SWELLING SEEDS, GREEN CAPSULES, FLESHY PLACENTAE AND NEAR-VIVIPARY: FRUIT AND SEEDS OF *BEILSCHMIEDIA TARAIRI*, *DYSOXYLUM SPECTABILE*, *GENIOSTOMA RUPESTRE* AND *SYZYGIUM MAIRE*

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While gathering fruit and testing seeds for their germination characteristics sometimes one comes across interesting aspects of natural history which do not seem to be explicitly on record. Here are some observations on four species, three trees and a shrub, of northern New Zealand lowland forests.

Beilschmiedia tarairi; taraire is a tree of the northern North Island, extending south to about Hamilton and East Cape. In late Sept. 1997, while visiting North Auckland I gathered 22 taraire seeds from a tree at Kaikohe. The large, single-seeded fruit are drupes, so the "seeds" are actually pyrenes, with the outer seed-coat surrounded closely by a tough endocarp layer. The soft outer pericarp is purplish-black (see glossary at end of article for definition of terms).

Five of the seeds were collected from their parent tree, still surrounded by fleshy pericarp. The rest had had the fleshy tissues removed by passage through kereru (native pigeon) and lay on the ground under the tree. They were greyish-brown, glossy and slippery and judged to have been voided within a day or two. A kereru fed in the tree as the seeds were gathered. Seeds that had been longer on the ground were dull, and dark brown, and some had fungal colonies on the endocarp. The freshly-cleaned seeds, though larger than those of *B. tawa* (3.2 x 1.8 cm as against 2.5 x 1.3 cm) were otherwise similar in character.

I kept the clean seeds and whole fruit cool, in a plastic bag, in an insulated bin. When I got home, seven days later I began to prepare them for a germination test. In that time 12 of the already cleaned seeds had undergone a remarkable change. The endocarp of each seed had split under pressure from swelling mucilage and they were enlarged to at least one-third more than their original volume. The mucilage, which appears to originate in the outer seed coat, bulged out through the endocarp fissures.

I removed the fleshy tissues from the five intact fruit, soaked them in tapwater for 12 hours and placed them and the five still ungerminated seeds into the test conditions that I routinely use (Burrows 1996). In it the seeds are exposed to maximum available daylight, and sit on filter paper, continually moist, in transparent plastic dishes. The tests are kept in an unheated, partially-shaded glasshouse at the Plant and Microbial Sciences Department garden area at the University of Canterbury.

All of these seeds swelled in the same way as the first 12. Within a few days embryo roots and shoots were visible. Thus the initial swelling of the seeds denotes germination. For the seeds originally from whole fruit the time taken to germinate was only five days. Why, then, did not all of the seeds gathered from the ground germinate earlier? I think this may be because of the presence in the endocarp of inhibitory chemical compounds. When I soaked the five seeds that I had cleaned a brown material leached into the water. Possibly the ungerminated seeds had not experienced enough rainwater leaching before I gathered them. Observations from my experiments germinating tawa seeds show that, when left with the fleshy pericarp around them, they will not germinate. I assume the same to apply to taraire.

The seeds of introduced weedy species of the genera *Linum*, *Lepidium* and *Plantago* exude quite fluid mucilage which is thought to allow a reliable connection to be made between the seeds and soil water. The mucilage is a form of carbohydrate (cf. Bewley & Black 1983; Mayer & Poljakoff-Mayber 1989; Van der Pijl 1982). In taraire the mucilage is stiff, looking very like hydrated "water crystals".

It is most likely that the swelling, gelatinous material of taraire seeds assists in water uptake during the period of germination, by absorption and steady release of water. This effect will continue during early seedling establishment. Also, as in tawa, the large cotyledons of taraire remain inside the seed coat and continue to supply food to the seedlings for several months after germination. Tawa does not have such a mucilage development, however. Nor have I found it so copiously in seeds of other New Zealand indigenous plants. *Sophora, Calystegia, Dodonaea*, and *Plagianthus* are genera with seeds that swell when they germinate. They probably have mucilage - containing cells in their seed coats, but they do not exude mucilage.

Dysoxylum spectabile; kohekohe is a tree of coastal regions as far south as the Marlborough Sounds and north-west Nelson. Capsules of most flowering plant species become hard and dry as they ripen, before opening in a variety of ways to release the seeds. Exceptions to this rule are seen in some species which maintain thick-walled green capsules until seed dispersal. One such is *Juglans regia* (walnut). Another, in our native flora, is kohekohe. The globular fruit, 2.5-3 cm in diameter, are borne in paniculate clusters which hang from old leaf-scar positions along otherwise bare upper branches. In May 1997 it was evident that the fruit on trees at Puponga, north-west Nelson, and Kenepuru Sound, Marlborough were opening while green. The capsules have three or four valves each containing two seeds. Open fruit on the trees were almost all empty and, eventually, kereru were seen eating the seeds. They are attracted to them by the fleshy orange arillodes which partly cover each large, shining, brown-coated seed. The seeds pass through the birds unharmed (see Court & Mitchell 1988).

About 60 fruit were collected and brought home in the insulated bin. Within a few days the capsules split open along zones of weakness exposing the beautiful seeds with their arillodes. As I cleaned the fleshy tissues away it was evident that some seeds were ready to germinate. Their thin, brown coats had split a little and the bright green cotyledons showed. When placed in my well-lit germination test conditions these seeds sprouted in a few days and all in the set had germinated within 25 days. The large green cotyledons emerged in these seeds. In another test where the seeds were buried 5 cm deep in soil, however, the cotyledons did not reach the soil surface, but the leafy shoots did and have grown strongly since then.

Geniostoma rupestre; hange hange is a shrub of forest margins and gaps. It extends south to Marlborough and Nelson. Hange hange has relatively small (1 x 0.5 cm) dry, brown capsules. When ripe they split longitudinally into two valves. The many, very small seeds can be seen, imbedded in the central, swollen, yellow, fused placenta tissue. The fleshy material is the attraction for birds and, in May 1996 silvereyes were seen eating it, complete with seeds, in shrubberies along Queen Charlotte Drive, Marlborough Sounds. Probably bellbirds and tuis do so, also.

Hange hange seeds germinate at a relatively slow rate. Some seeds in a set of 100 germinated in eight weeks, but germination of the remaining seeds was spread over a further nine weeks. They may have germinated faster in conditions warmer than Christchurch in mid-winter.

Syzygium maire; maire-tawake (or swamp maire) is a tree of very wet sites, confined to the North Island and a few places in the Marlborough Sounds. The bright red fruit of maire-tawake are borne in corymb-like clusters. Except that they have juicy outer pericarp and each has only one large seed, they resemble the fruit of some eucalypts, by having a shallow concavity at the distal end. If the fleshy pericarp is removed a thin somewhat fibrous cover of endocarp tissue remains. As it is not fused to the seed coat, technically the fruit is a berry. Removal of the endocarp tissue exposes the seed. When this was done for a few seeds collected from trees at Croisilles Harbour, Marlborough Sounds, in Feb. 1998, the proximal end of the seed, comprising the very thick cotyledons, was dark green, and the radicle, up to 5 mm long, was green, with a white, or pinkish tip. It lay in a slight concavity.

Thus it appears that maire-tawake is, (or is very close to being) viviparous. When a bird swallows the fruit the seed will pass through its digestive tract, leaving the endocarp intact. When seeds of this species were placed in germination test conditions the radicles soon pushed through the endocarp. All in a set of 100 seeds had sprouted within 30 days.

For bird-dispersed seeds, as Burrows (1993) noted, vivipary is hazardous, as the radicle, or whole embryo could be killed by the birds' digestive process. Seeds in fleshy fruit on the parent plants normally do not germinate because inhibitory compounds in the pericarp prevent this. Nevertheless, vivipary has been observed in a proportion of seeds of *Ripogonum scandens*, *Coprosma robusta* (Burrows 1993); *Solanum aviculare* (C.J. Burrows, unpubl. data); *Corokia macrocarpa* (Fountain & Outred 1991); and *Peraxilla tetrapetala* and *Tupeia antarctica* (Ladley & Kelly 1996). Thus the inhibitory influence of the pericarp can break down, especially if the fruit remain on their parents for a long time.

In maire-tawake the endocarp will protect the embryo from harm in the birds' gut. It is a moot point whether or not immediate readiness to send a root out into the world while the seeds are in fruit, on their parent, constitutes vivipary.

The capability for rapid seed germination of seeds of many New Zealand lowland forest species was noted by Burrows (1994). The information outlined here confirms results of other workers for *Syzygium* and *Dysoxylum* (Platt 1987a, b, Court & Mitchell 1988). The rate observed here for *Beilschmiedia tarairi* was faster than Platt (1987b) indicated. In these three species the capacity for quick germination is combined with an inability to withstand drying of the seeds. Not all quick germinators are in this category, as many seeds of *Coriaria arborea*, *Fuchsia excorticata*, *Melicytus ramiflorus* and *Macropiper excelsum* can come through several months of drying with their vitality unimpaired (Burrows 1997). The seeds of *Geniostoma rupestre* (not a quick germinator) also resist drying.

Glossary

arillode: fleshy tissue, partly enveloping the seed, which originates near the scar where the seed was attached to its stalk.
berry: a fleshy, indehiscent (i.e., not splitting open) fruit, containing one or more seeds enclosed by a relatively soft pericarp.
capsule: a usually dry, and usually dehiscent fruit (i.e., splitting open to release the seeds), containing one or more seeds enclosed by a relatively hard pericarp; some capsules open while their pericarp is still green and moist, and some are indehiscent.
corymb: an inflorescence (cluster of flowers) where the individual stalks are of different length, but the flowers are positioned more or less in one horizontal plane.
drupe: a fleshy, indehiscent fruit usually containing one seed enclosed by a pericarp consisting of an outer soft exocarp-mesocarp, and a hard, inner endocarp, which is fused to the seed coat wall.
endocarp: relatively hard inner wall of the pericarp of a fruit, consisting of fibrous or "stony" tissue; in a few cases endocarps are thin and "papery".
exocarp: outer relatively stiff wall of the pericarp of a fruit.
fruit: the mature ovary of a flower, containing seeds.
mesocarp: the middle layer of pericarp, often soft and pulpy.
ovary: the organ in flowers which contains the ovules.
ovule: the organ, in an ovary, which contains the megaspores (female elements) and which, when fertilized, by sperm cells, develops into a seed.
paniculate: an inflorescence form - branched, with the oldest, stalked flowers at the base, youngest at the distal end.
pericarp: fruit tissues (derived from the ovary) which enclose the seeds.
placenta: the tissue within the ovary/fruit to which the ovules are/were attached, by a short stalk through which the ovules (and later seeds) receive their nutriment.
pyrene: a seed which has surrounding endocarp tissue fused to it.
radicle: the first embryonic root which emerges from the seed.
vivipary: germination of seeds while still on their parent.

References

Bewley, J. D., Black, M. 1982. *Physiology and Biochemistry of Seeds in Relation to Germination. Vol. 2*. Springer-Verlag, Berlin.

Burrows, C. J. 1993. Vivipary and effects of maternal tissues on germination in some New Zealand seeds. *Canterbury Botanical Society Journal 27*: 47-48.

Burrows, C. J. 1994. The seeds always know best. *New Zealand Journal of Botany 32*: 349-363.

Burrows, C. J. 1997. Reproductive ecology of New Zealand forests. 2. Germination behaviour of seeds in varied conditions. *New Zealand Natural Sciences 23*: 53-69.

Court, A. J., Mitchell, N. D. 1988. The germination ecology of *Dysoxylum spectabile* (Meliaceae). *New Zealand Journal of Botany 26*: 1-6.

Fountain, D. W., Outred, H. A. 1991. Germination requirements of New Zealand native plants: a review. *New Zealand Journal of Botany 29*: 311-316.

Ladley, J., Kelly, D. 1996. Dispersal, germination and survival of New Zealand mistletoes (Loranthaceae): dependence on birds. *New Zealand Journal of Ecology 20*: 69-79.

Mayer, A. M., Poljakoff-Mayber, A. 1989. *The Germination of Seeds. 4th edition.* Pergamon Press, Oxford.

Platt, G. C. 1987a. Letter to C. J. Burrows on rates of germination of seeds of some native plant species.

Platt, G. C. 1987b: Commercial production of native plants from seed. *Botany Division, Department of Scientific and Industrial Research Newsletter Supplement 4*: 16-17.

Van der Pijl, L. 1982. *Principles of Dispersal in Higher Plants. 3rd edition.* Springer Verlag, Heidelberg.