

Functional Plant Biology

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Special Issue: Actinorhizal Plants

Foreword: Actinorhizal plants

Ana Ribeiro, Alison M. Berry, Katharina Pawlowski and Patrícia Santos v–vii

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| <p><i>Review: Progress on research on actinorhizal plants</i> Katharina Pawlowski, Didier Bogusz, Ana Ribeiro <i>and Alison M. Berry</i></p> | 633–638 | <p>Recently, work on chimeric transgenic plants has shown that <i>Frankia</i> Nod factor equivalents signal via the same transduction pathway as rhizobial Nod factors. Progress has also been made regarding the role of auxin in actinorhizal nodule formation, pathogenesis- and stress-related gene expression and nodule physiology.</p> |
| <p><i>Review: Actinorhizal plant defence-related genes in response to symbiotic Frankia</i> Ana Ribeiro, Inês Graça, Katharina Pawlowski <i>and Patrícia Santos</i></p> | 639–644 | <p>Actinorhizal plants are capable of high rates of nitrogen fixation due to their capacity to establish root nodule symbiosis with <i>Frankia</i>. Nodulation is a developmental process that requires highly coordinated mechanisms, amongst which are the induction and suppression of plant defences. This review focuses on actinorhizal defense/stress genes up-regulated during symbiosis.</p> |
| <p><i>Review: New perspectives on nodule nitrogen assimilation in actinorhizal symbioses</i> Alison M. Berry, Alberto Mendoza-Herrera, Ying-Yi Guo, Jennifer Hayashi, Tomas Persson, Ravi Barabote, Kirill Demchenko, Shuxiao Zhang and Katharina Pawlowski</p> | 645–652 | <p>Patterns of assimilation of fixed nitrogen in actinorhizal root nodules are discussed, with emphasis on the partitioning of key assimilatory functions between the host tissues and <i>Frankia</i>, and on the contrasting patterns that are becoming apparent among different actinorhizal host-microsymbiont associations.</p> |
| <p><i>Review: An overview of actinorhizal plants in Africa</i> Maher Gtari and Jeffrey O. Dawson</p> | 653–661 | <p>A synthesis of information derived from African plant databases and other sources indicates that there are six families, nine genera and 38 reported species of actinorhizal plants in Africa. The 21 native and 17 exotic species are distributed throughout Africa, occurring in virtually every nation of the continent.</p> |
| <p>Diffusible factors from <i>Frankia</i> modify nodulation kinetics in <i>Discaria trinervis</i>, an intercellular root-infected actinorhizal symbiosis Luciano Andrés Gabbarini <i>and Luis Gabriel Wall</i></p> | 662–670 | <p>Nodulation kinetics and nodule occupancy by <i>Frankia</i> were analyzed in co-inoculation experiments, using two incompatible actinorhizal symbioses pairs with different infection pathways. Our findings support the idea that diffusible substances that enhance nodulation can be modulated by the host plant but may be not enough to break the recognition barrier.</p> |

Cover illustration: Nitrogen-fixing root nodule, formed as a symbiosis between *Frankia* sp. and the actinorhizal host plant, *Datisca glomerata*, shown in cross-section. Two-way exchange of nitrogen and carbon between host and microsymbiont is affected by transport through a continuum of metabolic compartments, from *Frankia*-filled cells (enlarged, darkly-staining cells) to the vascular tissue. Photograph by Kirill Demchenko.

Diffusible factors involved in early interactions of actinorhizal symbiosis are modulated by the host plant but are not enough to break the host range barrier

Luciano Andrés Gabbarini and Luis Gabriel Wall 671–681

Frankia BCU110501 Diffusible Factors (DFs) might be involved in early interactions with *D. trinervis*. DFs stimulate nodulation rate. DFs are: MW <12 kDa; negatively charged at pH 7.0; sensitive to protease. DFs deform root hairs of *Alnus acuminata* suggesting common basic structure of symbiotic factors regardless the infection pathway.

Strain specificity in the *Myricaceae*–*Frankia* symbiosis is correlated to plant root phenolics
Jean Popovici, Vincent Walker, Cédric Bertrand, Florian Bellvert, Maria P. Fernandez and Gilles Comte

682–689

This article describes the effects of *Frankia* inoculation on root phenolic metabolism of two *Myricaceae* species (*Myrica gale* and *Morella cerifera*) with different host-symbiont compatibility status. Depending on the compatibility of the host plant with the strain inoculated, different modifications are observed, providing insights in the signalling process between *Frankia* and the *Myricaceae*.

Activation of the isoflavonoid pathway in actinorhizal symbioses
Florence Auguy, Khalid Abdel-Lateif, Patrick Doumas, Pablo Badin, Vanessa Guerin, Didier Bogusz and Valérie Hocher

690–696

The involvement of flavonoids was investigated in the actinorhizal nodulation process between the tropical tree *Casuarina glauca* and the actinomycete *Frankia*. Eight *C. glauca* genes involved in flavonoid biosynthesis were identified from a unigene database. Their expression analysis suggests, for the first time, that isoflavonoids are implicated in actinorhizal nodulation.

Antioxidant profiling of *Hippophae salicifolia* growing in sacred forests of Sikkim, India
Arvind K. Goyal, Bharat C. Basistha, Arnab Sen and Sushil K. Middha

697–701

Aqueous, methanol and acetone extracts of *Hippophae salicifolia* D. Don were evaluated for antioxidant activity, and phenolic and flavonoid contents. The phenolic and flavonoid contents were found to be highest in aqueous extracts. Methanolic extracts exhibited strong radical scavenging activity. The reducing capacity of extracts was as follows: water>methanol>acetone. Strong correlation was observed between DPPH scavenging activity and phenolic content.

Effects of elevated atmospheric carbon dioxide, soil nutrients and water conditions on photosynthetic and growth responses of *Alnus hirsuta*
Hiroyuki Tobita, Akira Uemura, Mitsutoshi Kitao, Satoshi Kitaoka, Yutaka Maruyama and Hajime Utsugi

702–710

The effects of soil N and P availability and soil drought on the physiological and morphological responses of *Alnus hirsuta* to elevated [CO₂] were evaluated by using the results of two experiments. This paper shows that the effects of P availability were more marked than those of N availability and soil drought. Soil P availability affected the growth responses to elevated [CO₂] through effects on photosynthetic properties and biomass allocation.

Evidence for community structuring associated with the actinorhizal shrub *Ceanothus americanus* in tallgrass prairies in Illinois, USA
John B. Taft and Jeffrey O. Dawson

711–719

The actinorhizal shrub *Ceanothus americanus* structures the composition, diversity and functional traits of plants at the local patch scale in remnant tallgrass prairie communities of Illinois. C₃ graminoid species are significantly more abundant in prairies associated with *C. americanus* than are C₄ species, while mean diversity is significantly lower.

Reproductive ecology of *Ochetophila trinervis* in Northwest Patagonia
M. Fernanda Reyes, Miriam E. Gobbi and Eugenia E. Chaia

720–727

The reproductive ecology of *Ochetophila trinervis*, a native actinorhizal species, was studied in NW Patagonia. It varied along an environmental gradient, showing a reduction in the number of reproductive structures from one phenological stage to the next. This result suggests the existence of a recruitment bottleneck in the species.

The *Casuarina glauca* metallothionein I promoter
in nodulated transgenic hairy roots of the
actinorhizal plant *Datisca glomerata*

**Behnoosh Rashidi, Sara Mehrabi, Kirill Demchenko
and Katharina Pawlowski**

728–737

The promoter of a metallothionein gene expressed in actinorhizal nodules of *Casuarina glauca* was previously shown to be active in the root cortex and epidermis of stably transformed dicots and monocots. Now, its activity was analysed in transgenic hairy roots of *Datisca glomerata* and in the model legume *Lotus japonicus*.

Taxonomic resolution of actinorhizal *Myrica* species
from Meghalaya (India) through nuclear rDNA
sequence analyses

**Mhathung Yanthan, David Biate
and Arvind K. Misra**

738–746

The paper deals with a molecular approach to resolving disputes with respect to classification of plant species, using genus *Myrica* as an example. A nuclear rDNA segment based scale defining the limits of genera, species and sub-specific variants has been developed. This approach will be useful for resolution of similar disputes.