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Editorial: Drivers of small-mammal community structure in tropical savannas

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Editorial on the Research Topic
Drivers of small-mammal community structure in tropical savannas

Background

Tropical and subtropical savanna ecosystems (TSE; Figure 1) contribute ∼30% of terrestrial primary productivity globally (Grace et al., 2006), while covering 20% of the land area of the Neotropics, sub-Saharan Africa, southern Asia, and northern Australia (Bond, 2016). The tremendous productivity of intact TSE is consumed by—among others—a diverse mammalian fauna of small herbivores and omnivores and both native and domestic large herbivores. Much of it, though, is pre-emptively consumed by fire. Large fires are conspicuously concentrated in regions of TSE, particularly sub-Saharan Africa, the Cerrado of Brazil, and northern Australia (Giglio et al., 2021). Herbivores help shape fire regimes, and fire regimes in turn shape herbivory (Young et al., 2022). We opened this Research Topic because, relative to their counterparts in tropical forests and temperate grasslands, the ecological roles of smaller mammals (small rodents, marsupials, shrews, etc.) in TSE are poorly understood (Schieltz and Rubenstein, 2016). Our particular focus was what habitat-related factors drive species composition, abundance, diversity, and trophic and non-trophic relationships. We invited participation of small-mammal ecological researchers with field experience on all four continents hosting TSE.

We were particularly interested in studies of the effects on small-mammal community structure of three major endogenous disturbances with which TSEs have evolved: fire, large-mammalian herbivory (LMH), and drought (Buisson et al., 2019). Only in African and parts of southern Asian TSE are native large herbivores still an important component of the trophic system, but domestic livestock herbivory is an important force shaping landscapes and biota in nearly all areas of intact TSE. Shrub encroachment is another driver of small-mammal community changes; this phenomenon may be an indirect effect of long-term changes to the other three disturbance regimes, or it may result from introduction of invasive exotic shrubs. Anthropogenic habitat destruction, alteration, and fragmentation, directly and indirectly through climate change make it even more urgent that we understand how habitat factors influence abundance and diversity of TSE small mammals. Murid rodents, a speciose

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family occurring in all areas of TSE, are especially important because of their diverse roles as dispersers and predators of savanna trees and shrubs (e.g., Maclean et al., 2011; Schoepf and Pillay, 2023) and as reservoirs of zoonotic disease arising in the tropics (Lecompte et al., 2006; Limongi et al., 2016).

What we know includes, for example, that heavy grazing by both native and domestic LMH in African TSE suppresses abundance and diversity (taxonomic and functional) of small mammals (Bergstrom et al., 2018; McCleery et al., 2018), that the same effect is caused by cattle in Australia (Radford et al., 2015), and that wildfires in the Brazilian Cerrado can cause a temporary shift in dominance from a diurnal species to a more insectivorous, nocturnal one (Vieira and Briani, 2013). In all three regions, data show that some small-mammal species are "increasers" in response to loss of cover, even when most others respond negatively to loss of cover due to fire, grazing, or drought, at least over the short term (McDonald et al., 2016; Loggins et al., 2019). Mostly from Australian TSE studies, we know that loss of cover exposes many small mammals to increased predation, especially by feral cats (Leahy et al., 2015); this, and lack of evidence for post-disturbance food limitation (Radford, 2012) argues that the responses of "decreasers" reflect top-down control. "Increaser" species may use non-vegetative cover (rock crevices, burrows), be more nocturnal, and/or may prefer early successional food resources (McDonald et al., 2016; Bergstrom et al., 2018). Whether this holds true for southern Asian species is currently unknown (Bergstrom et al.).

Summaries of articles in the Research Topic

While fire is a variable in the background of any study of TSE habitats of small mammals, three studies in this Research Topic explicitly examined the effects of fire on small-mammal communities: occurrence of fire in gallery forests within the Brazilian Cerrado increased the density of understory plants and herbaceous cover, decreased small-mammal species richness and abundance, and reduced seed removal rates by small rodents (Cazetta and Vieira); in northern Australian TSE, small-mammal abundance and diversity were enhanced at local scales by rock

FIGURE 1
Views of tropical savanna habitats from three of the continents indicative of where small-mammal studies in this Research Topic were conducted: **(A)** open savanna on red sandy loam soils of the Laikipia Plateau, central Kenya, overstory dominated by *Senegalia mellifera, S. brevispica* and *Vachellia etbaica*, with a discontinuous understory layer dominated by the grasses *Digitaria milanjiana, Cynodon dactylon, Pennisetum mezianum*, and *P. stramineum* (photo by Bradley J. Bergstrom); **(B)** overall view of a typical savanna landscape (known as cerrado *sensu stricto*) associated with sandy soils of the Cerrado biome (photo by André F. Mendonça, taken at Jatobá Farm, Jaborandi municipality, state of Bahia, northeastern Brazil); **(C)** typical *Eucalyptus miniata* dominated open savanna forest characteristic of tropical, high-rainfall savannas (>1000 mm) in the Top End of the Northern Territory and parts of the Kimberley region, Western Australia (photo by Ian Radford, taken on the Mitchell Plateau, north Kimberley); **(D)** typical southern African savanna dominated by acacia trees, with *Dichrostachys cinerea* in the shrub layer, and a dense tall grass layer; southern Kruger National Park, South Africa (photo by Ara Monadjem; note termite mound, a conspicuous landscape feature of TSE in Africa, South America, and Australia).

and shrub cover, by reduced late-dry-season burning, and by maximization of long-unburned and ungrazed habitat patches–presumably as predator refuges–but not by a mosaic of burned patches (Radford et al.). In a long-term compilation of studies of the rodent *Necromys lasiurus* in the patchy Alter do Chão savannas of the Amazon region, neither fire at a regional scale nor climate change was found to influence the species' population dynamics as much as food availability (da Rosa et al.). A fourth study looked at the effects of loss of tree cavities (hollows)—driven largely by fires, but also by LMH and tropical cyclones—on three threatened, regionally endemic, semi-arboreal savanna small mammals on northern Australia's Melville Island and found that their abundance was associated with availability of shrubby habitat patches rather than tree hollows, with the former providing refuges from feral cat predation (Penton et al.).

No study in the Research Topic focused primarily on LMH as a predictor of small-mammal community structure, although LMH was one of the indirect influences on habitat variability in the study by Penton et al. and 18 previously published studies on LMH effects on TSE small mammals were reviewed by Bergstrom et al.

Three studies in the Research Topic examined small-mammal communities in areas undergoing woody shrub encroachment: in native dry grasslands of western India, some rodents responded negatively to the invasion of the exotic *Prosopis* and the concomitant loss of grassy cover, whereas others responded positively to heavy encroachment (Misher et al.); murid rodents of southern African savannas depredated seeds of the invading shrub *Dichrostachys* a third more than those of the native canopy tree *Senegalia* (Teman et al.), suggesting they might control this invasion; and in the Brazilian Cerrado, woody encroachment driven by active fire suppression had species-specific consequences for small mammals, with some open-grassland specialists being negatively affected including two Cerrado endemic and regionally vulnerable murid species (Furtado et al.).

Two papers examined effects of loss of habitat amount and quality and of patch size due to fragmentation on the small-mammal community: habitat generalists were less affected by variation in these three attributes than habitat specialists in the Brazilian Cerrado, and species composition was better explained by habitat features at the local scale, whereas species richness was better explained by landscape-scale metrics (Melo et al.). Studying 36 forest patches within a Cerrado savanna matrix, smaller patches had higher small-mammal abundance, richness of generalist species increased with amount of habitat in the landscape, and richness of specialists increased with increasing quality of the habitat (Mattos et al.).

Two other papers examined cross-habitat comparisons of small-mammal richness and abundance in TSE: in a large-scale study across half of the Cerrado biome that has not been lost to agricultural conversion, heterogeneity of habitats (grassland, typical savanna, and forest formations) at all spatial scales examined was a good predictor of species richness and abundance and occurrence of narrowly distributed species (Carmignotto et al.). The miombo of Tanzania is unusual within the African savanna biome in that the unpalatability of grasses leads to absence of LMH and their predators. This camera-trap study had a detection threshold for body sizes larger than the focal mammals of other studies in this Research Topic (including several small carnivores), but for 19 species of meso-mammals detected, site utilization was greater in gallery forest than in woodland, and for several of these species—including a large murid—detections were significantly associated with termite mounds (D'Ammando et al.).

A global review of mostly experimental field studies of the effects of habitat-altering disturbances on TSE small-mammal community structure found 63 studies, of which 33 studied effects of fire, 18 of LMH, and eight of shrub encroachment. Most conclusive studies found that either loss of cover, or a combination of cover loss and alteration of food resources, explained small-mammal responses, which were mostly negative to loss of cover (Bergstrom et al.). Research gaps include any studies of LMH (cattle grazing) from South America, and any studies at all from southern Asia (but see Misher et al.).

We hope the new studies published in this Research Topic will advance our understanding of habitat-driven effects on TSE small-mammal communities and of certain species of interest due to their endangerment, their provision of ecosystem services, or their potential as zoonotic disease reservoirs. We further hope this set of studies will encourage small-mammal ecologists to fill research gaps by conducting experimental studies in all TSE areas, particularly south Asia, and LMH studies in the Neotropics.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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