, this shows that international cooperation is essential for saving and re-establishing wild pangolin populations, and ensure all captive pangolins receive appropriate care. Furthermore, it is also important to investigate the genetic structure of populations (may be subpopulations) of each species of pangolin for the re-introduction of individuals to avoid any non-natural hybridization of potential subspecies. In addition, any released animals should be healthy, and free from pathogens or parasites which could infect wild individuals as well as reducing survival probability. Considering that the illegal pangolin supply chain is multi-national, involving all relevant authorities to target the entire supply-chain will result in more effective and longer lasting prosecution and protection of pangolins. To accelerate research

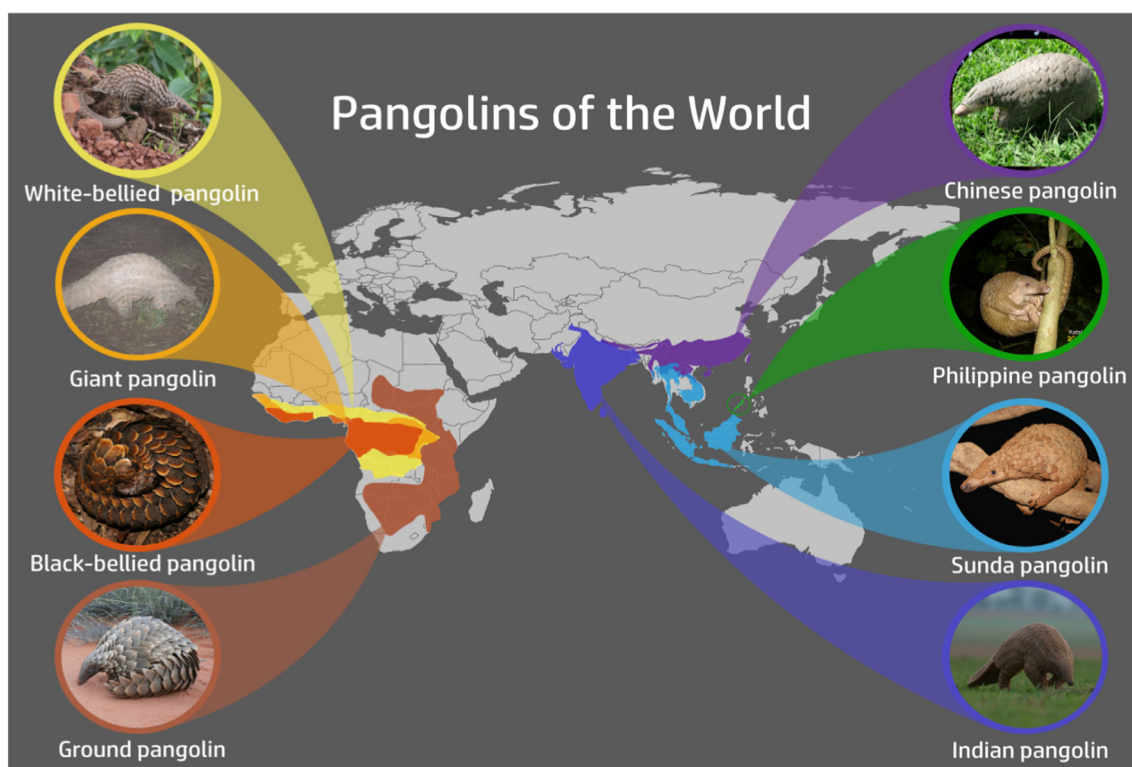


Fig. 1. Pangolin species distribution map. (Top) A Malayan pangolin (*Manis javanica*). Photo: Ju Lian Chong. (Bottom) Geographical distribution of eight extant pangolin species. Image courtesy of the IUCN/SSC Pangolin Specialist Group (Photo copyrights: White-bellied Pangolin - Tim Wachter/ZSL; Giant Pangolin - Tanzania Carnivore Program; Black-bellied Pangolin - Rod Cassidy; Ground Pangolin - Darren Pietersen; Chinese Pangolin - Sarita Jnawali; Philippine Pangolin - Katala Foundation, Inc.; Sunda Pangolin - Dan Challender; Indian Pangolin - Zeeshan Merchant).

and attract more experts to work on pangolin conservation, a green channel for fast-track regulatory approval should be provided. More funding should be developed to support the conservation efforts and to upgrade the facilities at rescue centres run by NGOs, and ensure that training

and resources are available in both range states, and regions where confiscations are recorded to have occurred. Additionally, efforts must be conducted to strengthen law enforcement and the protection of pangolin natural habitats.

The COVID-19 pandemic has had a substantial negative impact on pangolins, following two major announcements which were widely reported in the global media. Early in the pandemic, pangolins were misreported as the animal source of SARS-CoV2 as a coronavirus found in a pangolin had a 99% genome similarity with human SARS-CoV2 (Cyranoski, 2020; Kangpeng Xiao et al., 2020; Tommy Tsan-Yuk Lam et al., 2020; Department of Forestry of Guangxi Zhuang Autonomous Region, 2020; Hu et al., 2015). However, pangolins should not be considered the principal reservoir species for coronavirus in the absence of firm evidence, and their rarity combined with how pangolins are typically consumed make it highly improbable they played any role in disease transmission in the case of SARS-CoV2. Additionally, all the pangolins sampled in these studies were obtained during enforcement against the illegal wildlife trade, where they could have been infected by coronaviruses from other animals/reservoirs during transport, handling, or close contact with host species (including a range of carnivore species). Many subsequent studies have highlighted the improbability that pangolins were the intermediate host of SARS-CoV-2 (Siew Woh Choo et al., 2020; Boni et al., 2020; Lee et al., 2020). Despite this development a negative perception of the animals likely persists, whereas normal biosafety procedures would offset any genuine risks from handling the species. Any animal species on this planet can transmit viruses and we should not use any particular species or group of species as a scapegoat. Misconceptions of risk greatly hinder effective conservation, and unless pangolins are directly manipulated there is very little risk of disease transmission, highlighting that pangolins should be conserved and not poached, and should not be transported with animals known to be frequent reservoirs of coronaviruses or other zoonoses. With the largest spike in public interest of pangolins following this scapegoating misinformation, it is crucial to address the public's misperceptions on pangolins by underlining the increased presence of campaigns that highlight the importance of pangolin conservation (Heighton and Gaubert, 2021).

3) With the trafficking rates of pangolins continuously increasing since the pandemic (Aditya et al., 2021), it is timely to invest in community education, research and conservation capacity-building of trade source countries in unison with professional retraining of local hunters, traffickers, and sellers to permanently stop the pangolin trade. Recent international attempts included the 2015 First Pangolin Range States meeting, the 2016 MENTOR-POP (Progress on Pangolins) Fellowship Program, and various pangolin public awareness programs across the world conducted by Non-Governmental Organizations (NGOs) such as IUCN SSC Pangolin Specialist Group, WildAid and Humane Society International (HSI) with the objective to raise the profile of pangolins in the public consciousness. The increasing development and application of forensic tools are critical to investigating seizures of pangolin scales, identifying trafficking networks, and eventually shutting these down (Mwale et al., 2017; Moorat et al., 2020; Ewart et al., 2021). The public should avoid consuming/using pangolins and any pangolin-derived products, and should be encouraged strongly to report to authorities immediately if they witness evidence of poaching and/or trading of these threatened animals. The development of specific apps or similar technologies could also facilitate rapid reporting (Xin and Ziao, 2019).

CRediT authorship contribution statement

S. W. C., J. L. C., P. G., A. C. H. draft the manuscript. The manuscript was revised, proofread, approved and signed by all authors.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix 1. We sign this statement in solidarity with all parties who want to protect pangolins. All authors have approved this statement and declare no conflict of interest

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