A MULTI-ACCESS LUCID™ KEY TO COMMON PLANT PATHOGENIC FUNGI CAUSING DISEASES OF TEMPERATE CROPS

H.F. NEILSON and T.M. STEWART

*Institute of Natural Resources, Massey University, Private Bag 11222,
Palmerston North*

Corresponding author: t.stewart@massey.ac.nz

ABSTRACT

A LUCID™ multi-access computer-based key for identifying 175 genera of plant pathogenic fungi of temperate crops is described. The key takes a pragmatic, rather than a taxonomic approach to identification, enabling a non-specialist to key out many suspected plant pathogens based on microscopic examination of the fungal structures, and plant disease symptoms. Taxonomic jargon is kept to a minimum and images of morphological characteristics are used frequently. Fact sheets on the diseases caused by common pathogens are also included in the programme. The key is available in the public domain, and should be useful to anyone with a microscope wishing to identify a common fungal disease.

Keywords: fungi, pathogens, identification, key, plant diseases.

INTRODUCTION

Identification of fungal plant pathogens is commonly done using one of several well-illustrated dichotomous keys (e.g. Ellis 1971, 1976; Sutton 1980; Hanlin 1990; Barnett & Hunter 1998). Multi-access keys for identifying biological agents are very useful, especially for the non-specialist, as it is not necessary to be able to detect all of the fine distinctions usually found in dichotomous keys. The disadvantage of those printed keys is that they require the user to be able to scan a series of tables of numbers and select those that are common to the specimen being examined (Michaelides et al. 1979; Sutton 1980). This task is ideally suited to computers.

The LUCID™ system developed by the Centre for Biological Information Technology Transfer, University of Queensland (Norton 2000) allows development of multi-access keys that can also incorporate graphics and text. The result is a very powerful tool. Although some keys have previously been developed for fungi using LUCID™, they have generally been for specific groups such as rainforest fungi of Eastern Australia (Young 2001). Any key to plant pathogenic fungi would of necessity cover all taxonomic groups to a greater or lesser degree.

A KEY TO PLANT PATHOGENIC FUNGI

Early decisions when constructing the key involved both its scope and nature. The scope was set as being sufficient to cover the main genera of plant pathogens recorded in New Zealand, and the current key has 175 genera. Although plant pathogenic fungi are frequently identified on the basis of plant damage symptoms alone, it was decided that these would form no part of the main key, as symptoms can be misleading. Considerable experience is required to make an accurate diagnosis. However, information including photographs of symptoms, where possible, is given in the fact sheet (described later) for each fungus.

The initial inclination was to follow a taxonomic approach. This would involve having a general key with sub-keys to the ascomycetes, basidiomycetes, hyphomycetes, coelomycetes, oomycetes and agonomycetes. This proved to be rather complex as there

are some fungi which appear to have characteristics of unrelated groups. For example, the asci of *Chaetomium* sp. (Class: Pyrenomycetes) dehisce before maturity and so could readily be mistaken for a member of the coelomycetes. Conversely, there are some coelomycetes that form pycnidia without an ostiole and so could be confused with a cleistothecium. The alternative to this was to construct a key that would cover all relevant fungal genera.

The taxonomic system used follows that found in Farr et al. (1989). It was decided that although it is taxonomically correct to list those fungi that have both sexual and asexual stages using their sexual stage nomenclature, the name of the most commonly occurring state would be used in this key. Where both are found, as in the powdery mildews, then both are used. A further decision was which of the many synonyms for a fungus should be used. Obviously it is impossible to please all, but the names chosen generally reflect those currently considered taxonomically correct. This has certain disadvantages as many texts and lists use only older names. A supplementary list of synonyms is being prepared to overcome this problem.

The key is comprised of 51 characters, which has the potential for being rather cumbersome. For simplicity, the characters are placed in groups covering the characters and states relating to: the structures that spores are contained in (if any); spore characteristics; conidiophore characteristics; the mycelium; sclerotial formation; plant parts affected; and pathogenicity to other fungi.

All fungal genera were entered using the standard LUCID™ coding method where all states are scored as either absent, present, uncertain, commonly misidentified or rarely misidentified. Some genera have a range of spore shapes, and in these cases each shape has been entered, except for a few occasions where confusion could arise in the key by giving a spore shape which is of rare occurrence in temperate climates. As the key was designed primarily for use by non-specialists, a deliberate attempt was made to avoid using technical mycological terminology as much as possible. One disadvantage of this is that further decisions must be made about some states. Many users will not know the distinctions between allantoid and lunate, but all can understand curved and then make a further decision as to whether the ends of the spore are rounded or pointed. Line drawings and/or photographs of the various features are shown in the key.

Spore size, although important for distinguishing some genera, is not part of the key itself but, where relevant, spore sizes have been incorporated in the fact sheets. Fungi that have different shaped spore stages, such as most rusts, have each stage occurring in New Zealand entered. Obviously if only the urediniospore stage is present, then identification will be much more difficult than if the teliospore stage is present. No attempt was made to distinguish the conidiogonous cell from the conidiophore, as this requires a degree of expertise probably not found in those for whom the key was designed. Although the key is based on morphological features, there are a number of diseases which can be determined virtually absolutely by symptoms alone even by a beginner. Common examples of these are leaf curl of stone fruit and ringspot of brassicas. To assist with this there is a Taxon labelled "Others" which gives a list of six diseases which fit into this category. In each case there are photographs of symptoms and in some cases of the causal organism as well.

FACT SHEETS

Associated with each genus is a fact sheet giving photographs of plant disease symptoms commonly associated with important species within the genus. There is a brief description of symptoms or symptom types, and the general groups of plants attacked. Plant names are usually given by their common name. Some, but not necessarily all, synonyms of the important pathogen species are listed, and where appropriate the particular anamorph/teleomorph names are also given. Descriptions and/or photographs of the mycological features of the pathogens, particularly those that are of diagnostic significance, are also given where possible. Where there are groups of very similar fungi that could readily be confused, e.g. *Pestalotiopsis* with *Seiridium*, tables are

incorporated giving mycological distinctions in tabular form. In others, such as *Pythium* and *Phytophthora*, where it is difficult to produce the stages that distinguish the genera, a list of hosts that are specific for each of the two genera is given as a possible aid in identification.

USES FOR THE KEY

Although designed particularly for use by non-specialists, the key is also of value to those with experience in fungal disease diagnosis. Apart from being used in the strict sense of a key it may also be used as a reference manual to assist initial diagnosis. Frequently the first step in diagnosis is to use one of the lists of host plants with the genera of fungi attacking them to get some idea of what the pathogen may be. Known taxa can be quickly rejected or placed on a list of possibilities. Where the user does not know a genus, the fact sheets give a quick and convenient list to help eliminate or confirm a presumptive diagnosis, and so give a clue as to the best method of obtaining spores of the organism to allow a definitive diagnosis. The key is available as a free web download at: http://plant-protection.massey.ac.nz/resources/software/lucid_key.htm.

ACKNOWLEDGMENTS

We thank the Plant Protection Group in the Institute of Natural Resources, Massey University for supplying most of the images. We would also like to thank Dr B. Kendrick (Guelph University) and CABI Biosciences for use of line drawings, as well as DEFRA U.K., Dr I. Hood (Forest Research), Dr A.G. Spiers and MAF (NZ) for use of images. We would also like to thank Dr P.G. Long (Massey University) and Dr J.I. Cooper (Landcare Research) for helpful comments and suggestions.

REFERENCES

- Barnett, H.L.; Hunter, B.B. 1998: Illustrated Genera of Imperfect Fungi 4th ed. APS Press, St Paul, USA. 218 p.
- Ellis, M.B. 1971: Dematiaceous Hyphomycetes. CABI, Kew, England. 608 p.
- Ellis, M.B. 1976: More Dematiaceous Hyphomycetes. CABI, Kew, England. 507 p.
- Farr, D.F.; Bills, G.F.; Chamuris, G.P.; Rossman, A.Y. 1989: Fungi on Plants and Plant Products in the United States. APS Press, St. Paul, USA. 1252 p.
- Hanlin, R.T. 1990: Illustrated Genera of Ascomycetes. 3 Vols. APS Press, St Paul, USA.
- Michaelides, J.; Hunter, L.; Kendrick, B.; Nag Raj, T.R. 1979: Synoptic Key to 200 Genera of Coelomycetes. University of Waterloo Biology Series 20. University of Waterloo, Waterloo, Canada. 42 p.
- Norton, G.A. 2000: Multi-media keys for identification and diagnostics: the LucID experience. *International Workshop of the Asia-Pacific Advanced Network (APAN) and its Applications*: 27-30.
- Sutton, B.C. 1980: The Coelomycetes. CABI, Kew, England. 696 p.
- Young, T. 2001: 101 Forest Fungi of Eastern Australia. Knowledge Books and Software, Brighton, Australia. CD ROM.