

hole by matter falling into it, is not available to external observers. If a black hole evaporates totally due to emission of Hawking radiation, this information inside the black hole is lost. This is a serious violation of the laws of physics.

The author discusses such problems and in most cases gives his opinion also. In the case of the first problem, a direct answer is evaded in the book. George (the scientist in the book) says that the questioner already knows the answer. In answer to the second problem, George says that all these other universes will be covered up and go out of consideration, if a black hole is created by the physical collapse of a star. Chandrasekhar in his book also describes these bizarre predictions. He does not express any direct misgivings, but says that Cauchy horizon (through which one has to go) can be dangerous! To deal with the third problem, the author formulates the third law as non-attainability of absolute zero temperature in a finite number of operations (p. 251), which is satisfied by the black holes. This was originally suggested by Robert Wald in his book on black hole thermodynamics. Wald is a bit doubtful about the independence of this formulation of the third law from the second law. Wald, however, feels that the third law is not a fundamental aspect of thermodynamics and need not be satisfied in the form of Nernst theorem. The fourth problem, loss of information, is not discussed in the book, but the exposure of a naked singularity, it is pointed out can only be discussed after a quantum theory of gravity emerges. This holds for the information puzzle also, but is still in the distant future.

On the whole this book is highly informative, enjoyable and a beautiful piece of work. It should be specially attractive to laypersons with some sophistication and a love for Italian food. And yet, one hopes that the author will consider writing a book with an Indian audience in mind. Hopefully the book will have descriptions of Bisi bela holi, Biryani, Padhir poli, Badam Khir and such delicious dishes. It could also discuss stories of Arundhati, Saptarishis and others. Am I being chauvinistic?

N. PANCHAPAKESAN

K-110, Hauz Khas,
New Delhi 110 016, India
e-mail: panchu@bol.net.in

Annual Review of Phytopathology, 2006. N. K. Van Alfen, G. Bruening and W. O. Dawson (eds). Annual Reviews, 4139, El Camino Way, PO Box 10139, Palo Alto, California 94303-0139, USA. Vol. 44, 538 pp. Price: not mentioned.

This volume consists of 21 chapters covering a wide variety of topics of plant pathological interest. The first chapter by Seiji Ouchi sets the tone of the volume, by tracing the evolution of plant pathology from a descriptive science to molecular understanding of pathogenesis to biotechnology-led development of disease-resistant crops. It also highlights the need for further understanding of molecular plant-pathogen interactions for developing rational strategies for breeding disease-resistant crops. In recent years, there has been considerable thrust to unravel the biochemical and molecular mechanisms of plant-pathogen interactions. Other areas gaining interest are molecular characterization, ecology and emergence of plant pathogens, epidemiology, modelling, understanding the effects of global climate change on pathogens and the diseases they cause, judicious management of plant pathogens, biosafety concerns related to field release of GMOs, plant pathogens as non-tariff barriers in world trade of agricultural produce and food-borne diseases. These trends are amply highlighted in the present volume.

Kamoun has reviewed the complexities and functions of the effector secretome of plant pathogenic Oomycetes. Effector proteins play a key role in the pathogenesis of Oomycetes. An attempt has been made to classify and catalogue the major apoplastic and cytoplasmic effectors of Oomycetes. van Loon *et al.* have comprehensively reviewed the role of PR proteins in helping plants adjust to constantly changing environment. A large number of genes are up- or down-regulated in plants under biotic and abiotic stresses, but only a limited number of inducible defense-related proteins have been characterized. Broekaert *et al.* while discussing the role of ethylene in host-pathogen interactions, provide insight of cross-communication between ethylene signalling and other defence mechanisms of plants; ethylene increases resistance to some necrotrophic but not to biotrophic pathogens. This is just a beginning; more efforts are required to get a full picture of the role of ethylene in pathogenesis.

Xu *et al.* highlight the potential role of fungal genomic studies in improving understanding of the molecular basis of host-pathogen interactions. So far, eight plant pathogenic fungi have been sequenced and many more are being sequenced. The reviewers rightly point out the need to build comprehensive genome database for fungal pathogens, and to develop efficient bioinformatics tools for genome profiling and functional analysis. Loria *et al.* have traced the evolution of plant pathogenicity in *Streptomyces*, which are mostly free-living soil saprophytes. Some *Streptomyces* like *S. scabies* are plant pathogens. These have emerged in agricultural systems through the natural transfer of pathogenicity island (PAI), consisting of genes coding for thaxtomin and other virulence determinants. Further characterization of diversity of PAI will show the role of horizontal gene transfer in the evolution of pathogenicity in *Streptomyces* and identification of plant cell targets of virulence determinants.

Carris *et al.* have given well-illustrated biology of *Tilletia indica* and *T. horrida*, which cause minor losses in yield and quality, but have severe economic impact. Karnal bunt, caused by *T. indica*, is a major non-tariff barrier in the export of wheat, and kernel bunt of rice caused by *T. horrida*, is a constraint in the production of certified hybrid rice seed due to low tolerance levels. Turf-grass has emerged as the fastest growing agricultural business. Bonos *et al.* discuss the developments in turf-grass breeding for resistance to a variety of diseases. Ngugi and Scherm have attempted to classify flower-infecting fungi, by drawing parallel with the venereal diseases of animals, into three groups based on the mode of infection and whether the fungus also infects other parts of the plants. This grouping has left many open questions due to the limited information available on the subject.

Enterobacteria are not only human and animal pathogens, but also cause some serious plant diseases. Toth *et al.* have compared the genome of animal pathogenic enterobacteria with the plant pathogenic *Erwinia carotovora* subsp. *atroseptica* (*Eca*), which is the first plant pathogenic enterobacterium to be sequenced. These pathogens share a 'backbone' of common enterobacterial genes; *Eca* seems to have acquired several genes by horizontal gene transfer for interactions with plants. These include secretion systems, phyto-toxins and cell-wall degrading enzymes,

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which enhance the capacity of *Eca* to survive in a variety of environments. Brandl has described the epidemiology of food-borne diseases and the behaviour of human enteric pathogens like *Salmonella enterica* and *Escherichia coli* on plants. Considering an increase in the number of outbreaks of food-linked enteric diseases in recent years, there is a need to generate more knowledge about the factors influencing survival of enteric pathogens on plants, which will be useful in developing agricultural practices to minimize food contamination of plants by these ubiquitous human pathogens. In recent years, fluorescent bacteria have been widely used for biocontrol of plant diseases. Their efficacy depends on the antibiotic properties of pigmented heterocyclic nitrogen-containing secondary metabolites known as phenazines. Mavrodi *et al.* have reviewed the information on biosynthesis and regulation of phenazine compounds by pseudomonads. The review discusses the environmental impact, mode of action, genetics, biochemistry and biosynthesis of these compounds, and the biotechnological approaches for enhancing the performance of bacterial agents. Concerns related to the release of GM biocontrol agents to the environment have also been addressed. The review also raises several challenging questions in this emerging area of research.

Nematodes are serious pathogens of agricultural and non-agricultural plants. Niblack *et al.* have reviewed biology, population dynamics, genetic diversity and interactions with hosts of the soybean cyst nematode, which causes extensive damage to the production of soybean in many parts of the world. Recent advances in the identification of putative nematode parasitism genes will be useful in developing strategies for nematode-resistant transgenics.

RNA viral genomes are generally considered as linear molecules, but recent evidences, reviewed by Miller and White, show that viral RNA genomes appear to be three-dimensional due to the occurrence of long-distance RNA–RNA interactions across hundreds or thousands of nucleotides. The long-distance RNA–RNA interactions play a critical role in regulating viral processes like translation, replication and sg mRNA transcription. Rao has given well-illustrated mechanisms regulating selective packaging of viral RNA in mono-, bi- and tripartite isometric plant viruses, many of which also have

sub-genomic RNAs, which are packaged separately or along with the genomic RNA in virus particles. The review is expected to motivate similar studies for understanding the complexities of genome packaging in icosahedral viruses. Ng and Falk deal with an important but neglected area of vector transmission of plant viruses. They have given an illustrated account of the mechanisms of transmission, elucidated by recent application of molecular and cell-biology techniques. Hopefully, this review will generate interest in virus–vector–host interactions. Fargette *et al.* have discussed molecular ecology and the mechanisms involved in emergence of tropical plant viruses like Rice yellow mottle, Cassava mosaic and Banana streak in Africa, and emphasize the need of multidisciplinary approaches to address the challenges of the emerging plant viruses.

Burdon *et al.* have examined the role of soil-borne and invasive pathogens on the structure and dynamics of natural plant communities at a broad range of genetic, ecological, spatial and temporal scales, including the expected direct and indirect effects of global climate change. Fitt *et al.* review the coexistence of related pathogen species on arable crops in space and time, with particular reference to data from long-term and medium-term experiments at Rothamsted. The long-term Rothamsted experiment is the only one of its kind providing data of over 160-year period. The review well illustrates the co-evolution of related pathogen species, *Septoria tritici* and *S. nodorum*, *Oculimacula yallundae* and *O. acufiformis*, *Leptosphaeria maculans* and *L. biglobosa*. Savary *et al.* highlight the need of generating quantitative data, analysis and modelling for efficient use of disease management tools. In the last chapter, Garrett *et al.* examine the effects of climate change on plant disease. Limited research has been done in this area, but there are distinct indications of change in host–pathogen–vector interactions. The review emphasizes the need of closer link between empirical and modelling studies for better understanding of the climate-change effects.

The Editors and Editorial Committee of this volume must be complimented for selecting the topics and inviting authors to write outstanding critical reviews on the selected topics. The Editors also need to be complimented for their efforts in defining terms and acronyms used in in-

dividual reviews and also for highlighting key references through the judicious use of margin notes. This volume is a must for all those interested in plant pathology, microbiology and molecular biology.

ANUPAM VARMA

*Indian Agricultural Research Institute,
Division of Plant Pathology,
New Delhi 110 012, India
e-mail: anupamvarma@vsnl.net*

Ecology, Environment and Resource Conservation. J. S. Singh, S. P. Singh and S. R. Gupta. Anamaya Publishers, New Delhi. 2006. 688 pp. Price: Rs 850.

During the past fifty years, since the publication of *Fundamentals of Ecology*¹, which promoted the science of ecology worldwide, and particularly since its third edition 35 years ago², the earth's environment has undergone large and significant changes. The human population has increased considerably, land use/land cover has undergone drastic changes, forest cover and wetlands have declined, many species have become extinct or greatly reduced in their populations, air and water are increasingly polluted and global warming has become a reality. The concern for the rapidly degrading environment is therefore no more academic but has become real, as its consequences are being felt everywhere. Since the 1972 Stockholm Conference, the world community is increasingly engaged with environmental issues, and several conventions focus on different aspects of environmental conservation and protection. The importance of ecosystems in providing invaluable goods and services is now recognized and the terms 'ecosystem' and 'ecosystem services' have entered the everyday vocabulary of the policy- and decision-makers. Industrialists and the corporate community have recognized the need for action regarding conservation, and are gradually becoming partners for environment protection. Sustainability of economic development based on the limited natural resources is the key to the future of humans on the earth. Therefore, the need for education about environment, the causes of its degradation, and the mitigatory measures are more urgent than ever