Root Nodules in Non-leguminous Plants in New Zealand

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Until recently there has been little interest in this subject of non-leguminous root nodules although they have been recognised as characteristic plant organs since 1829 (Allen and Allen, 1958).

Plants from eight dicotyledonous genera outside the Leguminosae have been shown to bear nodules. These have been stated by Bond *et al,* (1956) to belong to widely separated families, but they based this observation on the classification proposed by Engler and Diels (1936). If these families are placed in Orders according to Hutchinson's classification (1926) they appear to be more closely related than Bond *et al* have recognised (Table I).

1950) the former bearing both nodules and mycorrhizas simultaneously (McVean, 1956). The Fagaceae contains *Quercus, Fagus* and *Nothofagus* all of which mycorrhizal. *Myrica, Casuarina* and *Coriaria* all belong to monogeneric Orders. The remaining genera are placed by Hutchinson in the Rhamnales so that this Order contains five of the nine reported nodulated genera. *Pomaderris,* a member of the Rhamnaceae, has been found to bear ectotrophic mycorrhizas so that in the New Zealand Rhamnaceae the situation is similar to that in the Betulaceae.

The Nature of the Endophyte

This has remained a controversial subject since it was initially suggested that the endophyte in *Alnus* was a nonseptate filamentous fungus (Allen and Allen, 1958). Of the most recent papers, one (Hawker and Fraymouth, 1951) describes the endophyte of *Alnus, Myrica* and *Hippophae* as belonging to the Plasmodiophorales while another (Fletcher, 1955) regards the endophyte of *Myrica* as an actinomycete.

	Genus	*Family*	*Order* *Engler and Diels*	*Hutchinson*
1.	Myrica	Myricaceae	Myricales (6)	Myricales (46)
2.	Alnus	Betulaceae	Fagales (12)	Fagales (48)*
3.	Casuarina	Casuarinaceae	Verticillateae (1)	Casuarinales (49)
4.	Coriaria	Coriariaceae	Sapindales (27)	Coriariales (25)
5.	Hippophae	Elaeagnaceae	Myrtiflorae (32)	Rhamnales (54)
6.	Shepherdia			
7.	Elaeagnus			
8.	Ceanothus	Rhamnaceae	Rhamnales (28)	

* Order 47 is the little known Balanopsidales of New Caledonia.

TABLE I.—*Genera reported to be nodulated. (Serial number of Order in parenthesis)*

To this list must now be added *Discaria toumatou* a Rhamnaceous shrub native to New Zealand which, in all plants so far examined, has been found to bear nodules of a type similar to those described in other non-leguminous plants.

The Order Fagales, to which *Alnus* belongs, is composed of families that are largely mycotrophic. Thus the two genera in the Betulaceae, *Alnus* and *Betula,* are both mycorrhizal (Kelley,

Functions of the Nodules

Until recently the significance of nodules to non-leguminous plants has not been clear. Com-

parisons of the nitrogen contents of nodules and roots and those of shoots of nodulated and non-nodulated plants have given some indication of nitrogen fixation, but over-all the records are not conclusive (Allen and Allen, 1958).

Making use of isotopic nitrogen, Bond (1957) has been able to show that nodules of plants of six of the non-leguminous nodulated genera can fix atmospheric nitrogen. The three genera at present not conclusively shown to be capable of fixing nitrogen are thus: *Coriaria, Elaeagnus* and *Discaria.*

Nitrogen Fixation in Coriaria

It has been known for some years now that species of Coriaria in New Zealand were nodulated. An experiment with excised nodules of *Coriaria arborea,* to be published elsewhere, showed that these organs could fix significant amounts of ^{15}N when exposed to an atmosphere enriched with this isotope. Dr. G. Cone has shown (pers. com.) that intact plants of this same species are able to fix atmospheric nitrogen.

How far other species of *Coriaria* and other organs apart from nodules are able to carry out a similar process remains to be demonstrated. In this respect it is noteworthy that plants of *C. sarmentosa* from widely differing habitats have not yet been found to bear nodules.

Field evidence substantiates that plants of at least some species of *Coriara* can fix nitrogen, Thus plants belonging to this genus are characteristic on gravel screes, rock faces, river terraces and in tussock grasslands (Oliver, 1942). In tussock grassland on Mt. Egmont, *C. plumosa* and *C. pteridoides* have been observed to produce a vigorous response in growth of *Danthonia rigida* (A.P. Druce, pers. com.),

Discaria toumatou likewise is characteristic on loess, alluvial fans and gravel screes and is a member of the sparse vegetation of the arid regions of Central Otago. Nodules of this plant, to be described elsewhere, are morphologically similar to those of *Coriaria* and both appear to be infected by the same endophyte. Their nitrogen-fixing capacity has not yet been tested.

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Changes in Salt-marsh Vegetation

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The salt marshes on Scolt Head Island in Norfolk, Great Britain, were re-visited in August 1957 and remapped. These maps could be compared with maps prepared in 1932 and 1933. One portion, the western, of the island is in a state of steady growth and considerable changes have taken place in the marshes during the 25 years. Missel marsh, formerly a Salicornietum strictae, with considerable bare areas, has been transformed into an Asteretum tripolii and plants of the next stage, the General Salt Marsh, are already invading the area. Very little bare ground now remains.

On the youngest marsh, a sand flat with a Zosteretum nanae in 1933, the eel grass bed has been reduced as a result of increased height and fewer submergences, and there are a number of patches of *Spartina townsendii.* The most