Benefits of seed dispersal for escaping seed predation and examining the life history, host suitability/preference and impact of the polyphagous obligate seed predator *Cryptaspasma querula*

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"The creation of a thousand forests is in one acorn"

- Ralph Waldo Emerson

Abstract

Cryptaspasma querula is an endemic moth (Family Tortricidae) that is the only known polyphagous obligate post-dispersal seed predator in New Zealand. It is suggested to have multiple hosts including tawa (*Beilschmiedia tawa*), taraire (*Beilschmiedia tarairi*), miro (*Prumnopitys ferruginea*), hinau (*Elaeocarpus dentatus*), karaka (*Corynocarpus laevigatus*), and acorns from exotic oaks (*Quercus sp*.). There have been few studies clarifying these claims and fewer still showing the effects *C. querula* has on the host plants' seeds' germination and establishment. Little is also known about the life history, host preferences, specialist predators/parasitoids and host cues of *C. querula*. The drilling damage *C. querula* does to its hosts has been noted in several studies but none have recorded the extent of this damage over the course of the season or what the end percentage of damaged seeds are.

Of the described hosts, the broadleaf tree tawa has had been studied the most. The apparent rarity of good germination and establishment under the parent canopy has been noted previously. It is unclear however, whether the impact of seed predators make dispersing seed away from the parent canopy (where fewer seed predators are in theory) more beneficial for tawa. If it is more beneficial, then the extent of dispersal through faunal influences will be important to know.

Life history and host cues (in the form of wind tunnel tests used to test olfactory attractants) of *C. querula* were examined in a controlled environment where rearing observations were taken and variables could easily be manipulated. The host preference and suitability for *C. querula* was examined in two settings: Laboratory and Field. The controlled environment utilised the seeds of tawa, taraire, hinau, and miro to see whether these were plausible hosts. The field experiments utilised the species miro, karaka, and acorns from exotic oaks. The examination of potential specialist predators or parasitoids took place in two settings: Field and Glass house (semi-controlled environment).

In captivity, mating of *C. querula* adults raised from field collected larvae frequently occurred and many eggs were produced which could be used in choice

tests and behavioural assays. Females lay a variable number of eggs and seemed to prefer ovipositing on smooth surfaces. The time spent in each instar and pupation varied greatly among individuals. Wind tunnel tests were inconclusive for both adult and larvae specimens. However, in choice tests and even when given no other hosts, many of the proposed hosts of *C. querula* appeared to be unsuitable and were not occupied by *C querula* larvae in the lab. These included miro, hinau, and karaka where *C. querula* either ignored the fruits provided, or, if endosperm was utilised, the larvae did not complete their lifecycle. The only suitable and preferred hosts in these trials were tawa and taraire. However, it is highly likely acorns from exotic oaks are also suitable and preferred by *C. querula* since field trials showed frequent occupancy in acorns. Only one potential competitor (no specialist predators/parasitoids) of *C. querula* was discovered and it was a generalist facultative diptera (*Sylvicola sp.*).

In a factorial field experiment (repeated at three sites) in which fruit density, the presence or absence of fruit flesh, and the position either under or away from a tawa canopy were assessed, germination and establishment of tawa were highest in high seed density treatments showing potential predator satiation may be occurring. Seeds dispersed away from tawa canopy also had a higher establishment rate than seeds under the parent canopy, suggesting the importance of faunal dispersers The effect of flesh removal was variable but generally favoured establishment. Several additional factors such as vertebrate seed predators/predators, abiotic influences, and site differences appeared to have influenced the results. Drilled/damaged seeds could still germinate/establish but their chances were much lower than undamaged seeds.

In these same three sites, plus an additional 8 sites added to widen the study, seed predation at the end of season was very high despite a very heavy fruiting season. As the season progressed, over 90% of tawa seeds ended up being drilled by *C. querula* suggesting the likelihood of very heavy influences on tawa regeneration. The proportion of bird dispersed seeds was also unexpectedly low (maximum of 8% of seeds beneath the canopy were bird dispersed). The surrounding floral species composition (and dominance) did not appear to influence the damage received to tawa seeds.

Information on *C. querula's* life history, host preferences/suitability and the impact on hosts are better understood through this thesis. Seed dispersal and high seed density are shown to offer the best strategy for tawa seeds' establishment and survival. The extent of drilling damage on tawa fruits over the course of the season has been shown to be higher than expected and strongly detrimental and demonstrates the importance of predation escape. Thus, tawa is highly dependent on the remaining kereru populations and will be sensitive to further declines to dispersal service.

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