RESEARCH - WEEDS and FERALS

SPREADING WEEDS - THE HIDDEN COSTS OF RABBITS AND FOXES

Laurie Twigg

Readers will no doubt be aware of the direct detrimental impacts of introduced vertebrates (e.g. rabbits, foxes, feral pigs) on biodiversity and agricultural production in Australia. Such impacts include soil erosion, crop and pasture losses, degradation of on-farm bush remnants, competition with native species, preventing native plant regeneration, damage to tree plantations, predation of domestic and native animals (e.g. rock wallabies, woylies, bandicoots, numbats, and quolls), and the maiming of livestock (e.g. calves and lambs). However, readers may be less aware that many pest animals can also have indirect environmental and agricultural impacts, such as the spread and maintenance of weeds. Again, you may be aware that some animals can spread seeds contained in fleshy fruits (e.g. foxes and blackberries, silvereyes and bridal creeper), but I suspect you may just be a bit surprised to learn that some pest animals can also spread viable seeds not contained in fleshy fruits (hereafter, non-fruited seed). Such occurrences have implications for the successful management of exotic and other undesirable plants. Thus, to enable us to better understand just how important vertebrate-spread of non-fruited seed is in weed management, we undertook a collaborative study with Mike Calver's (Murdoch University), and Ric How's (Western Australian Museum) groups investigating the ability of a range of vertebrates to disperse *viable,* non-fruited seed.

Our methodology

Three main techniques were used to assess the importance of rabbit and foxes in dispersing non-fruited seeds; 1) faecal material was collected from several locations in the agricultural region of WA, and the number and viability of any seeds present was determined; 2) the seed preferences of captive-held, wild-caught rabbits were assessed to determine if rabbits consumed weed seed (e.g. gorse); and 3) seed passage time through the gut, which influences seed dispersal distances, was determined in captive-held rabbits. All recovered seeds were placed in 'incubators' for at least four weeks to assess their viability (i.e. produced seedlings). Test-seed included soft-seeded crimson clover, gorse, and canola. Their consumption was compared to that of a commercial rabbit-seed mix.

Rabbits

In summer, viable seeds were recovered from 3-4% of the rabbit faecal pellets compared to 21-40% of pellets in autumn (Fig. 1). Of the 1,136 seeds recovered from these pellets, 16% germinated. Overall, 13-30% of rabbits passed viable seeds in summer, and this increased to 44-73% of rabbits in autumn. We also know that seeds make up a around 50% of rabbit's diet during their summer/autumn dispersal period. Ten (77%) of the 13 species of seed identified in the faecal pellets were known weeds (e.g. flat weed, capeweed, Guildford grass, goosefoot, crowfoot/storksbill, dock). Seedlings identified during the passed-seed germination trials included goosefoot, *Crassula* sp. (Pygmyweed), clover (two species), Guildford grass, and a range of grass species. Seedlings of crimson clover and gorse were also grown successfully during the passage time trials. However, overall, the viability of recovered seeds of these species was reduced compared to that of undigested seeds (crimson clover 57% vs. 100%; gorse 14% vs. 84%).

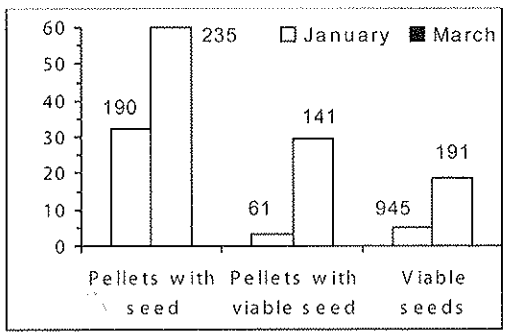

Fig. 1 The percentage of rabbit faecal pellets containing seed, viable seed only, and the viability of passed-seed. Internal values are the numbers assessed.

Our findings fit nicely with earlier work where over 65 species of plants, including 18 alien species, were identified in the diet (stomach contents) of rabbits from south-western WA. European rabbits are also important seed-dispersers in coastal sand dunes and woodlands in Spain, and in some British forests. Many of the viable seeds passed by the British rabbits were domesticated or weed species.

In our captive wild rabbits, passage time of biomarked seed (dyed with Carmine Red) through the intestinal tract was 4-7 hours. These relatively quick passage times, and the fairly small home ranges of rabbits, suggest that seed dispersal by rabbits may generally occur over short distances (<1 km). However, seasonal rabbit-dispersal distances for adult males can be up to 15 km, and even the

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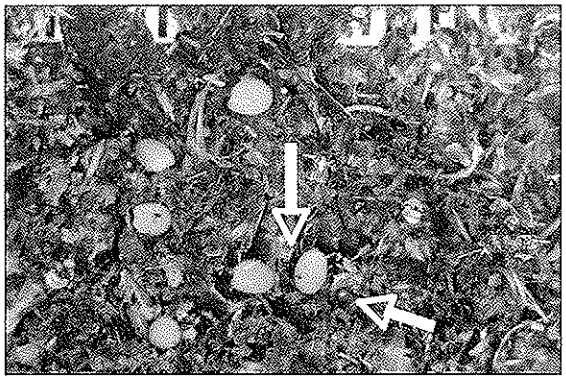


Some small and large seeds in a rabbit faecal pettet.

more routine dispersal distances of 1-2 km would often take viable seed beyond the usual dispersal boundary of plants. With unassisted dispersal, the vast majority of seeds are usually only dispersed 100 to 200 m from the parent plant.

The recovery of viable Goosefoot seeds from rabbit pellets is particularly interesting as species from this genus are known to be allelopathic, and can cause considerable crop losses unless control measures are implemented prior to seeding. Finding viable gorse seed in some faecal pellets also has possible implications for the management of this declared weed species in Australia and New Zealand.

Foxes

Although 48% of scats (n=62) contained whole seeds, fortunately, only 12.9% of all scats contained viable seed (Fig. 2). Our study is the first we know of which clearly indicates that foxes are potential dispersers of viable non-fruited seed via their scats. Where examined, approximately 21% of foxes had whole seeds in their hides, usually in the belly region. Most were grass seeds and 50% were viable (4/8 seeds). Thus, considering all recovered seeds, 63% (12/19) of seed species identified in the scats and hides of foxes were weeds (e.g. nightshade, dock, Guildford grass, grasses). Seedlings grown from the recovered seeds included nightshades, grasses, clover, and figs.

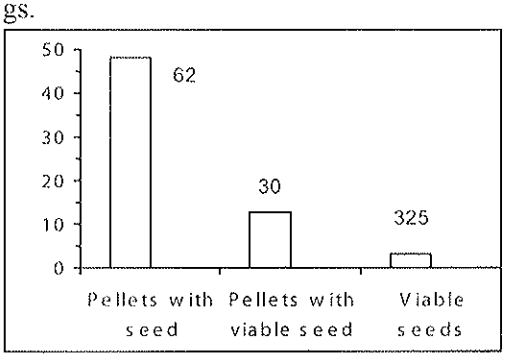
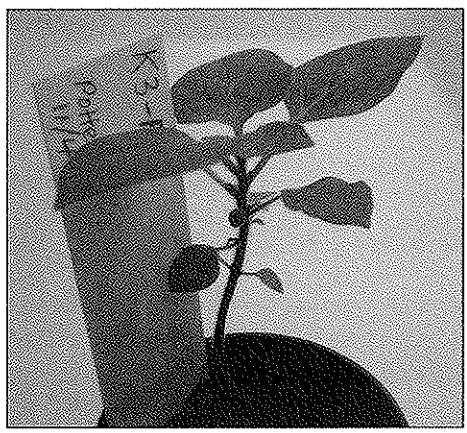


Fig. 2 The percentage of fox scats containing seed, viable seed only, and the viability of passed-seed during autumn. Internal values are the numbers assessed.

It is difficult to speculate about the origin of the seeds found in our fox scats, but some seeds were probably deliberately ingested (e.g. nightshades, mulberries, figs). Yet other seeds (e.g. clover, Guildford grass, grasses, flatweed, crowfoot/storksbill) were probably ingested secondarily through the rabbit-prey. It is difficult to predict the effect of seed-passage through the gut of foxes on seed viability, as this depends upon whether the seed is fruited or non-fruited. Such passage often increases or maintains germination of fruited seed, and decreases the viability of non-fruited seed. In some cases, foxes seem to prefer alien seed and fruits over native species. Our, and the findings of others, indicate that foxes have the potential to disrupt ecological communities by favouring the short and long-distance dispersal of alien plants.



Nightshade (Solanum nigrum) grown from a fox scat.

Long distance seed dispersal

Dispersal is generally defined as the unidirectional movement of an individual away from its source location. With plants, dispersal is often passive, and the dispersal of seeds usually only occurs over short distances. Long-distance dispersal events (distances greater than 100-200 m), although often rare, can be disproportionately important to the long-term survival of plant populations as they enable new individuals to establish away from other plants with potentially less competition for space and nutrients. Such dispersal can be critical to a species' survival as many plant populations are spatially isolated due to the patchy nature of many landscapes. This is particularly so in the spread of invasive plants following climate change in fragmented landscapes.

Some caveats

Remember that dispersal, germination, establishment, survival, and successful reproduction are important determinants in the establishment of new plant populations, and that the passage of seed through mammals and other seed consumers can also have indirect effects on seed germination rates. For example, whether seed deposition occurs in an environment which is suitable for plant establishment is at least partially governed by

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where and how often defecation occurs. Also, the simple presence of seed in the gut or scats does not necessarily imply that viable seeds are dispersed, as the viability of such seeds must be determined. Unfortunately, such assessment is often overlooked in many studies.

Also remember that our assessments of passed-seed viability will represent minimum estimates as we were generally only able to monitor germination for a 4-week period. That is, we have probably underestimated the ability of both mammal species to spread viable seed.

Conclusions

When both dispersal of seeds via the digestive tract (endozoochorous), and by adhesion to animals (exozoochorous), are considered, we believe that rabbits and foxes can be legitimate dispersers of viable seeds. Thus, suppression of weeds can be added to the benefits of reducing the abundance of rabbits and foxes in Australia. Moreover, as rabbits and foxes can travel relatively large distances, and as seed retention times are sufficient to enable viable seed to be dispersed, we suggest that both species could also act as long-distance dispersal agents. However, the importance of such dispersal remains unknown as the dispersal efficacy of rabbits and foxes is yet to be determined in Australian environments. But, it is becoming increasingly evident that the role of mammals in the dispersal of some Australian plants may be greater than previously thought, and that the influence of such dispersal needs to be considered in the management of weeds and ecological communities.

Acknowledgments

I thank the many people who helped with this project, particularly Tim Lowe and Gary Martin from DAFWA. The Feral Animal Control Program of the Australian Government's Natural Heritage Trust also supported this project. [*For refs, contact Ed.*]

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