
Preface

The fungal kingdom consists of a wide variety of organisms with a diverse range of forms and functions. They are ubiquitous in nature, having been recovered from almost every ecological niche – from deep-sea sediments to the jet stream. The utilization and application of fungi by mankind has a long and varied history that probably predates any written records. This utilization includes the very early use of edible fruiting bodies as foods, and the 2000–3000-year-old histories of fungi in brewing, baking and as medicinal treatments. Mankind's use of fungi has broadened and grown considerably in the last 100 years. Well-known examples of this include the discovery and production of antibiotics and the wider utilization of fungi in the food industry, where they are used commercially, both as food products and in the production of compounds and enzymes for food processing (e.g. citric acid and pectinases).

The association of many fungi with plants and invertebrates has resulted in their use in agriculture as both biological control agents against plant pests and diseases, and as plant growth stimulants such as mycorrhizal inoculants. Although all of these applications could be considered as relatively long-established processes, new applications continue to be developed. Recent examples include the development of the commercial production of a mycoprotein food product, continuing advances in the environmental remediation of soils and industrial wastes, and the identification and production of a wide range of enzymes and compounds for biotechnology. Within the biotechnology area there has been a particular growth in the application of mycology, and current research includes the use of fungi in the production of biofuels, and fungally mediated chemical transformations.

This book is intended to provide both students and researchers with a broad background to some of the fastest developing areas in current applied mycology. It was clearly not going to be practical to incorporate all of the

different aspects and directions of such a broad area into a single volume, and so we have brought together a range of contributions to highlight the diverse nature of current applied mycology research. Environmentally, fungi are of vital importance and their activities are closely linked with those of bacteria and lower plants in undertaking the nutrient and chemical cycles needed to maintain life on Earth. Despite such fundamental importance, mycology is frequently overlooked in many scientific courses and treatments. The opening chapter of this volume provides some examples of how mycology is often neglected, and presents a case for considering mycology as a megascience.

The subsequent chapters have been loosely grouped into four sections in order to reflect the wider 'customers' or context of the particular mycological areas or activities. As with many biological groupings, this categorization is largely for the convenience of the user, in this case the reader, and there are aspects of many of the chapters that are of direct relevance in additional areas or processes. In each section we have attempted to include contributions that show either new applications or developments of well-established technology, or novel research into new technology or environments.

The environment, agriculture and forestry are represented by contributions that illustrate novel fungal associations or new aspects of well-known interactions. The role of mycorrhizal fungi in agricultural and other environmental systems has been increasingly recognized in recent years. In this section we have selected two examples to demonstrate how natural mycorrhizal communities may be affected by environmental stress, and how the application of mycorrhizal treatments may benefit forestry productivity. Ochratoxin A is a relatively well-known contaminant of various natural products, and in this section we include an example of the relevance of this contamination in the human food chain. Novel associations are represented by the presence and distribution of aquatic (Ingoldian) fungi in tree canopies, and the potential role of endophytes in litter decomposition.

The section on foods and medicine reflects the long history of applied mycology in the manufacture of alcoholic beverages, with two chapters devoted to beer production and winery spoilage issues. Although the production of alcohol by fermentation for human consumption is a long-established mycological application, the fermentation of agricultural wastes for industrial ethanol and biofuels is a much younger technology, and the chapter on lignocellulosic fermentation also demonstrates how modern genomic technologies can be applied in practice. Medicine is represented by two chapters. The first combines old and new by reviewing the results and indications from recent pharmaceutical and cell-line-based screens for *Ganoderma lucidum*, a fungus that has been associated with medicinal use for some 2000 years. A chapter on dematiaceous fungal infections has been included, as fungi causing infections in humans are increasingly being recognized as significant pathogens. Looking to the future, the increase in cases of human immunocompromisation as a result of medical treatments

and conditions has led to such mycotic infections being considered as 'emerging' diseases.

Chapters in the section on biotechnology and emerging science reflect some of the current interests in fungal enzymes and their importance in broader environmental processes and applications. At a very broad level, multiple activities of a single fungus may be utilized in a variety of processes, and this is illustrated by considering some of the biotechnological applications of *Trichoderma harzianum*. In contrast, a wide range of fungi may all show a similar property or activity that has biotechnological applications, and particular aspects of these are reviewed in the chapters on chitinases and proteases. A common topic in many of the chapters in this book is the need for, or the potential benefits of, genetically manipulated strains in research and development. In this section the chapter on the use of the *Agrobacterium* prokaryotic model system to transfer fungal genes provides a number of insights into both DNA transfer and transformation methods. Collectively, the fungal kingdom contains a very diverse range of biochemical properties and pathways. The biotechnological relevance of some of these, such as proteases, has long been recognized, and has been extensively studied. It is likely that fungi have many other pathways and properties with as yet unrecognized biotechnological significance, and one aspect of this is demonstrated by the chapter reviewing the very recent work on the formation of potentially industrially useful metal nanoparticles in fungal mycelia.

This volume demonstrates that there is a long history in the identification and utilization of a wide variety of 'mycotechnology'. However, it is also clear that the existing processes are likely to represent only a small fraction of those technologies that are potentially available. It would seem likely that the overall application and use of fungi will increase in both the environmental and biotechnology fields. Environmental changes and increasing pressure on agriculture are both areas where mycological processes for soil remediation, fertility and biocontrol are likely to be further developed. In biotechnology, the increased interest in biofuel production, waste composting and the wider applications of fungal enzymes and metabolites all provide many opportunities for mycology.

Since the original discovery of penicillin there has been a long history of identifying and isolating bioactive and pharmaceutically useful compounds from fungi. Now, and in the future, the increased knowledge of fungal ecology and biochemistry can provide markers to help identify candidate strains for targeted screening programmes. Developments in technology are also likely to involve applied mycology, and it is worth noting that two of the commonly used enzymes in the recently developed molecular biology and biotechnology fields, Proteinase K and Novozym 435, are largely obtained commercially from fungal material. There are many positive indicators for the future development of applied mycology, but there are also concerns, such as those raised in Chapter 1, for the future of the underlying systematic and mycological skills necessary to allow further developments.

We are grateful to Stefanie Gehrig and Sarah Mellor of CABI for their patience, encouragement and suggestions. MR also acknowledges the help and support provided by Alka Karwa, Aniket Gade, Ravindra Ade, Avinash Ingle, Dnayeshwar Rathod, Vaibhav Tiwari, Alka Yadav and Jayendra Kesharwani.

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