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Monotypic species and extinction risk: looking at lagomorphs

Innovative perspectives in meta-analyses, like the study of lagomorph diversity produced by Verde Arregoitia et al. (2013), are clarifying the poorly understood relationship between biodiversity and ecosystem function. As a result, maintaining current ecosystem function relies on the preservation of as much biodiversity as possible, especially for rare or unusual clades that may have specialized roles in their environments. Species-poor vertebrate clades are more common than predicted to occur by chance (Ricklefs et al. 2007), suggesting that non-random mechanisms promote the persistence of relict species, members of once-large clades that rarely generate new species (Fig. 1). These species-poor clades, which have low net diversification, are thought to be at greater extinction risk in the anthropogenic world because of their propensity to contain species with marginal, specialized niches (Verde Arregoitia et al. 2015; Ricklefs et al. 2007). Loss of these clades would disproportionately impact global biodiversity, due to their evolutionary uniqueness, and potentially ecosystem function if evolutionary uniqueness is also related to both unusual and important functional characteristics (Hampe and Petit 2005).

In Lagomorpha, unlike other mammalian orders (such as Rodentia), there is a direct correlation between genus size and extinction risk, where species-poor clades are more likely to include threatened species (Verde Arregoitia et al. 2013). This correlation may explain why an unusually high proportion of lagomorphs overall is under threat of extinction. In a follow-up study, Verde Arregoitia et al. (2015) seek to explain the potential underlying causes of this pattern. They find that lagomorph diversity tends to be low in biotically diverse areas like the tropics, and high in areas with low richness of other mammal species. They find that lagomorphs are most diverse in temperate latitudes, opposing the latitudinal diversity gradient that predominates in most taxa. Sensitivity to high temperatures restricts the geographic ranges of many of these species (Rolland et al. 2014). Verde Arregoitia et al. (2015) also find

that evolutionary distinctiveness does not correlate with biogeographic patterns like range size. These counterintuitive results may also have implications for niche breadth, which is often related to range size.

Classic ecological studies of species and their habitats offer snapshots of species' current niches. However, they may not provide broad-enough information about a species' extinction risk or whether relatives should be expected to share similar risks. In conjunction with fossils and paleoenvironmental data, phylogenetics can be used to reconstruct within-clade evolutionary relationships, providing historical and evolutionary insight into potential threats (Cavender-Bares et al. 2012). Measures of extinction risk can often be informed by study of processes that have driven extinction in a clade in the past or through analysis of risk to related species by highlighting ecological, biogeographic, and evolutionary similarities and differences between family members (Ricklefs 2005).

Contrary to expectations, Verde Arregoitia et al. (2015) found that there may not be a direct relationship between evolutionary distance and extinction risk for species-poor lagomorph genera. Rather (p.9), "...threatened and species-poor genera... occur in productive megadiverse areas that currently experience strong habitat degradation..." and increasing anthropogenic pressure, whereas species in more diverse genera tend to live in harsher environments that have much lower overall mammalian diversity. Thus, the correlation between genus size and extinction risk is driven by a relationship between genus size and habitat quality, in which high-productivity and at-risk habitats contain a disproportionately large number of species-poor lagomorph genera. Further work is necessary to determine whether this relationship is due to lagomorphs' ability to exploit nutrient-poor habitats (Hirakawa 2002 Hacklander et al. 2008), or due to neutral processes.

This relationship between genus size and habitat quality contradicts a common explanation

given for the persistence of monotypic clades: the sleep/hide hypothesis (Verde Arregoitia et al. 2015, Liow et al. 2009). Sleeping and hiding in burrows or tunnels may buffer small mammals from variable environmental conditions, making burrowing species less extinction-prone (Liow et al. 2009). This behavior is exhibited in leporids (rabbits and hares), where monotypic genera sleep and hide more often than species-rich genera, but not for pikas, which are diverse at both species and genus levels. The sleep/hide hypothesis is a possible explanation for how species-poor clades persist, but it suggests that these clades should be at lower risk of extinction rather than the higher risk predicted by the habitat quality hypothesis. These hypotheses may not be mutually exclusive; it is possible that leporids tending toward sleep/hide behavior are most often found in these “productive megadiverse areas” that are currently under threat by anthropogenic modification. Further research will be required to reconcile these hypotheses and to better understand the strategies that enable these generally poorly studied species to persist.

Despite the overall correlation between landscape alteration and extinction risk, habitat degradation does not always predict increased extinction risk for an individual species. An important piece of future work will be to disentangle differential species or genus responses to varying types of habitat alterations. Certain types of habitat modification, like artificially cleared deer ranches, may benefit generalist groups like cottontail or European rabbits (Smith 2008) while threatening distant relatives that occupy similar habitats.

Understanding extinction risks in lagomorphs, and other clades, allows us to better predict overall risks to biodiversity and potentially to preserve ecosystem functions. While the conclusions from Verde Arregoitia et al. (2015) apply chiefly to lagomorphs, their methods can help to determine the relationship between threat status and phylogeny in many other clades. Orders that do not follow typical trends in proportion of monotypic species per genera, like Chiroptera and primates, are ideal candidates for future research.

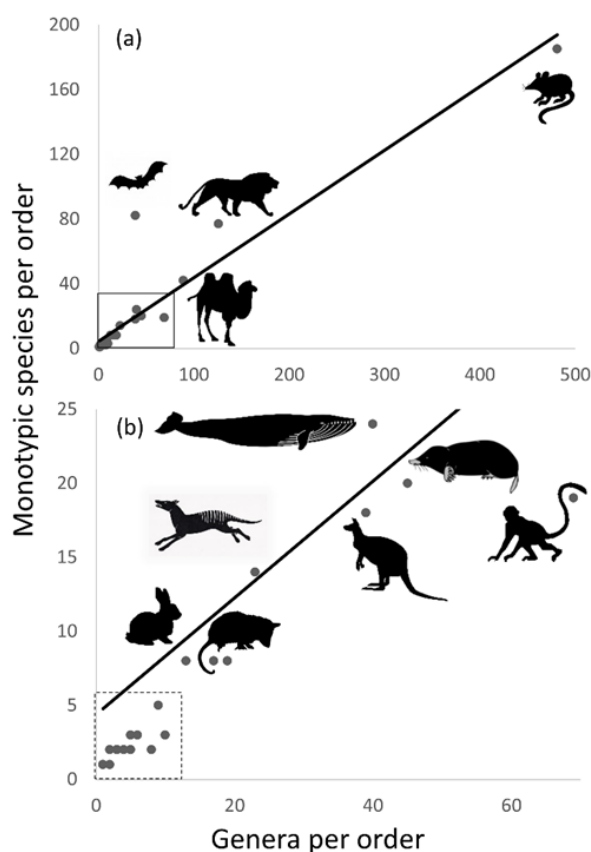


Figure 1. (a) comparison of the number of monotypic species of the 26 mammal orders compared to the number of genera in each order. The solid inset box outlines the boundaries of (b). (b) Lagomorphs follow the typical mammalian pattern. The regression line (solid line) is the same between 1a and 1b. The 15 orders with five or less monotypic species and under 20 genera (dashed inset box) contain less than 0.16% of all mammal species (Wilson & Reeder, 2005).

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References

- Cavender-Bares, J., Ackerly, D. & Kozak, K.H. (2012) Integrating ecology and phylogenetics: the footprint of history in modern-day communities. *Ecology*, 93, sp8, S1–S3.
- Hackländer, K., Ferrand, N. & Alves, P. (2008) Overview of lagomorph research: what we have learned and what we still need to do. In: *Lagomorph biology: evolution, ecology, and conservation* (ed. by P.C. Alves, N. Ferrand and K. Hackländer), pp. 381–391. Springer.
- Hampe, A. & Petit, R.J. (2005) Conserving biodiversity under climate change: the rear edge matters. *Ecology Letters*, 8, 461–467.
- Hirakawa, H. (2002) Supplement: Coprophagy in leporids and other mammalian herbivores. *Mammal Review*, 32, 150–152.
- Liow, L.H., Fortelius, M., Lintulaakso, K., Mannila, H. & Stenseth, N.C. (2009) Lower extinction risk in sleep-or-hide mammals. *The American Naturalist*, 173, 264–272.
- Ricklefs, R.E., Losos, J.B. & Townsend, T.M. (2007) Evolutionary diversification of clades of squamate reptiles. *Journal of Evolutionary Biology*, 20, 1751–1762.
- Ricklefs, R.E., (2005) Phylogenetic perspectives on patterns of regional and local species richness. In: *Tropical rainforests: past, present, and future* (ed. by E. Bermingham, C.W. Dick and C. Moritz), pp. 16–40. University of Chicago Press, Chicago, USA.
- Rolland, J., Condamine, F.L., Jiguet, F. & Morlon, H. (2014) Faster speciation and reduced extinction in the tropics contribute to the mammalian latitudinal diversity gradient. *PLoS Biology*, 12, 1–11.
- Smith, A.T. (2008) Conservation of endangered lagomorphs. In: *Lagomorph biology: evolution, ecology, and conservation* (ed. by P.C. Alves, N. Ferrand and K. Hackländer), pp. 297–315. Springer.
- Verde Arregoitia, L.D., Leach, K., Reid, N. & Fisher, D.O. (2015) Diversity, extinction, and threat status in Lagomorphs. *Ecography*, doi:10.1111/ecog.01063.
- Verde Arregoitia, L.D., Blomberg, S.P. & Fisher, D.O. (2013) Phylogenetic correlates of extinction risk in mammals: species in older lineages are not at greater risk. *Proceedings of the Royal Society Series B*, 280, 20131092.
- Wilson, D.E. & Reeder, D.M. (eds.) (2005). *Mammal species of the world. A taxonomic and geographic reference*. 3rd edn. Johns Hopkins University Press, 142 pp.

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