How intraspecific differences in spatial memory and olfaction affect seed dispersal by rodents

Forest rodents, numerous and ubiquitous, are among the most important consumers of tree seeds—particularly those of species that are economically and ecologically significant, such as beech and oak. It is therefore no surprise that foresters often regard them as pests. At the same time, however, rodents help disperse many seeds by stashing away any surplus, burying them shallowly in the soil. They never return to many of these caches, and the seeds thus planted gain optimal conditions to germinate and grow. Consequently, the role of these animals in plant interactions is complex: they can reduce tree reproduction by seed predation yet also promote it by seed dispersal. This leads to a key question: what determines whether their overall impact is positive or negative?

Until now, researchers have mainly focused on external factors such as the intensity of competition or predation risk, as well as on the characteristics of specific seed species. Nonetheless, progress has been slow. A new and promising research direction is to examine differences between individual animals, since recent years have shown that intraspecific variability influences many crucial ecological processes. However, in plant-animal interactions, a potential issue arises when correlating various rodent traits with multiple aspects of seed dispersal (for instance, the probability of consumption or caching, the choice of hiding place, or dispersal distance), because there are no robust theoretical foundations from which to derive precise predictions. As a result, statistically significant yet essentially random relationships may be "discovered," sending research down dead ends.

There are, however, certain traits more directly linked to seed dispersal—those fundamental to the behavior itself. These include spatial memory and olfactory abilities. Spatial memory is essential for remembering cache locations, while olfaction helps rodents locate caches made by other individuals (which is significant because mutual pilfering of caches is an important aspect of rodent-tree interactions). Moreover, the latest studies show that these two abilities have evolved together and remain closely interconnected. For example, experimentally blocking a rodent's sense of smell also impairs its spatial memory. Notably, rodents can vary greatly in these traits even within the same species.

Such observations support the hypothesis that individual differences in olfactory ability and spatial memory lead to different seed-foraging strategies. Individuals with poorer abilities will tend to consume most of the seeds they encounter, given their low likelihood of relocating their own caches. Those with better abilities, however, should excel both at hiding seeds and pilfering from others' caches. Consequently, even within the same species, some individuals will function predominantly as seed predators (exerting a negative effect on plants), while others become key seed dispersers (with a positive effect).

To test these predictions, we will conduct large-scale field experiments assessing rodents' sense of smell and spatial memory, followed by marking them with transponders. By using automatic transponder readers and infrared-triggered camera traps, we will track what specific individuals do with the seeds. In addition, we will investigate the molecular mechanisms underlying differences in olfaction and spatial memory by examining gene expression in key brain regions of animals exhibiting varied foraging strategies.

The results of this project could reshape our understanding of the mechanisms by which rodents affect seeds and tree recruitment. Such knowledge will enable more accurate predictions of how animal-plant interactions influence the dynamics of forest ecosystems and may, in the future, help develop new strategies for forest regeneration.