

Functional Plant Biology

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Contents

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Review: Mechanisms of anoxia tolerance in plants. II.
Energy requirements for maintenance and energy
distribution to essential processes

Hank Greenway and Jane Gibbs 999–1036

The second of a two-part review of adaptation to anoxia, this paper focuses on strategies employed by plants to cope with the 'energy crisis' that results from anoxia in plant tissues. The authors discuss how plants reduce their energy requirements for maintenance, and also direct the limited amount of energy produced to those energy-consuming processes critical to survival.

Regulation of apple leaf aldose-6-phosphate reductase
activity by inorganic phosphate and divalent cations

**Rui Zhou, Richard C. Sicher, Lailiang Cheng
and Bruno Quebedeaux** 1037–1043

Carbohydrates are the main determinants of plant yield, so there is much interest in elucidating the regulatory mechanisms of their metabolism. This manuscript reports that inorganic phosphate inhibits apple leaf aldose-6-phosphate reductase activity, and that metal ions either activate or inhibit activity, depending on their concentration and that of the substrate glucose-6-phosphate.

Genetic transformation in commercial Tasmanian
cultivars of opium poppy, *Papaver somniferum*, and
movement of transgenic pollen in the field

**Julie A. Chitty, Robert S. Allen, Anthony J. Fist
and Philip J. Larkin** 1045–1058

The manuscript describes the development of a transformation protocol for opium poppy that is effective on a wide range of genotypes. For the first time, this allows the transformation of high morphine commercial lines of poppy, including elite Australian cultivars. A transgenic field trial is reported which quantifies gene flow risks; the distances travelled by transgenic pollen into buffer rows, and whether seed collected from adjacent weedy poppy species contained transgenes.

Oxygen isotope composition of phloem sap in relation to
leaf water in *Ricinus communis*

**Lucas A. Cernusak, S. Chin Wong and
Graham D. Farquhar** 1059–1070

The paper describes measuring the oxygen isotope composition of leaf water and phloem sap exported from photosynthesizing *Ricinus communis* leaves. The authors found that the oxygen isotope ratio of phloem sap dry matter correlated to the oxygen isotope composition of average lamina leaf water, and that enriched leaf water could be exported from photosynthesizing leaves in the phloem. These results have implications for predicting and interpreting oxygen isotope ratios in plant organic material.

Variation in chloroplast small heat-shock protein function
is a major determinant of variation in thermotolerance of
photosynthetic electron transport among ecotypes of
Chenopodium album

**Deepak Barua, Craig A. Downs and
Scott A. Heckathorn** 1071–1079

Heat-shock proteins are important for protecting cells against stress; most appear to protect proteins or membranes during stress or facilitate repair or degradation of damaged proteins following a stressful event. The contribution of variation in chloroplast small heat-shock protein to ecotypic variation in photosynthetic thermotolerance was investigated. The authors demonstrate direct consequences of natural variation, and show that functional variation is associated with adaptation to habitat.

Cover illustration: Opium poppy produces pharmaceutically important morphinan alkaloids. Genetic transformation of Tasmanian cultivars opens opportunities to enhance alkaloid yields and modify the chemistry (see Chitty *et al.*, pp. 1045–1058).

Viewpoint: Evolution of cultivated chickpea: four
bottlenecks limit diversity and constrain adaptation

Shahal Abbo, Jens Berger and Neil C. Turner

1081–1087

Chickpea has a different adaptation profile than other crops of West Asian origin. These authors present a viewpoint that suggests that a series of evolutionary bottlenecks is responsible for this phenomenon, including the scarcity of the wild progenitor, domestication effects, the early shift from winter to summer cropping, and the replacement of locally-evolving landraces by elite cultivars produced by modern plant breeding.
