Ecological significance of C₄ photosynthesis: A comparison of C₃ and C₄ subspecies of Allotropis semialata and other NADP-ME Panicoid grasses

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The photosynthetic efficiency of C₃ grasses declines with increasing temperature and C₄ grasses are predicted to be advantaged at temperatures above 15 °C. We demonstrated an above-ground productivity difference in a common-garden experiment with Allotropis semialata and show that it is related more to differences in life-history than to photosynthesis. Frost caused leaf mortality in the C₄ but not C₃ subspecies, which maintained photosynthetic leaf area throughout the winter. As a consequence the C₃ plants were detrimentally affected by fire while the C₄'s were not. C₃’s retained a greater proportion of biomass belowground and through reallocation were able to re-grow leaf area faster than the C₄’s. Differences in growth and allocation may be related to the greater photosynthetic productivity and nitrogen use efficiency of C₄ plants. Drought experiments on Allotropis and other Panicoid grasses showed differential effects on C₃ and C₄ productivity, removing the C₃ photosynthetic advantage due to greater metabolic limitations of photosynthesis and prolonged recovery on re-watering. This drought response may explain the paradox of declining NADP-ME species numbers with decreased rainfall, despite the apparent water use efficiency advantage of C₄ photosynthesis.

doi:10.1016/j.sajb.2008.01.100

A histological examination of desiccated Eucalyptus in vitro axillary buds

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Eucalyptus grandis is the most important and widely planted eucalypt in South Africa. It has a wide range of uses including pulpwood, poles, firewood, charcoal, flooring, mining, furniture and general carpentry. Conservation of plant genetic resources including those used in agriculture, horticulture and forestry has become an issue of common global concern. Cryopreservation involves the storage of plant material at ultra low temperature (~196 °C). The techniques for cryopreservation currently in use are varied and include the older classical techniques and the new vitrification-based techniques. Desiccation is commonly used in the preparation of in vitro material for cryostorage. During desiccation, the physical and physiological characteristics of the cell change because of the removal of water and damage is reflected by the lack of resumption of normal activity upon rehydration. In a previous study conducted in our laboratories it was concluded that the application of ABA for a preculture period of 5 days resulted in an induction of better tolerance to desiccation compared with the untreated control material. The study is investigating the cause of loss of cell viability in the existing cryopreservation protocol for E. grandis and is making use of various forms of microscopy. The present contribution will illustrate the effects of ABA pre-treated and partial desiccation on the tissues of isolated in vitro axillary buds of E. grandis.

doi:10.1016/j.sajb.2008.01.103

Discovery of new fungi associated with the decline and death of Euphorbia ingens in the Limpopo Province of South Africa

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The genus Euphorbia (Euphorbiaceae) consists of 24 species and is endemic to South Africa. The genus exhibits a high degree of floral variation, and pollination occurs through a wide variety of pollinators (bees, flies, moths, birds). In Tritoniopsis revoluta, considerable variation is seen in perianth tube lengths (14–85 mm), which led me to hypothesize that the variation in the tube lengths of Tritoniopsis revoluta may be due to different pollinator morphology at different populations. Seven different Tritoniopsis revoluta populations with tube lengths spanning the entire length-range were found using herbarium data. From these populations pollinator and tube-length data were collected, and compared. I found that tube length can be divided into 2 discrete categories, namely short (10–45 mm) and long (50–85 mm). In addition to this there is one population with a bimodal distribution in corolla tube length, which suggests that plants with different tube lengths could be incipient species. Flies with proboscis lengths matching the short category have been caught, but no flies have been caught in populations with long tubes. Future research will concentrate on how different morphs are maintained in different populations, and in sympathy. In particular I will undertake a population genetics study to establish whether there is gene flow between different morphs in bimodal populations, and whether there is gene flow between the different populations themselves.

doi:10.1016/j.sajb.2008.01.102

Pollinator-driven floral variation in Tritoniopsis revoluta

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The genus Tritoniopsis (Iridaceae) consists of 24 species and is endemic to South Africa. The genus exhibits a high degree of floral variation, and pollination occurs through a wide variety of pollinators (bees, flies, moths, birds). In Tritoniopsis revoluta, considerable variation is seen in perianth tube lengths (14–85 mm), which led me to hypothesize that the variation in the tube lengths of Tritoniopsis revoluta may be due to different pollinator morphology at different populations. Seven different Tritoniopsis revoluta populations with tube lengths spanning the entire length-range were found using herbarium data. From these populations pollinator and tube-length data were collected, and compared. I found that tube length can be divided into 2 discrete categories, namely short (10–45 mm) and long (50–85 mm). In addition to this there is one population with a bimodal distribution in corolla tube length, which suggests that plants with different tube lengths could be incipient species. Flies with proboscis lengths matching the short category have been caught, but no flies have been caught in populations with long tubes. Future research will concentrate on how different morphs are maintained in different populations, and in sympathy. In particular I will undertake a population genetics study to establish whether there is gene flow between different morphs in bimodal populations, and whether there is gene flow between the different populations themselves.

doi:10.1016/j.sajb.2008.01.103

Does autogamy contribute to invasion in Lilium formosanum?

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The Taiwanese geophyte Lilium formosanum is invasive in the eastern parts of South Africa. Although it is capable of autogamy, a pollinator, the hawkmoth Agrius convolvuli, is present. Reproduction may therefore take place both by self- and cross-fertilisation. The relative importance of these modes of pollination for seed production is evaluated using emasculation experiments. The potential contributions of outcrossed and selfed progeny to invasion are assessed in progeny performance trials.

doi:10.1016/j.sajb.2008.01.102

Discovery of new fungi associated with the decline and death of Euphorbia ingens in the Limpopo Province of South Africa

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Euphorbia ingens (Euphorbiaceae), commonly known as naboom or candelabra trees, are a dominant feature of the Limpopo Province vegetation. In recent years, these trees have been observed to be diseased and dying. A recent survey of E. ingens trees at the National Zoological Gardens Biodiversity Conservation Centre at Mokopane revealed that more than 90% of the trees in that area are diseased and dying. The aim of this study was to describe the disease and to consider the possible involvement of fungi and
insects in this disease. Samples were collected from diseased and dying trees during three surveys in 2007. Fungi and insects collected were identified based on morphology and in some cases using DNA sequence comparisons. Symptoms included a greying of the succulent branches, death of individual branches and eventually collapse of entire trees. Internal symptoms included browning and rotting of the tissues in the succulent branches, blue stain of the woody main stem and insect infestation. Several genera of fungi, including species of Cibesii, Fusarium, Lasiodiplodia and Ophiostomatoid fungi were isolated. Insects included several genera in the Curculionidae. Three different genera of Ophiostomatoid fungi were identified, of which two represent previously undescribed species. These fungi were also isolated from the scolytine beetles collected. Lasiodiplodia theobromae was the fungus most commonly isolated from the blue stained wood, and it was also common in the freshly developing brown lesions in the branches. Although the exact cause of the decline and death of the E. ingens trees is not yet clear, this study has provided a foundation for further investigations. Results also illustrate the great lack of knowledge regarding the fungal biodiversity on native tree species in South Africa.

doi:10.1016/j.sajb.2008.01.104

Symptomatic defence mechanisms include wound callose deposition after *Rhopalosiphum padi* L. infestation of barley leaves

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Wound callose deposition is a known rapid response of plants to wounding of its cells. The formation and deposition of wound callose during infestation of grain crops by phloem feeding aphids have been recently linked to the expression of visible damage symptoms by host plants. The deposition and subsequent symptoms expressed by infested plants were investigated during feeding on barley leaves by bird cherry-oat aphid (BCA), *Rhopalosiphum padi* L., an aphid that do not inflict any symptoms on host plants, especially at low level of feeding populations. Our results with aniline blue fluorochrome stain for callose observed using fluorescence microscopy, has revealed that wound callose deposition starts to appear after 14 days of feeding at low aphid levels (5 adult aphids) of infestation. Deposition of wound callose increases and becomes more pronounced with time to 21 days. Interestingly, feeding by larger populations (50 adult aphids), results in the formation and deposition of wound callose within 72 h, with deposition along longitudinal intermediate and cross veins. These results confirm that the formation and deposition of aphid-induced wound callose is partly involved in symptomatic expression of host plants during aphid feeding. Wounding responses include golden yellow streak symptoms that occur during heavy infestation by BCA.

doi:10.1016/j.sajb.2008.01.105

Molecular events in senescing soybean nodules

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Nodules play an important role as nitrogen fixing organs on leguminous plants such as soybean, enabling them to perform well even under nitrogen limiting conditions. The symbiosis has however a limited lifespan, and nitrogen fixation activity of the nodules usually ceases before the final pod filling stage. Pre-mature senescence of nodules caused by environmental stresses such as drought or cold can therefore affect the nitrogen metabolism of the plants and seed quality of the soybean crop. Nitrogen fixation capacity was monitored during different stages of soybean growth and RNA transcripts in mature and senescing soybean nodules were compared. Understanding of the molecular processes in the senescing nodules can help to select key events responsible for the sudden decrease in nitrogen fixation capacity, and can lead finally to specification of new criteria for selection of soybean varieties for farming in unpredictable environments and nitrogen poor soils.

doi:10.1016/j.sajb.2008.01.106

Performance of seedlings subsequent to cryopreservation of embryonic axes of *Amaryllis belladonna*

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Cryopreservation is the most promising route for the long-term germplasm conservation of recalcitrant seeds. Since the ultimate aim of cryopreservation is the re-introduction of viable plants into the field, the vigour of plantlets derived from embryonic axes subjected to cryopreservation must be assessed. Embryonic axes excised from seeds of *Amaryllis belladonna* were subjected to one of the following treatment combinations: a) no cryoprotection, no dehydration and no freezing (F), b) cryoprotection with glycerol, rapid dehydration to ±0.20 g/g and rapid rehydration (D); and c) cryoprotection with glycerol, rapid dehydration to ±0.24 g/g, rapid cooling (hundreds of °C/s), rapid thawing and rehydration (D+C). Plants generated from these treatments were regenerated in vitro, hardened-off ex vitro and then exposed to either no water stress or a water deficit, imposed by withholding water (and then re-watered to see if they recovered). Embryonic axes subjected to partial dehydration (D) and the combination of partial dehydration and cooling (D+C) produced seedlings that were less vigorous than those from fresh axes. Failure to equilibrate with soil water potential overnight, indications of permanent leaf wilting, a decrease in potential photochemical efficiency and leaf chlorophyll content, as well as abnormal root growth characterised such seedlings. Seedlings derived from *D* axes performed better than *D+C* seedlings when water stressed, but seedling mortality was comparable in both treatments. Plantlets derived from cryopreserved *Amaryllis belladonna* axes may require specific nursery treatment prior to re-introduction to the wild.

doi:10.1016/j.sajb.2008.01.107

Fields of papaya and honey: The scent of beetle-pollinated *Protea* species

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Inflorescences of four grassland and savanna *Protea* species in KwaZulu-Natal show features specialized to exploit generalist cetonid beetles. These include large open bowl-shaped inflorescences, extremely large pollen rewards, accessible dilute nectar, fruity/honey scent, colourful bracts, and a low growth form when frequently burnt. This contrasts to bird-pollinated *Protea* inflorescences that are typically robust, tall, unscented, with hidden nectar resources that are only accessible by a long beak or larger protea beetles. The scents of four *Protea* species were investigated using GCMS and the resulting chemical profiles analysed using correspondence analysis. The floral scents of *P. caffra*, *P. simplex*, and *P. dracomontana* resemble the fermenting fruit of *Carica papaya*, and share volatiles such as linalool, its oxides, and methyl benzoate. The scent chemistry of *P. welwitschii*, however, is highly complex with esters forming from a variety of acids and alcohols. Analyses involving dissected flowers revealed that the nectar is a main source of these odours, and that the scent production peaks with anthesis and nectar production. Scent preference tests with cetonid beetles confirmed that the odor of *P. simplex* is likely to be the principal attractant. Behavioural assays and GCEAD will be performed with these beetles and specific scent volatiles from the proteas in an attempt to explain the evolution of scent