lopment of selected organs and immune system; the subsequent four papers describe the ability of the fish larvae to synthesize and use fatty acids for development. This is followed by two papers on the consequences of pollutants while the last few deal with larval recruitment. Apparently, the selected topics are rather a mosaic than being focused on a specific theme.

Tunas are among the most important fish species, but are among the least known in terms of early life history. In a simple but elegant contribution, G. Kawamura and his colleagues have described the sequence of development of sensory system and the attendant behavioural changes of the bluefin tuna, which have far-reaching implications to larval ecology and to hatchery operation. R. G. Northcutt's description of the embryonic development of electro-receptive ampullary organs on the lateral line is a fascinating evolutionary story.

Most teleosts undergo strong or gradual metamorphosis on changing their body configuration from larval to juvenile form so as to adapt to the new habitat; a striking example is the flatfish larva, whose body structure undergoes a dramatic translocation of the eye from the right to the left; inhibition of pigmentation on the left; development of anal fin and so on. Such metamorphic processes are in general promoted by the thyroid hormone (TH). In an interesting contribution, N. Okada and his collaborators have focused on the response of individual tissues to the hormone. Treatment of the Japanese flounder larvae with an inhibitor of TH synthesis, thiourea (TU), resulted in the inhibition of translocation of the right eye, shortening of dorsal fin rays and body pigmentation. To examine the hormone responsiveness, the TU-treated larvae were given thyroxine (T4) two and four weeks after treatment. Among the T4-treated larvae, the two-week post-TU-treated larvae underwent the usual changes, but those receiving T4 after four weeks of TU treatment failed to do so.

Among other impressive presentations are those on preservation of unfertilized rainbow trout eggs; the use of trace elements in otoliths to track fish movement, and mass rearing technique of live feed copepods. Trace elements signature in otolith growth bands provides a powerful tool for fish biologists to track the movement of fishes. In their presentations, C. M. Jones and Z. Chen have described how the laser-operating properties can be constrained to manipulate crater dimensions of otoliths and can reliably be used to determine the trace elements in larval otoliths that are less than 1000 μm in size.

In view of their importance for genetic selection and manipulation, preservation of sperm, eggs and embryos of fishes has become important. There are established techniques for preservation of fish sperm. Interestingly, M. Y. Komrakova and W. Holtz have developed a new technique for storing unfertilized eggs. For this, they have stored the freshly stripped unfertilized rainbow trout eggs of 3–5-year-old females in 2–4 layers in vials either uncapped or capped with Biofolie at 2°C under moisture-saturated atmosphere; 125 IU penicillin, 125 μg streptomycin and coelomic fluid were also added to avoid infection. More than 50% of the stored eggs remained fertilizable for longer than 25 days.

Development of techniques for live feed culture remains a major problem in larval rearing of economically important fishes. A cost-effective, high-yielding commercial technique is yet to be developed. Admirably, A. Rhodes has developed a continuous culture, in which the harpacticoid copepod, *Nitokra lacustris* reached a density of 1000 per litre; understandably, the copepod has shortest (10 days) generation time at 20°C and produces 7–18 nauplii per female per day. While summarizing the available information, Rhodes has also cited one of the most successful recent trials, which lasted for longer than a year, and produced daily 440,000 nauplii of the calanoid copepod, *Gladioferens imperipes*.

However, presentations on cod larvae, though some of them have used sophisticated Silhouette Video Photography technique, have failed to realize the objective. For instance, one of them intended to know whether the presence of microalgae in the culture environment affects the behaviour of larvae of Atlantic cod, but ended stating that microalgae might enhance nutritive quality.

The book also contains a large number of avoidable editorial corrections. Abbreviations for scientific journals have neither been followed nor is there uniformity. For instance, *Aquaculture* (p. 61) is cited *Aquacult.*, *J. Fish. Biol.* as *Jour. Fish. Biol.* (p. 93) or *Jour. of Fish. Biol.* (p. 64), *Trans. Am. Fish Sci.* (p. 120) as *Trans. Amer. Fisher. Soc.* (p. 95), *Am. Nat.* in p. 121, but *Amer. Natur.* in p. 94, *Can. J. Fish. Aquat. Sci.* in p. 121, but *Can. Jour. Fish. Aquat. Sci.* in p. 94 and so on.

Despite these, the book is a timely contribution to the larval biology of fishes.

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Microbial Diversity and Bioprospecting. Alan T. Bull (ed.). American Society for Microbiology, ASM Press, Washington DC. 2004. 496 pp. Price not mentioned.

Microorganisms are suddenly in the eye of the storm, literally. This can be attributed to two recent realizations – their astounding diversity (only 1–5% of the microbes extant in nature have been discovered), and their all-pervading existence. Microbes have been shown to be present in rivers under the arctic snow frozen for millions of years, thermal vents where no other life form possibly exists and inside the body of each living being. The book under review is an outcome of perceiving this astonishing diversity as the microbial resource, and sustainable use of this resource for the betterment of the human society using state-of-the-art tools. The book has been divided into nine sections, each comprising several chapters with contributions from the desks of the best minds in the world on microbial diversity and bioprospecting. An introductory chapter (section I) by the editor explores the art of exploiting biology, reinforcing his arguments with case studies as to how microbial prospecting can lead to process improvement, process substitution, energy saving, waste minimization and pollution control. The editor also systematically dispels the notion that exploitable microbiology may have ex-

hausted, even to the extent of advocating dereplication (the process of recognizing identical species or strains of organisms, and thereby preventing redundant and wasteful screening effort) using newer techniques. Put in simpler words, it means that exploitable microbiology is an unlimited resource.

Section II is an exploration to estimate the scale of microbial diversity. As a prelude to this exercise, the various topics discussed include species concept in bacteria, operational taxonomic unit, speciation and state-of-the-art approaches to microbial identification (Fourier transform infrared spectroscopy, MALDI-TOF, electro-spray ionization mass spectrometry). This section also includes unculturable microbes, molecular chronometers, phylogenetic frameworks and polyphasic approach to taxonomy. A strong case has been put to integrate statistical tools for making meaningful estimates of microbial diversity.

Section III comprising fourteen chapters, by far the largest in the book, is devoted to microbial ecology, which is the key to discovery. In this regard, the role of innovative cultural procedures such as extinction cultures and culture-independent methods for unravelling the full extent of microbial diversity have been discussed. A detailed account of various culture-independent methods, viz. PCR amplification and sequencing of rRNA genes, denaturing or temperature gradient gel electrophoresis, single-strand conformational polymorphism, terminal restriction fragment length polymorphism, fluorescence *in situ* hybridization, quantitative dot blot hybridization and gene arrays have been included in this section. Another chapter describes how unculturable microorganisms may be recovered by the use of resuscitation-promoting factor (Rpf), the so-called bacterial cytokine produced by culturable bacteria. A chapter each on metagenomic approach to study soil microbes, deep biosphere (marine sediments and subsurface), icy biosphere of the earth, extremophiles (pH, temperature, salinity and pressure), oligobacteria and sulphate-reducing bacteria gives a fascinating account of the diversity of microbes, known or suspected, in these habitats. Metagenomic approach to prospect functional diversity of bacteria present in soil is now well established and has already yielded new antibiotics and enzymes. The challenge, however, is to reconstruct full genomes of a few unculturable microorganisms using this approach. An initial estimate of the magnitude of deep biosphere surprisingly indicates that vast majority (ca. 97%) of bacteria reside in the subsurface. These bacteria grow extremely slowly, with average division times between 1000 and 2000 years! It is enigmatic as to how energy sources are available to these microbes over millions of years, and at kilometres of depth of subsurface. The possibility that subglacial environments of Antarctica may harbour microbial ecosystems thousands of kilometres below the ice, isolated from the atmosphere for as long as 20–25 million years, has generated much excitement. The extremophiles have already proven their supremacy in providing unique molecules having biotechnological potentials. The oligobacteria are uniquely adapted to the extremely dilute nutrient conditions of the marine and other aquatic environments. Despite their abundance the physiological, molecular, biological and cytochemical properties of oligobacteria remain uninvestigated. The sulphate-reducing bacteria provide an apt example of microbes having the most versatile metabolic activity that may be autotrophic, lithoautotropic, heterotrophic or respiration-type under anaerobiosis. The last three chapters under this section describe the microbial associations with marine sponges, insects and plants respectively. The authors clearly bring out the high diversity of microbes associated with sponges and insects and their biotechnological potentials. However, difficulties in culturing these endosymbionts remain paramount to realize their full potential as resource for useful natural products. The interesting aspects of microbe–insect associations as exemplified by intracellular endosymbionts, viz. *Wolbachia* group and *Buchnera aphidicola*, have also been addressed. None of these microbes has been grown in pure culture as yet. The microbe–plant symbiotic associations discussed include plant growth promoting rhizobacteria, endophytes, ectomycorrhizal fungi and vascular arbuscular mycorrhizal fungi. Such microbes can be exploited for plant growth promotion, increasing nutrient supplies, alleviating heavy metal toxicity and as agents of biocontrol.

A debatable and less studied area – biogeography and mapping of microbial diversity, obviously because of the lack of appropriate framework and tools, is the subject of section IV. Is everything everywhere? – the cosmopolitan versus endemic distribution of microorganisms. The cosmopolitan distribution draws from the fact that dispersal ensures survival of species. Chinks in this hypothesis are primarily due to the fact that it has not been rigorously tested using molecular biological methods and it would be premature to discount the possibility of endemic microorganisms. It appears from the chapters presented under this section, that this debate will continue till more experimental data are generated on these issues. What is the feasibility of constructing biodiversity maps of microorganisms like those of flora and fauna? Is it possible to accurately construct such maps? Are they worth the effort? Their need could be justified in terms of biodiversity conservation and value for biodiversity prospecting. Till date, the only attempt at this is with respect to the Yellowstone National Park, which utilizes the GIS (Geographical Information System) approach. Biogeography nevertheless is an interesting area of microbial diversity or microbiology in general – certainly an area of research for those who are of the adventurous kind.

Bioinformatics, the buzzword for drug discovery, pharmacogenomics and biology in general, is certainly a paradigm shift in microbial bioprospecting (section V). Although various components of bioinformatics – genomics, proteomics, phenomics, and phylogeny and functionality have all been discussed in separate chapters from the point of view of bioprospecting, each chapter also provides a general account of these subjects. Readers interested in having an overview of these areas without much interest in bioprospecting per se, would also find these chapters extremely informative and handy. The various topics which have been discussed in chapters included under this section are: rational design, directed evolution, tools for comparative (genome-wide) genomics, integration and interoperability of diverse databases, proteomics approaches to microbial typing, pathogenesis and therapeutics, biomarkers and dereplication.

Which molecules should be targetted for bioprospecting and why? What approach should be followed to achieve these goals? The editor has followed a scrupulous and systematic approach to answer these questions. This is evident from the chapters included under section VI, which is basically a comprehensive survey of the biotechnology industry. A combination of factors that drive biotechnology, viz. the target molecules, screening methodologies, novelty of molecules, groups of

microorganisms worth exploration and above all, profitability have been discussed. Although the established biotechnology sectors like antimicrobials, pharmacologically active agents and industrial enzymes have been dealt with in fair detail, the emphasis is on emerging technologies such as plant growth-promoting and antifouling agents, nutriceuticals, mineral processing, biomaterials and biomimetics. These chapters would be especially useful to those working on bioprospecting, allowing them to identify the limitations/bottlenecks of their work and to circumvent them either by recourse to time-tested strategies or by trying innovative approaches.

Like the subject of biogeography and mapping of microbial diversity, an equally debatable issue where only few experimental data are available, is the *in situ* conservation of microbes (section VII). Is microbial diversity really being lost? Do anthropogenic factors lead to permanent loss or extinction of microbial diversity? In the face of species redundancy, how does it matter if microbial diversity is being lost? Has not the biodiversity recovered after each major episode of mass extinction in the evolutionary history? It is really difficult to answer these questions. However, two points are clear – that loss of microbial diversity does have an adverse impact on ecosystem functioning and it definitely compromises the bioresources. The authors contend that challenges are considerable but some kind of prioritizing for *in situ* conservation, such as that of endangered habitats and biodiversity hotspots may see us through this complex situation.

Any discussion on bioprospecting is incomplete without reference to Convention on Biological Diversity (CBD) and the post-CBD scenario. It is true for this book also. The first chapter in section VIII discusses pros and cons of benefit sharing as enshrined in the CBD. The author notes that the principles of CBD are finding their way into national laws and policies, and into the working practices of scientists. Readers interested in this area will find reference to a number of websites for further information. In another chapter, four historical cases, viz. busy lizzie, *Saintpaulia* (both ornamental plants), periwinkle (source of anticancer vincristine and vinblastine) and 'Hardangervidda fungus' (source of immunosuppressive agent cyclosporin A) have been discussed in the context of the present scenario of bioprospecting – some shades of the turmeric patenting imbroglio closer to home. Three case studies on bioprospecting partnership – the Merck & Co – INBio (National Institute of Biodiversity, Costa Rica), Diversa–Yellowstone National Park and the International Cooperative Biodiversity Groups may serve to lay the framework for future bioprospecting partnership endeavours. The authors clearly bring out how the throny issues of access, intellectual property rights, and benefit sharing may be handled deftly in bioprospecting partnership programmes. The concluding section (section IX), with only one chapter on the value of biodiversity, brings out the difficulties in valuation of biodiversity, much less the microbial diversity.

This book is a landmark publication on the subject of microbial diversity and bioprospecting. The whole gamut of the subject has been discussed authentically, making it a reference book of high standards. Interestingly, the editor has prefaced every section with a preamble. Each preamble not only summarizes the contents of the section, but also explores the wider perspective of the topics under discussion. The language is simple and lucid. A moderately good number of references published in high-quality journals have been included at the end of each chapter. This book will be useful not only to those specifically interested in microbial diversity and bioprospecting, but also to general microbiologists, microbial taxonomists and biotechnologists alike.

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Random Harvest, Biographical Sketches, Memoir 60. B. P. Radhakrishna. Geological Society of India, P.B. No. 1922, Gavipuram, Bangalore 560 019. India. 2005, 291 + vii pp. Price: Rs 250, US$ 25.

Biographies, short or long, of persons of 'noble character', have always fascinated me. A collection of 45 short biographies in this 'Memoir 60' of the Geological Society of India, Bangalore (GSI, not to be mistaken for Geological Survey of India) is a labour of love, written out of respect, at various times, regarding personalities of a bygone era and of a few of our times. These 'sketches and portraits' have come through the pen of B. P. Radhakrishna (BPR), the President of GSI and formerly Editor of *Journal of Geological Society of India*. Radhakrishna, the doyen amongst Indian geologists, now in late eighties, had an illustrious career spanning over 60 years in the field of geology. During his tenure in the Department of Mines and Geology in the erstwhile Mysore state spanning 37 years, the last ten of which as Director and subsequently, his circle of friends, associates and others, left indelible impressions on him. Writing biographies appears to be his forte. His daughter Lakshmi Krishna notes, 'apart from the articles and books written on Indian Geology and groundwater resources, etc. he has written many biographies in Kannada of various scholars and scientists. His goal of writing biographies of noted scholars and scientists is to infuse in youth the value of education, science and culture. The very first book he wrote was in 1948, *Nanna Thande* (My Father) portraying the life of his father Bangalore Puttaiah'. Out of the forty-five biographies, a sizeable number were written during the past thirty-five years and published in *J. Geol. Soc. India*. The very first biography in this compendium, on D. N. Wadia is not dated and the second one relating to N. Panduranga Rao is dated September 1952.

The biographies cover persons born as far back as in 1726 (James Hutton) and as recently as in 1961 (Kalpana Chawla). Several contemporaries (Anna Saheb Hazare, Salumarada Thimmakka, Sunderlal Bahuguna, M. V. Kamath) are also covered. One may wonder as to what made BPR write about this wide spectrum of personalities in a journal of geology. No doubt many of them are related to geology, mines, earth sciences and the like but all of them found a place because, as BPR says 'association with (some) of them enriched my life', 'many … laboured for advancement of India', '(some) devoted their time and energy to the advancement of our science' and 'other mighty minds of a bygone age whose writings opened up new areas of knowledge and have been a never failing source of inspiration to me'. Then there are others who fall in the category of "close personal associates, friends and colleagues "by virtue of their