Support for rodent ecology and conservation to advance zoonotic disease research

Thomas E. Lacher, Jr.[1,3*], Rosalind Kennerley[2], Barney Long[3], Shelby McCay[1], Nicolette S. Roach[1,3], Samuel T. Turvey[4], Richard P. Young[2]

[1]Department of Ecology and Conservation Biology, Texas A&M University, College Station, TX 77843, USA, [2]Durrell Wildlife Conservation Trust, Les Augrès Manor, Trinity, Jersey JE3 5BP, Channel Islands UK, [3]Global Wildlife Conservation, P.O. Box 129, Austin, TX 78767, USA [4]Institute of Zoology, Zoological Society of London, Regent's Park, NW1 4RY, UK

*Corresponding author, Email: tlacher@tamu.edu

Running Head: Rodents and zoonotic disease

Article impact statement: Our scientific knowledge of basic ecology and conservation science is lacking for rodents, which is critical for zoonotic disease research

Keywords: Zoonoses, population dynamics, commensalism, small mammals, pandemics

The emergence of COVID-19 has drawn world-wide attention to zoonotic diseases and increased the urgency to understand the origin and spread of zoonotic pandemics. Recent zoonosis investigations have included controlling wild-sourced animals in the exotic pet trade, markets and high-density wildlife farms (Can et al. 2019). Zoonotic host contact due to the increase in synanthropic rodent populations is also increasing transmission in human-dominated systems (Morand et al. 2019; White & Razgour 2020). The conversion of ecosystems to agriculture and suburban-urban landscapes provides more opportunities for contact between humans and vectors of potential emerging diseases (Gibb et al. 2020).

We represent researchers engaged in the IUCN SSC Small Mammal Specialist Group, responsible for the assessment of extinction risk and catalyzing conservation of the orders Rodentia, Eulipotyphla, and Scandentia. There are nearly 2,600 described species of rodents, comprising 40% of mammalian species, and many are able to survive habitat degradation, have commensal potential, and exhibit high reproductive rates (White & Razgour 2020). Recent estimates suggest that 10.7% of rodent species are known hosts of zoonoses, including bartonella, *Borrellia*, leishmaniasis, *Leptospirosis*, and plague (White & Razgour 2020), with higher viral richness than bats (Streicker & Gilbert 2020). Recent research has shown that SARS-CoV-2 variants B.1.351 (South Africa) and P.1 (Brazil) infect laboratory mouse cells and can replicate to high titers (Montagutelli et al., 2021). The potential for transmission of SARS-CoV-2 has recently been documented among deer mice (*Peromyscus maniculatus*), with this species and other wild rodents possibly able to serve as a reservoir host for the virus across a broad area of North America (Fagre et al. 2020).

Increased knowledge and understanding of the biology of hosts and vectors and a clearer understanding of the effects of human activities on host population dynamics are an important component of research on zoonotic diseases (Dobson et al. 2020). The ecology and population dynamics of rodents remain understudied, and of the 2,545 species assessed on the IUCN Red List, about 15% of the most diverse families (Cricetidae and Muridae) are classified as Data Deficient. These are also families tolerant of human disturbance and capable of explosive population growth. Ecologists and infectious disease specialists need data on rodent population and community ecology and species responses to habitat fragmentation, human incursions into wild lands, and rodent expansion into human-dominated landscapes. Fragmentation and the creation of edge and transitional habitats will draw potential hosts into closer contact with human populations working in this agricultural matrix. Fragmentation will also alter community composition and community dynamics through processes like the fragmentation threshold, resulting in the loss of specialist species and the dominance of generalists. These generalist

taxa are overwhelmingly abundant, Least Concern species more likely to be zoonotic hosts (Keesing & Ostfeld 2012) and to function as “superhosts” capable of harboring multiple zoonotic viruses. Common, abundant species require research investment for these reasons. A recent study on the role of biodiversity in reducing infectious disease risk (the dilution effect) documented increased infectious disease risk when human disturbance generates biodiversity gradients and loss of species (Halliday et al. 2020), leading to a dominance of generalists more likely to have “superhost” potential. Altered community composition also impacts patterns of viral sharing among mammalian hosts, and rodents are generally the taxon that dominates viral sharing in networks (Carlson et al. 2019). Research on landscape ecology and conservation planning integrated with studies of viral diversity and host sharing (Carlson et al. 2019), within communities of species known or suspected to be potential hosts for zoonotic diseases, is a critical component of field-based monitoring and surveillance of emergence and transmission.

Conservation must adjust to deal with global crises that impact all biodiversity (Schwartz et al. 2020). We need to invest in research on the ecology and conservation biology of wildlife species most likely to be abundant, come into contact with humans, and be potential reservoirs in future zoonotic outbreaks. Given the global presence of SARS-CoV-2 and the number of potential rodent hosts and their use in markets, microlivestock, and the wildlife and pet trade, we need more data on viral presence in rodent species. How do life history traits and population dynamics of understudied and overlooked rodent species, their status and persistence in human-modified habitats, their response over time to human disturbance, and their natural viral loads determine which species have the potential to become sources of future outbreaks? Ecology and conservation biology will be a critical component in improving zoonotic disease monitoring and control.

Literature Cited

Can OE, D'Cruze N, MacDonald DW. 2019. Dealing in deadly pathogens: taking stock of the legal trade in live wildlife and potential ricks to human health. Global Ecology and Conservation **17**: e00515.

Carlson CJ, Zipfel CM, Garnier R, Bansal S. 2019. Global estimates of mammalian viral diversity accounting for host sharing. Nature Ecology and Evolution **3**:1070-1075.

Chomel BB, Belotto A, Meslin F-X. 2007. Wildlife, exotic pests, and emerging zoonoses. Emerging Infectious Diseases **13**:6–11.

Dobson AP et al. 2020. Ecology and economics for pandemic prevention. Science **369**:379–381.

Fagre A et al. 2020.SARS-C0V-2 infection, neuropathogenesis and transmission among deer mice: implications for reverse zoonosis to New World rodents. BioRxiv https://doi.org/10.1101/2020.08.07.241810

Gibb R, Redding DW, Chin KQ, Donnelly CA, Blackburn TM, Newbold T, Jones KE. 2020. Zoonotic host diversity increases in human-dominated systems. Nature **584**:398-402.

Halliday FW, Rohr JF, Laine A-L. 2020. Biodiversity loss underlies the dilution effect of biodiversity. Ecology Letters **23**:1611-1622.

Huong NQ et al. 2020. Coronavirus testing indicates transmission risk increases along wildlife supply chains for human consumption in Viet Nam, 2013-2014. PLoS ONE **15(8)**: e0237129.

Keesing F & Ostfeld RS. 2021. Impacts of biodiversity and biodiversity loss on zoonotic diseases. Proceedings of the National Academy of Sciences **118**: e2023540118.

Montagutelli, X. et al. 2012. The B1.351 and P.1 variants extend SARS-CoV-2 host range to mice. BioRxiv https://doi.org/10.1101/2021.03.18.436013

Morand S, Blasdell K, Bordes FE, Buchy P, Carcy B, Chaisiri K et al. 2019. Changing landscapes of Southeast Asia and rodent-borne diseases: decreased diversity but increased transmission risks. *Ecological Applications* **29**:e01886.

Schwartz MW, Glikman JA, Cook CN. 2020. The COVID-19 pandemic: a learnable moment for conservation. Conservation Science and Practice 2020;**2**:e255.

Streicker D, Gilbert AT. 2020. Contextualizing bats as viral reservoirs. Science **370**:172-173.

White RJ, Razgour O. 2020. Emerging zoonotic diseases originating in mammals: a systematic review of effects of anthropogenic land-use change. Mammal Review doi: 10.1111/mam.12201.