Nodulation of *Lathyrus* and *Vicia* spp. in non-agricultural soils in East Scotland

Euan K. James1*, Pietro P.M. Iannetta1, Gregory Kenicer2, Janet I. Sprent3, Geoffrey R. Squire1

1The James Hutton Institute, Invergowrie, Dundee DD2 5DA, Scotland UK  
2Royal Botanic Garden, 20A Inverleith Row, Edinburgh EH3 5LR, UK  
3Division of Plant Sciences, University of Dundee at JHI, Invergowrie, Dundee DD2 5DA, UK

Email: euan.james@hu+on.ac.uk

**Introduction, Aims and Methods**

- Legumes in the genera *Lathyrus*, *Pisum* and *Vicia* can have all their N-requirements supplied by forming N₂-fixing symbioses with a common soil bacterium called *Rhizobium leguminosarum* bv. *viciae* (Rlv).

- Some of these legumes, such as faba bean (*Vicia faba*), are of great economical and agricultural importance, and are widely grown in temperate regions, including East Scotland.

- Seedlings of native rare and/or scarce species of *Lathyrus* and *Vicia* ("vetches") were grown in soil from their native environments (coastal, woodlands or highland) in order to induce nodulation by "trapping" the indigenous Rlv rhizobia.

- Effectiveness of nodulation was determined by acetylene reduction assays and by microscopical analysis of nodules.

**Fig. 1.** *Lathyrus* and *Vicia* species in various undisturbed ecosystems in East Scotland: A, *L. japonicus* ("sea pea") growing on the seashore at Carnoustie, Angus; B, *L. linifolius* ("bitter vetch") growing in woodland in Crambie Country Park, Angus; C, *V. lutea* ("yellow vetch") growing near the seashore at Monifieth, Angus; D, *V. sylvatica* ("wood vetch") on scree slopes at Arthur’s Seat, Edinburgh.

**Fig. 2.** Light and electron micrographs of nodules of *Lathyrus japonicus* (A, C, E) and *Vicia lutea* (B, D, F) grown in native rhizosphere soil: A, Nodules on a root of *L. japonicus*; B, Nodules on a root of *V. lutea*; C, Longitudinal section (LS) through a *L. japonicus* nodule showing the meristem (m), invasion zone (it) and the N₂-fixing zone (*); D, LS of a *V. lutea* nodule; E, Electron micrograph (EM) of a pleomorphic bacteroid (b) in a *L. japonicus* nodule; and F, EM of *V. lutea* bacteroids. Bars, 250 µm (A, B), 20 µm (C), 40 µm (D), 500 nm (E), 1 µm (F).

**Results and Further work**

- Coastal soils with very low N concentrations resulted in highly effective nodulation of most species examined (Fig. 2, Table 1).

- However, some species, such as *L. linifolius*, which live in more fertile woodland soils may have less use for symbiotic N₂ fixation (Table 1).

- Rlv isolates from all the plant/soil combinations are now the subject of a molecular analysis of their core “housekeeping” (16S rRNA, recA) and their symbiosis-related genes (nodD) to see how they compare with rhizobia that can nodulate the crop species *P. sativum* and *V. faba* (Mutch & Young, 2004).

**Table 1.** Symbiotic nodulation of uncommon/rare *Lathyrus* and *Vicia* spp. from coastal, woodland and highland locations in East Scotland as determined by visual observation of effective nodules (see Fig. 2), and by acetylene reduction assays of nitrogenase activity. The activities of all plants were determined at 2 – 3 months after planting of seedlings grown as “trap” plants in soil obtained from the rhizospheres of the various parent plants. The common legume *Vicia sativa* was s ‘inoculated’ in the same soils and was tested in parallel.

<table>
<thead>
<tr>
<th>Species/rhizosphere soil</th>
<th>Environment</th>
<th><em>L. japonicus</em></th>
<th><em>L. linifolius</em></th>
<th><em>L. linifolius</em></th>
<th><em>V. lutea</em></th>
<th><em>V. alysiva</em></th>
<th><em>V. alytica</em></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Seashore</td>
<td>0 nodules</td>
<td>n.d.</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
</tr>
<tr>
<td></td>
<td>Woodland</td>
<td>0 nodules</td>
<td>n.d.</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
</tr>
<tr>
<td></td>
<td>Woodland</td>
<td>0 nodules</td>
<td>n.d.</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
</tr>
<tr>
<td></td>
<td>Screeslope</td>
<td>0 nodules</td>
<td>n.d.</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
</tr>
<tr>
<td></td>
<td>Cliff</td>
<td>0 nodules</td>
<td>n.d.</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
<td>0 nodules</td>
</tr>
</tbody>
</table>

**Acknowledgements**

We thanks Pete Rowell for use of his GC, and Legume Futures for helping to fund this work.

**Further Reading**