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WHAT PHYTOPHTHORA INFESTANS RACE CAUSED THE IRISH POTATO FAMINE?

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Mycological Research News¹

Mycological Research News features what *Phytophthora infestans* race caused the Irish Potato famine?

Molecular work in this issue compares *Glomus* isolates from mycorrhizal roots and soil in the same field and reveals some discrepancies and probably novel taxa. New mt SSU rDNA primers have been designed for use in filamentous ascomycetes and applied to *Botryosphaeria* and related anamorphs. β -tubulin gene sequences are used in a phylogenetic study of species of *Calonectria* and associated *Cylindrocladium* anamorphs.

Microsatellite DNA analysis is used to examine variation in several fungi: a single clonal lineage of *Phytophthora cinnamomi* from different trees shows asexually derived morphological and pathological variation; *Coniothyrium minitans* proves to be rather invariable at the molecular level; five microsatellite loci in *Dothiostroma pini* generated with an anchored PCR technique enable most isolates to be differentiated; and in *Beauveria brongniartii*, ten microsatellite markers have been identified with the potential for monitoring biocontrol.

An analysis of substrate preferences amongst aquatic hyphomycetes indicates that some substrates support relatively specialized assemblages of species. The establishment of arbuscular mycorrhizas in the saltmarsh plant *Puccinellia nuttalliana* is shown to be limited by edaphic factors and not the presence of a suitable host. Further studies on the occurrence of three fungi on pine needles along a climatic gradient in France are reported. β -carotene has been found to inhibit sclerotium differentiation in *Sclerotinia sclerotiorum*, and epifluorescence microscopy has been used to study the galls formed by *Biatoropsis usnearum*.

Taxonomic papers included present six further *Biscogniauxia*'s from Taiwan (with a key to the world species), assess the positions of *Poronia pileiformis* and *Xylaria cranioides* based on cultures of the anamorphs, report on new species of *Inocybe* in Spain, revise *Entoloma* species with cuboid spores in Madagascar (with a key to 13 taxa), and survey the species of *Tulasnella* in the Patagonian Andes.

The following new scientific names are introduced: *Biscogniauxia ambiens*, *B. cylindrospora*, *B. formosana*, *B. latirima*, *Entoloma pseudoheimii*, *E. rufovinascens*, *Inocybe barrasae*, *I. ortegae*, and *Tulasnella robusta* spp. nov.; *B. abosticta* var. *orientalis*, and *B. formosana* var. *kentingensis* vars. nov.; *E. cuboidosporum* var. *chromostomum* (syn. *Rhodophyllus cuboidosporum* var. *chromostomum*), and *E. heimii* (syn. *R. heimii*) combs. nov.

IN THIS ISSUE

The need for caution in surveying arbuscular mycorrhizal fungi by molecular methods is highlighted in a study of *Glomus* isolates from roots and field soil in which they grew; some root-derived lineages were not recovered from the soil samples, some species isolated from the soil were not found forming mycorrhizas with the roots, and many lineages did not match any known reference species included in the analysis (pp. 1027–1032). The mt SSU rDNA sequence is being increasingly used in phylogenetic analyses around the generic level, but appropriate primers have been a limiting factor in the case of applications in ascomycetes. Now, two new primers have been designed to amplify this region in filamentous ascomycetes as their utility is demonstrated in *Botryosphaeria* and some allied fungi; most species formed a

monophyletic group, although *B. vaccinii* was shown to be better-placed in *Guignardia*, the name *B. stevensii* may have been used for more than one species, and the status of some related anamorphs was confused (pp. 1033–1044). Another sequence receiving increased attention in fungal phylogenetics is the β -tubulin gene. Its utility is demonstrated in a major study involving over 30 species of *Calonectria* and associated *Cylindrocladium* anamorphs which supports the existing morpho- and biological species concepts in use in the group and again demonstrates the ease with which anamorphs can be aligned by molecular methods (pp. 1045–1052).

A single clonal lineage of *Phytophthora cinnamomi* from two different trees in Australia has been identified by microsatellite DNA analysis, and within the clone a broad and continuous range in asexually derived morphological and pathological variation, the latter extending from killing all plants within 59 d to ones still being symptomless after 182 d (pp. 1053–1064). SSR-PCR amplification using a microsatellite primer and RNA sequences show *Coniothyrium minitans* strains from many regions to be a rather invariable species at the molecular level, closely allied to *C. fuckelii* (with which *C. sporolusum* was identical), but more distant from *C. cerealis*; the two *Coniothyrium* groups showing affinities with '*Leptosphaeria*' *bicolor* and *Phaeosphaeria* respectively (pp. 1065–

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1074). Profiles from five microsatellite loci in *Dothiostroma pini* generated with an anchored PCR technique have yielded a method of distinguishing most isolates of this pathogen tested (pp. 1075–1078). In the case of the entomopathogenic *Beauveria brongniartii*, ten microsatellite markers have been identified which differed in the extent of polymorphisms shown and show this to be a powerful tool for the monitoring of biocontrol strains (pp. 1079–1087).

An analysis of substrate preferences amongst 52 aquatic hyphomycetes on different types of plant litter in 92 Belarus watercourses indicated that some substrates supported relatively specialized assemblages of species, for example those on wood and grass as opposed to leaf litter (pp. 1088–1093). Field observational and transplant studies on the occurrence of arbuscular mycorrhizas on the saltmarsh plant *Puccinellia nuttalliana* in Manitoba showed colonization by the mycorrhizal fungus to be limited by edaphic factors and not the presence of a suitable host (pp. 1094–1100). Further studies on the occurrence of three fungi on pine needles along a climatic gradient in France showed *Cyclaneusma minus* and *Lophodermium pinastri* to coexist and increase with frequency with altitude, while the occurrence of *Verticicladium trifidum* was at first dependent on the presence of the other species and decreased at higher altitudes, probably due to interactions with the other species (pp. 1101–1109).

β -carotene has been discovered to be formed at low and high levels in the undifferentiated and sclerotium-forming stages of *Sclerotinia sclerotiorum* respectively, and also in conditions of low or high oxidative growth, and studies with a non-sclerotium forming strain suggest that this compound inhibits sclerotium differentiation by lowering the oxidative stress (pp. 1110–1115). Light and epifluorescence microscopy has been used to elucidate the biology of the heterobasidiomycete *Biatoropsis usnearum* which forms galls on *Usnea* species; the galls start to form in the cortex, have haustoria in the central part, and include much living material of the host (pp. 1116–1122).

Six further *Biscogniauxia*'s are recognized from Taiwan, and a revised key to the 57 species now known throughout the world is provided (pp. 1123–1133). Anamorphs cultured from *Poronia pileiformis* and *Xylaria cranioides* belong to *Lindquistia* and *Xylocoremium* respectively and confirm the generic placements (pp. 1134–1136). New species of *Inocybe* have been discovered in Spain and compared with pertinent type collections (pp. 1137–1143). The *Entoloma* species with cuboid spores in Madagascar have been revised, leading to the discovery of two new species, and a key to the 13 taxa now known is presented (pp. 1144–1148). Finally, five species of *Tulasnella* are recognized in the Patagonian Andes of Argentina, one of which proved to be new (pp. 1149–1151).

WHAT PHYTOPHTHORA INFESTANS RACE CAUSED THE IRISH POTATO FAMINE?

Pathologists have generally assumed that the race of *Phytophthora infestans* responsible for the Irish potato famine of 1845–46 was a direct ancestor of the asexual clone US-1 (Ib mitochondrial DNA haplotype) which predominated in potato-growing areas of the world until the 1980s. Most of the genetic variation in the species occurs in the Toluca Valley, Mexico, where a range of races reproduce sexually and US-1 has been presumed to originate from such a centre of diversity although this and some other races are not present today in Mexico.

Early collections of diseased plant material exist in the reference collections of numerous herbaria and museums around the world, either filed under the name of the pathogen or the host. In the case of *P. infestans*, specimens collected at the time of the Irish potato famine still exist, including one from the Botanic Garden in Dublin studied by Berkeley and now preserved at the Royal Botanic Gardens Kew. Ristaino, Groves & Parra (2001) successfully amplified DNA from 39 specimens collected in Great Britain, Ireland and France in the period 1845–47, including one from the solanaceous Australian *Anthocercis ilicifolia* which was introduced into the Dublin botanic garden in 1842 — the earliest known definite report of an alternative host for the pathogen.

Surprisingly, the historic specimens did not belong to US-1 race, but the sequence data did not permit a clear identification with any other extant race. The precise diagnosis

of the race will require studies of additional sequences, but it is now evident that the origin of the Irish potato famine pathogen was probably not from Mexico but perhaps from somewhere in areas of South America where potatoes are native.

The study is of especial importance not only for shedding light on this particular epidemic, but demonstrating that the historic tracking of plant diseases at the molecular level can be undertaken with collections over 150 years old. As noted in a commentary on the work by Money (2001), the study also emphasizes the relevance of herbarium collections to the elucidation of how plant disease epidemics arise and spread. Further, it shows the importance of depositing voucher specimens to document reports of modern disease occurrences, an issue of on-going international concern (Agerer *et al.* 2000).

Agerer, R., Ammirati, J., Blanz, P., Courtecuisse, R., Desjardin, D. E., Gams, W., Hallenberg, N., Halling, R., Hawksworth, D. L., Horak, E., Korf, R. P., Mueller, G., Oberwinkler, F., Rambold, G., Summerbell, R. C., Triebel, D. & Watling, R. (2000) Always deposit vouchers. *Mycological Research* **104**: 642–644.

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Ristaino, J. B., Groves, C. T. & Parra, G. R. (2001) PCR amplification of the Irish potato famine pathogen from historic specimens. *Nature* **411**: 695–697.