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While some hepatics (liverworts) have long been recognized as being endomycorrhizal, the extent of the phenomenon and systematic placement of the fungi involved has generally been obscure. Now, using molecular and ultrastructural approaches to examine the situation in 28 species drawn from ten families, the largest and most detailed examination of these fungi so far is reported (pp. 957–968). *Aneura piguis* (Metzgeriales) was found to be associated with *Tulsanella* spp., while members of the *Jungermanniales* studied all had sebacinoid mycobionts; the latter are considered more ancient evolutionarily, and the new term ‘jungermannoid mycorrhiza’ is introduced for this special type of mycorrhizal association.

Various *Conocybe* species are known to be toxic to humans, but the active compounds have not always been identified. Here, *C. lactea* is shown to produce small amounts of phallotoxins, the first time they have been reported outside *Amanita*, and molecular studies provide new information on the relationships in the

genus and further of allied sequestrate species referred to *Gastrocybe* (pp. 969–979). It is suggested that the strange morphology of *G. lateritia* could be due to a bacterial infection. Animals can suffer from ‘locoism’ after consuming swainsonine-containing legumes in the western USA, especially *Astragalus* and *Oxytropis* species. Studies of endophytes isolated from locoweed plants, however, showed that all produced the alkaloid swainsonine, and molecular studies indicated that these were most closely related to *Embellisia*.

While the role of fungi in the decomposition of leaf-litter is well-known, the enzymes responsible for lignin depolymerization have rarely been investigated, even in species thought to have major ecological roles in this process. Experimental studies using different media have demonstrated that in *Mycena galopus*, laccases, peroxidases, mannases and xylanases are formed, but that there are differences in enzyme production between varieties and strains within the species (pp. 996–1008).

DOI: 10.1017/S0953756203228495

KELO TREES: A VANISHING FUNGAL HABITAT

Under natural conditions, individual *Pinus sylvestris* trees may live for 300–500 yr, and then remain standing but dead and without bark for a further 300–500 yr; these dead standing dead pines are referred to as ‘kelo’ trees. Such trees are now exceptionally rare throughout Europe, but they offer a specialized habitat for fungi which is currently vanishing. One site where such trees are still to be found in central Europe is the Bia_owie_a forest in Poland, but others still occur in some areas of Fennoscandia, such as northernmost Finland, and may also be found occasionally in mixed forests further south. Niemelä, Wakkenius & Kotiranta (2002) have made a particular study of the kelo trees and the polypores and corticioid fungi associated with them, also reviewing the literature on these fungi in this habitat. They tabulate 28 species growing exclusively on or which strongly favour

kelo trees, amongst the most characteristic of which are *Antrodia crassa*, *A. infirma*, *Chaetoderma luna*, *Gloeophyllum protractum*, *Odonticum romellii*, *Phlebia cornea*, *Postia hibernica*, *P. lateritia*, and *Sistotremastrum suecicum*. It is likely that such trees are also important habitats for other groups of fungi as well, for instance calicioid species and other xerophytic ascomycetes. It is clearly not only ancient deciduous trees that merit protection as sources of unusual and increasingly rare fungi, and conservationists in general should be urged to protect kelo trees wherever they occur.

Niemelä, T., Wakkenius, T. & Kotiranta, H. (2002) The kelo tree, a vanishing substrate of specified wood-inhabiting fungi. *Polish Botanical Journal* **47**: 91–101.

DOI: 10.1017/S0953756203238491

POLARIZED GROWTH IN FISSION YEAST

In *Schizosaccharomyces pombe*, the protein tealp is transported to cell tips by association with growing microtubule ends, and then associates with the cell cortex and coordinates polarized growth. But that is not the end of the story. Now, Snaith & Sawin (2003) have discovered another key protein, mod5p, that occurs in the cortex and regulates the behaviour of tealp. Studies with mutant yeast cells enabled the authors to establish that the new protein is necessary

to anchor tealp at the cortex so that it accumulates to the required levels. The two proteins appear to act in a positive-feedback loop in orientating the microtubules that mediate with them in regulating cell polarity. First-rate immunostained photomicrographs prepared with a confocal laser microscope elegantly illustrate the phenomenon. The extent to which this same mechanism operates in other kinds of cells, not only those of fungi, remains to be established. This

study also demonstrates the value of using fungal models to investigate fundamental aspects of cell development in general.

Snaith, H. A. & Sawin, K. E. (2003) Fission yeast mod5p regulates polarized growth through anchoring of tealp at cell tips. *Nature* **423**: 647–651.

DOI: 10.1017/S0953756203248498

COMPARATIVE GENOMICS AND FUNCTIONAL ELEMENTS IN THE YEAST GENOME

As more complete sequences become available from different organisms, and especially closely related ones, the possibility of comparing these as part of the process of determining what particular genes do starts to become a reality. The yeast genomes are amongst the most intensively studied to date, *Saccharomyces cerevisiae* had its complete genome sequenced six years ago and *Schizosaccharomyces pombe* was completed last year². Now, 'draft' sequences are available for three other *Saccharomyces* species, *S. bayanus*, *S. mitake* and *S. paradoxus*. Kellis *et al.* (2003) have aligned the genomes of all four species of the genus, determined their evolutionary relationships, defining the regions and mechanisms of change. They then developed methods for the direct identification of genes and regulatory motifs, resulting in a revision of what is known of yeast genes. The total number of genes known in *S. cerevisiae* is now calculated as 5538, a reduction by around 500 of earlier reports. Thirty-three pairs of consecutive genes were merged,

redefinitions of start/stop codons reduce the number by about 300, and some 60 new introns were recognized. The analysis also revealed 72 genome-wide and well-conserved elements, including most known regulatory motifs, and many hitherto uncharacterised ones; putative functions could be assigned to many of the latter. The approach is sure to have wide applications as more and more complete genome sequences become available and enhances the value of *S. cerevisiae* yeasts as a model for not only functional but also comparative genomic studies. Salzberg (2003) provides neat figure comparing key aspects of the elements in the genomes of the four species.

Kellis, M., Patterson, N., Endrizzi, M., Birren, B. & Lander, E. S. (2003) Sequencing and comparison of yeast species to identify genes and regulatory elements. *Nature* **423**: 241–254.

Salzberg, S. L. (2003) Yeast rises again. *Nature* **423**: 233–234.

DOI: 10.1017/S0953756203258494

WHEN PHYSICS MEETS BIOLOGY: HIGH-RESOLUTION LASER-BASED TECHNIQUES TO STUDY PLANT–MICROBE INTERACTIONS

Laser technologies were applied to the study of plant–pathogen interactions in an EC project to monitor the evolution of plant natural compounds, such as the plant hormone ethylene and the plant natural antibiotic resveratrol (3,5,4'-trihydroxystilbene). The recently completed 'Fruta fresca: improvement of natural resistance in fruit' project was funded in 1999 by a grant from the European Commission to laboratories in Spain, Italy, The Netherlands, Israel, and Switzerland (FAIR CT98-4211). The project facilitated collaboration between 'hard-core' physics laboratories and molecular biology and agronomy research teams. The project aimed to develop laser techniques to allow fast, highly sensitive, and possibly real-time detection of volatiles, such as C₂H₄, C₃H₆, higher alkanes, acetaldehyde, hexenal, and non-volatiles (mainly resveratrol),

in plants and their fruits during fungus attack. Another aim of the project was to identify treatments that could potentially induce pathogen resistance in harvested fruit, possibly by invoking the production of natural compounds with antimicrobial activity, or by external treatment with such 'natural antibiotics' as alternatives to industrial fungicides. Two laser techniques were developed; one based on laser photoacoustic (LPA) spectroscopy which had already proved useful in studying bacterial physiology (Staal *et al.* 2001), and the other on laser desorption (REMPI-TOF) which had not previously been applied in the life sciences.

The LPA system is based on the generation of acoustic waves as a consequence of light absorption. For a gas sample in a closed volume, light absorption results in temperature variation that is accompanied by a pressure variation, which in turn creates a sound wave that can be detected with a sensitive microphone. The system allows the detection of a large number of volatile

² See Mycological Research News (*Mycological Research* **106** (4): 386, April 2003).

molecules that have biological significance (An.). When applied to the phytopathogen *Botrytis cinerea* on tomato fruits and *in vitro*, the sensitivity of the system enabled fungus-produced ethylene to be measured, something almost undetectable with standard procedures. Ethylene emission was correlated with fungus growth, and was compared with ethylene emission from infected fruits to relate it to the progress of the disease (Cristescu *et al.* 2002). The REMPI-TOF system is based on the analysis of ions generated from a resonant multiphoton ionization system (REMPI) with a time-of-flight mass spectroscope (TOF). This system was highly sensitive, and could analyse single molecules even from raw plant extracts without any pre-purification. When coupled to the LPA system, it enabled the microbiota of grapes to be studied (Montero *et al.* 2003), and showed a relation between the resveratrol content of the fruit and the ethylene emission, as well as the effect of exogenous applications of resveratrol on fruit in relation to the release of ethylene and microbial colonisation. The antifungal activity of resveratrol was then studied in detail when applied to other fruit types (J. B. Jimenez *et al.*, unpubl.), indicating the wide potential of such molecules for the control of the microbiota on fruits. The ability to induce this plant defence response to prolong the shelf-life of fruit was also evaluated by pre-storage treatments that could result in decay reduction without loss of quality. Hot water rinsing and brushing, as well as an anoxia treatment, resulted in a reduction of decay development in harvested tomatoes while maintaining fruit quality (Fallik *et al.* 2002, 2003). Although the components that function in the induction of antimicrobial activity in the fruit with these different treatments still needs to be identified, it seems clearly that prolonged shelf-life of fruits can be achieved without the use of industrially produced antimicrobials.

This collaboration between physicists and biologists has provided new tools to approach the study of plant-microbe interaction, enabling us to study pathogen

progress with higher sensitivity, and to develop new methods to control the microbiota of fresh fruit. Applied laser technologies is a fast moving field that can has the potential to be adapted to the needs of life scientists. The future evolution of such cutting-edge techniques into user-friendly tools will enable old questions to be answered using new approaches.³

For a detailed description of the LPA system, consult <http://www-tracegasfac.sci.kun.nl/>, and for a complete list of publications and patents from FAIR CT98-4211 contact: A. Ureña, Universidad Complutense de Madrid, e-mail: laseres@eucmax.sim.ucm.es.

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ACKNOWLEDGEMENT

As Executive Editor, I wish to thank Domineco De Martinis (Sezione Genetica e Genomica Vegetale, Cassaccia Research Center, Via Anguillarese 301, I-00060 Roma, Italy; e-mail: demartinis@casaccia.enea.it) for assistance in the final editing of accepted

manuscripts in the three months February through April 2003. His support in cross-checking references, making stylistic corrections, and identifying potentially unclear or conflicting items in need of attention contributed to a speedier processing of papers in this period.

³ A further recent example of the application of new tools developed in another area of science being used in mycology is the use of an electronic nose to distinguish mushrooms by their volatile products (Keshri *et al.* 2003).