

FRUIT AND SEED OF BEILSCHMIEDIA (LAURACEAE) IN NEW ZEALAND

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SUMMARY

The differences in the fruit and seed of the two New Zealand species of *Beilschmiedia*, *B. tarairi* and *B. tawa*, indicate that these organs might be a fertile source of taxonomic characters in the genus. *Beilschmiedia neocaledonica* of New Caledonia is like *B. tarairi* in having a mucilaginous layer in both fruit wall and seedcoat, while *B. tawa* lacks these layers.

INTRODUCTION

In New Zealand there are two species of *Beilschmiedia*, the tawa [*B. tawa* (A. Cunn.) Kirk] and the taraire [*B. tarairi* (A. Cunn.) Kirk]. Both are common lowland forest trees and have the New Zealand native pigeon (*Hemiphagia novaeseelandiae*) as their principal if not their sole agent of dispersal (McEwen, 1978).

The usual descriptions of the fruits of these two species suggest that they are rather alike, being purple, fleshy, slippery-stoned drupes two to three centimetres long (Allan, 1961; Wright, 1984). But in fact their similarity is hardly skin-deep, and this article describes the numerous morphological and anatomical differences present, with the implication that fruit and seed structure might be significant in the taxonomy of the genus. Their seedlings are also briefly compared.

Beilschmiedia neocaledonica Kostermans of New Caledonia bears some general likeness to *B. tarairi* (Kostermans, 1974), and the anatomy of its fruit and seed is noted here too.

MORPHOLOGY AND ANATOMY OF THE LAURACEOUS SEED

Corner's monograph (1976) on dicotyledon seeds characterizes for each family the kinds of cell in the layers of the seedcoat, and it contains information on the seeds of seven lauraceous genera (though not *Beilschmiedia*). These are described as usually having the seedcoat's outer part (the testa in Corner's terminology) closely adherent to a lignified, stellate- or undulate-faceted endocarp; the outer epidermis of the testa is unthickened, the mesophyll usually multiplicative, and the inner epidermis composed typically of short tracheids. The inner layer of the seedcoat, the tegmen, is ephemeral. Corner also noted that the pericarp of the fruit has oil cells and often stone cells. All these characterizations were seen to hold for the *Beilschmiedia* fruit studied in the present work.

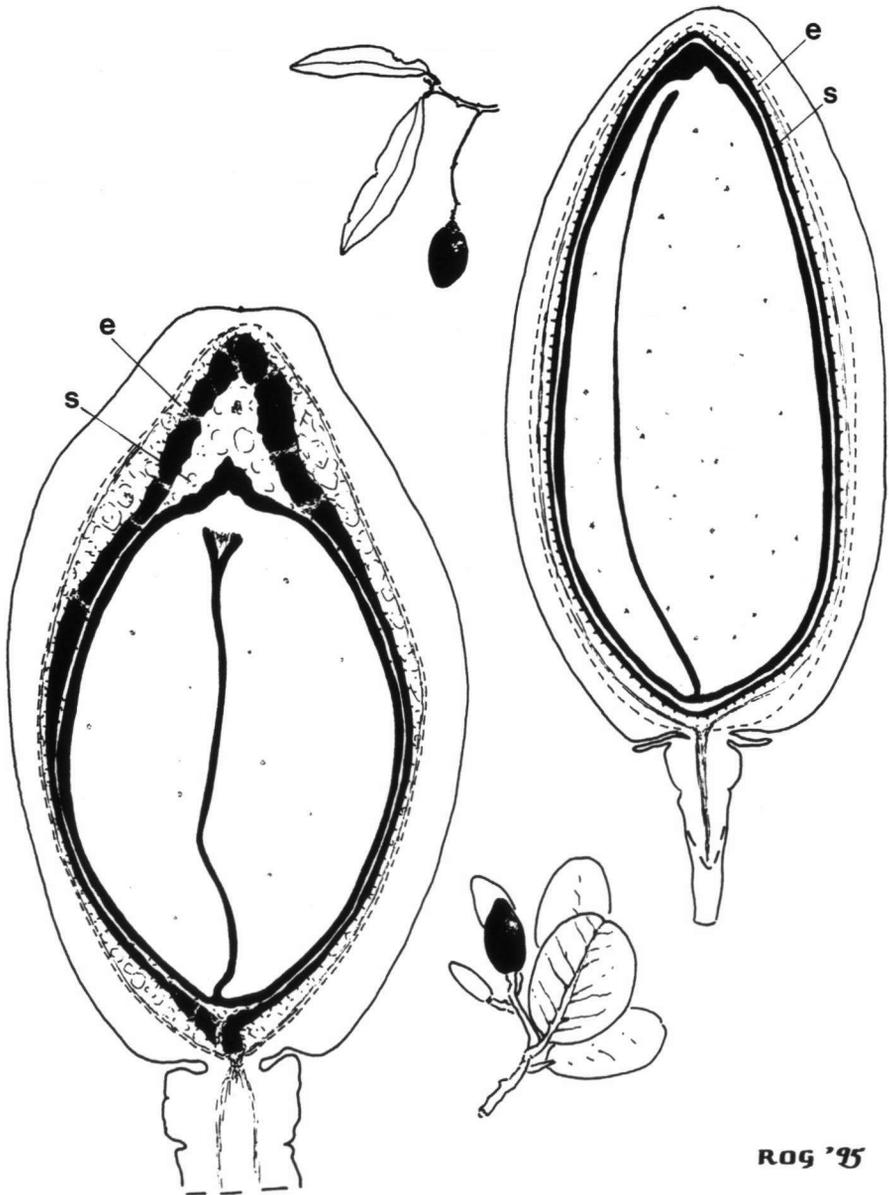


Fig. 1. Fruit of *Beilschmiedia tarairi* (left) and *B. tawa* (right), longitudinal section; $\times 2.8$. Schematic, the thickness of layers only approximately to scale. Air spaces (black) exaggerated. Mesocarp shown featureless outside endocarp (e = outer limit of this dashed, with vascular bundles shown as diffuse lines). Seedcoat (s). *Beilschmiedia tarairi*: seedcoat with a conspicuous apical cone of mucilage cells, shown free from cotyledons and from endocarp (innermost layer of endocarp weakly hatched, inside a conspicuous layer of mucilage cells); seedcoat and endocarp connected to each after dissection by mucilage strands from cut cells in each. *Beilschmiedia tawa*: endocarp (innermost layer strongly hatched) and seedcoat both without mucilage cells.

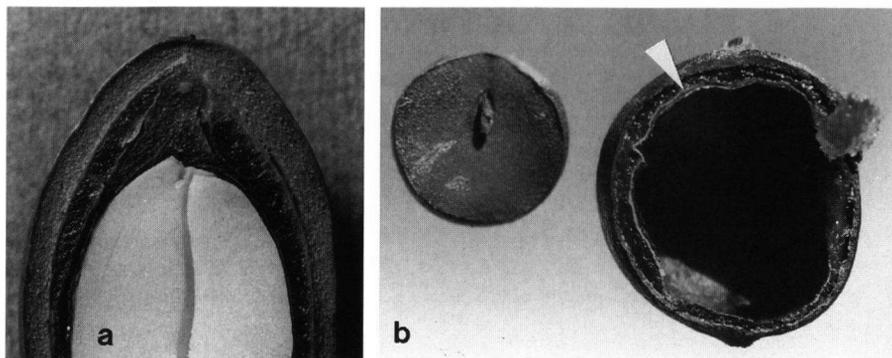


Fig. 2. — a. Fruit of *Beilschmiedia tarairi*, distal portion; $\times 1.7$. Showing mucilage layer of fruit wall and of seedcoat (conspicuous conical structure, with bundle of funicle showing pale). — b. Fruit of *B. neocaledonica*; $\times 2.1$. Left, cotyledon with subcentral plumule and radicle. Right, fruit wall and seed coat. Arrow points to innermost layer of endocarp (lignified cells), with mucilage layer outside. To inside, seedcoat consists mostly of a mucilage layer. Semi-detached blob of mucilage at upper right.

METHODS

Fruit and seeds were obtained from a number of trees of tawa and taraire at three Auckland localities (see 'Specimens' below). A single fruit of *Beilschmiedia neocaledonica* was rehydrated for dissection.

DESCRIPTIONS

The differences between the fruit and seeds of tawa and taraire, and some notes on these in *Beilschmiedia neocaledonica*, are given in the descriptions below; see also Figures 1 and 2. There is a striking contrast between the mucilaginous endocarp and testa in taraire and *B. neocaledonica*, and the leathery endocarp and non-mucilaginous testa in tawa.

There are cells in the mesocarp of the three species which are yellowish and contain an oil-like substance. They can be presumed to give the mesocarp its somewhat sticky-resinous character, and their comparative abundance in taraire is probably why this fruit is much less palatable to humans than that of tawa. The traditional term 'oil cells' has been used below, though actually these cells are heavier than water. Also, the term 'endocarp' is used to refer not only to the innermost (lignified) layer of the fruit wall but also to the vascular tissue and adjacent layers internal to the mesocarp. This usage accords with that of Hyland (1989).

Except where stated the descriptions of tawa and taraire are of the mature living infructescence, fruit and seed. The word 'comparatively' indicates that the condition in one of these two species is being compared with the condition in the other.

***Beilschmiedia tarairi* (A. Cunn.) Kirk**

Infructescence often with 2 or 3 fruits (or occasionally fruit solitary), these borne erect, the pedicels and other axes c. 6 mm diameter.

Ripe fruit on a hardly swollen receptacle (the sepals having been shed early by abscission just above their bases, the basal stubs quite obscure in ripe fruit), \pm ellipsoid, to c. 4 \times 2.2 cm, sometimes slightly acuminate to the obtuse apex ('bottle-nosed') especially in drying, the style usually in a shallow excentric apical depression; fruit after detaching with basal scar 2.5–3 mm diameter.

Exocarp comparatively stiff (but hypodermis lacking), glaucous, deep purple, in dry fruit becoming thrown into copious shallow mostly longitudinal wrinkles a few mm long.

Mesocarp c. 3 mm thick centro-laterally, pulpy, greenish yellow, with numerous stone cells and subglobose oil cells, the latter more numerous on inner side.

'Stone' of fruit usually greater than 15 mm diameter, not grooved dorsally, the vascular strands readily visible; endocarp c. 0.4 mm thick centro-laterally, outside vascular tissue the endocarp tissue as a thin layer of stretched and flattened cells, and internal to it as greatly enlarged mucilage-filled cells that tend to run in bulging contiguous vertical strands, this 'jelly layer' thickest at base and apex of seed cavity, the innermost layer of endocarp comparatively thin, as lignified cells with stellate-undulate facets.

Seed with testa also as a 'jelly layer', which is best developed apically around the funicle and down over the embryo apex as a cone, diminishing below to expand again somewhat at chalaza. Plumule with pale to rusty lignified hairs.

Cotyledons yellowish, faces usually slightly interlocked in the distal half, when cut browning readily in the air, with a few small mucilage and oil cells.

***Beilschmiedia tawa* (A. Cunn.) Kirk**

Infructescence usually bearing a solitary pendulous fruit (occasionally with 2 or 3 fruits), the pedicels and other axes c. 1 mm diameter.

Ripe fruit on a slightly swollen receptacle (to 2.75 mm diameter), with persistent sepals, ellipsoid to suboblong, to 3.5(–4) \times 2 cm, obtuse apically, the style slightly excentric, hardly depressed and in dry fruit often seen as an apicule at the acute apex; fruit after detaching with a basal scar slightly less than 1 mm diameter, the rim with 6 radial impressions left by the sepals.

Exocarp comparatively flexible (but with a hypodermis 1(–3) cells deep, its walls slightly thickened), slightly glaucous, deep purple, in dried fruit the exocarp forming comparatively few and elongate longitudinal folds.

Mesocarp c. 2.5 mm thick centrolaterally, comparatively watery, cells tending to be radially elongate, very pale green, stone cells absent, a few small oil cells present.

'Stone' of fruit rarely greater than 15 mm diameter, often with a distinct dorsal groove (dorsal bundle lying in the edge of the gap between the cotyledons), the vascular bundles obscured by a flexible outer layer of somewhat thick-walled, tangentially elongate cells outside larger thin-walled cells (some with oil), then inside the vascular bundles another layer of thin-walled cells, then dense thick-walled cells with

much condensed tannin, then the innermost layer of endocarp as lignified cells with stellate-undulate facets. 'Stone' when thoroughly dry without dorsal groove and with vascular bundles somewhat apparent.

Seed with testa closely appressed to endocarp, the testa (and rest of seedcoat) very thin, slightly thicker at apex but like the inner part of the fruit wall apparently completely without mucilage cells; plumule glabrous.

Cotyledons white, faces flat or slightly curved, when cut not browning on exposure to air, without mucilage or oil-containing idioblasts but with abundant translucent (sticky) gum in the intercellular spaces.

Beilschmiedia neocaledonica Kosterm.

Infructescence with several fruits, these borne erect.

Ripe fruit globose, c. 1.5 cm diameter, on a slightly swollen receptacle, the sepals triangular, persistent.

Mesocarp packed with oil cells, stone cells also present (mostly near level of vascular bundles).

'Stone' with a mucilage layer in inner endocarp.

Testa with mucilage layer. Plumule and radicle lying subcentrally.

Cotyledons with oil cells and abundant mucilage cells.

Specimens

Beilschmiedia neocaledonica, Kuaua, *Suprin 1760*, 31 March 1982 (NOU). — *B. tarairi*, Auckland, Kirk's Bush, *Gardner 7556*, 25 Dec. 1994 (AK 219382). — *B. tawa*, Auckland, Kirk's Bush, *Gardner 7555*, 25 Dec. 1994 (AK 219381). — *B. tawa* (*B. tawaroa*), Waiwera Hill, *Gardner 7478*, 3 March 1994 (AK 222025).

THE SEEDLINGS

As noted above, the principal disperser of tawa and taraire is the New Zealand native pigeon, which digests the pericarp and excretes the slippery 'stone' (endocarp and seed). Germination is hypogeal and cryptocotylar, as it is in other members of the genus (and family) that have been studied (De Vogel, 1982). In neither species is there a specialized area at the apex of the stone that would facilitate the emergence of the radicle.

In tawa, the leathery endocarp and the seedcoat of the germinated seed remain intact except at the very apex. In taraire, however, these split dorsiventrally (which is usually the plane of the cotyledon faces). Splitting is initiated at both ends of the stone. The cotyledons spread somewhat, but even after several months of exposure on or near the surface of the leaf litter they get only faintly tinged with chlorophyll. Between the cotyledons, particularly around the radicle, the newly-split taraire stone bears a jelly-like mass from dissolution of the two mucilage layers (Myers, 1984, unpub. thesis). The mucilage is neither bitter nor astringent (own observ.), and it is difficult not to suppose that it might be of use in resisting desiccation. This supposition would be in accord with taraire's more subtropical distribution in New Zealand

(north of c. lat. 38° S), and its higher light and warmth requirements for establishment; tawa, in contrast, has a more temperate distribution than taraire (extending south to lat. 42° S) and a higher altitudinal limit, and it regenerates most effectively in small gaps in the primary forest (Knowles & Beveridge, 1982; Myers, unpub. thesis).

CONCLUSIONS

The considerable number of differences in their infructescence, fruit and seed suggests that tawa and taraire are probably not closely related to one another. There do not seem to be clear relationships with any Australian species (Hyland, 1989), none of these having, for example, the opposite and finely areolate leaves of tawa, nor mucilage layers in the fruit wall and seedcoat (but fresh or rehydrated fruit should be checked for such layers). Conversely, tawa and taraire do not have any of the unusual features found in the Australian species, such as foetid flowers, or only six fertile stamens.

It can be noted here that material of the so-called third species of *Beilschmiedia* in New Zealand, *B. tawaroa* A.E. Wright (Wright, 1984) proved anatomically identical with that of tawa, and is not described separately (nor do I accept *B. tawaroa* as a distinct species).

Beilschmiedia neocaledonica resembles taraire in its sturdy pubescent shoot, broad leaves, and upright several-fruited infructescence. It differs in its flat rather than revolute-margined leaves which lack a soft apicule when young, and in its wine-coloured rather than brown pubescence. Its globose fruit and persistent sepals are unlike those of taraire. The mesocarp is composed mostly of oil-cells and perhaps remains firm in the ripe fruit, but, like that of taraire, does contain stone cells. And as in taraire, a mucilage layer is present in both endocarp and testa. The significance of these similarities needs to be examined in the light of a better knowledge of the anatomy of the species of Australia and eastern Malesia.

ACKNOWLEDGEMENTS

I am grateful to the Director, O.R.S.T.O.M. de Nouméa (NOU), for permission to dissect herbarium material.

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