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Book Reviews

Seed and nursery technology of forest trees edited by D. G. W. Edwards and S. C. Naithani, New Age International Publishers (P) Limited, 4835/24, Ansari Road, Darya Ganj, New Delhi 100 002, 1999, pp. 317, Rs. 550.

Conservation and restoration of the species-rich, but much threatened, tropical forests, of great climatic, ecological and economic value, are some of the major challenges facing the humans today. As Richard B. Primack (1995) states in *A primer of conservation biology*: "Once a species goes extinct, its population cannot be restored, the communities that it inhabited are impoverished, and its potential value to humans can never be realized." Any study aimed at regeneration of forest is therefore to be viewed with due importance. The book on *Seed and nursery technology of forest trees* is a promising work in this direction.

A compilation of 29 papers, this book is the outcome of a symposium held in India, in 1997, on forest tree seed and nursery technology, sponsored by the International Union of Forestry Research Organizations (IUFRO). The variety of techniques used and experimented with for seed germination and seedling establishment, although covers mainly some commercial species, are of practical value and will suffice to instil innovative spirit among foresters and forest biologists.

In his curtain-raising paper Ram Prasad defines, describes and categorizes forest tree seeds. The annual requirement of forestry seeds in India is projected to be 10,000 tonnes, to plant about 1.5–2 million hectares. Forestry seed business in India can be promising although very little is done to promote it. Quality seeds are in good demand, but forest departments have no infrastructure to fulfill the requirements. Seeds of grasses and legumes, medicinal herbs and of various indigenous fuel-wood and fodder plants are generally not available. The paper also mentions about storage methods and pre-treatments before germination. Interestingly, the digestive enzymes of cattle and goats favour germination of some tree species. Termites as well as fermentation can breakdown seed dormancy. A biologist, however, would have been happier to devour more of species-specific information of this kind about the role of birds and mammals of the wild on a multitude of species that live in the Indian forests.

G. P. Maithani lashes out at the concepts of seed stands, seed production area, clonal seed orchards and use of certified seeds as mostly confined to the realm of academicians, scientific institutes and labs. Private sector is unable to meet the demand as 90% of forests are with the Government. He calls for production of field manuals and feels NGO participation in educating people about quality seeds.

Edwards and Naithani, the editors, consider 'recalcitrant' seeds (seeds that cannot be dried and stored without major, often, complete loss of seed viability) as a problem that has severely constrained regeneration of several tropical forest trees. On the contrary, 'orthodox' seeds can endure desiccation. Berjack and Pammenter highlight the physiological mechanisms involved in conferring desiccation tolerance to seeds. Seed behaviour is placed along a continuum, although for convenience seeds may be classified into orthodox, intermediate or recalcitrant. Finch-Savage unravels mechanisms which create desiccation tolerance, like accumulation of

certain sugars, the expression of 'late embryogenesis-abundant' (LEA) genes and adequate provision against oxidative attack. The absence of one or more of these mechanisms is supposed to cause varied degrees of seed recalcitrancy. High respiration rates are recorded in the seeds of several recalcitrant species at shedding. Membrane damage during drying is speculated as one of the reasons for recalcitrant seeds to lose their viability.

Boby Varghese and Naithani report desiccated neem seeds survived six days in liquid nitrogen, whereas non-desiccated seeds showed complete loss of viability within five minutes. Three papers in the book deal with storage and germination of teak seeds. Osmotic priming of *Pinus* seeds is also discussed. D. G. W. Edwards describes inexpensive methods for breaking seed dormancy and for effecting rapid and complete germination. Simple techniques to separate viable from non-viable seeds are also dealt with. N. K. Bohra and D. K. Purohit report on storage damage to seeds and pods of *Acacia senegal* by *Aspergillus flavus*.

Despite the richness of methodology, the book betrays the expectations of conservationists. India is a megadiversity country, a veritable home for about 15,000 species of flowering plants. The book however reflects the sad fact that forestry seed research is still revolving around very limited number of species, which are common trees. These include tamarind, neem, *Pongamia* and *Acacia* and some exotic ornamentals like *Delonix regia* (gulmohar), *Peltophorum*, *Cassia*, etc., the seed germination and seedling establishment of which are in the realm of the common man. Most such trees are hardy and with orthodox seeds. Silence reins through the book about the scores of endemic tree species of the country, the survival of which is in jeopardy due to deforestation, especially, in the Western Ghats and the north-east Himalayas, two of the biodiversity hot spots on the earth.

Shorea robusta (sal) is an exception among recalcitrant tree species to have merited good attention. Krishna Chaitanya and Naithani found sal seeds exhibit 100% viability only up to 4 days after maturation, and became absolutely nonviable 8 days after. The seeds treated with kinetin and stored at 15°C, retained 100% viability up to 10 days and some up to 35 days. M. R. Ahuja highlights the importance of cryopreservation of seeds and buds in the conservation of genetic diversity of forest tree species.

V. A. Bapat and P. S. Rao have done interesting work on the production of synthetic seeds, or rather propagules, in sandalwood (*Santalum album*). Synthetic seeds refer to encapsulation of somatic embryos, buds, bulbs or meristem, which can develop into plantlets. Somatic embryo, developed by tissue culture, develops like zygotic embryo to form a plant. A gel matrix is used to produce a "synthetic seed coat." The encapsulated propagules have certain advantages. Nutrients, biofertilizers, antibiotics, etc. can be incorporated into the matrix. The encapsulated somatic embryos have uniform germination and could possibly remove many disadvantages associated with natural seeds.

The papers on nursery technology, in the usual way, deal with clonal multiplication of forest trees and various chemical and hormonal treatments of seeds and seedlings. A field that craves for greater attention is the study on the symbiotic association of higher plant roots with soil microorganisms. The roots of many tropical forest species have fungal or bacterial partners, which supply nutrients. Seedlings of many species fail to establish on soils without suitable friendly fungi or bacteria. B. N. Johri therefore pleads, justifiably, for cataloguing, conserving and utilizing the services of a wide variety of soil microorganisms. Venkatesh *et al.*

observed enhanced growth in *Pongamia pinnata* inoculated with microflora like *Rhizobium*, Phosphobacteria and VAM. S. C. Tiwari found higher growth rate and high nodule production by the roots of *Casuarina* seedlings inoculated with nodule extract.

Seed technology should emerge from its present sedentary state in lonesome labs and nurseries into the more dynamic and holistic field of ecosystem management, taking into consideration the whole gamut of natural factors which operate in forests and play decisive role in seed dispersal, germination and seedling establishment. We need to track also the fate of seeds of an astounding number of forest species being subjected to increasing anthropogenic factors like habitat fragmentation, edge effect, subversion of hydrological regimes for human wants, logging, forest fires and annihilation of wild animals along with their habitats. Seed biologists surely will have a greater role to play in future in the restoration of natural forests.

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Seminar on stochastic analysis, random fields and applications edited by R. C. Dalang, M. Dozzi and F. Russo, Birkhauser Verlag AG, Klosterberg 23, CH-4010 Basel, Switzerland, 1999, pp. 312, sFr. 158.

'Stochastic' is a Greek word which means 'random' or 'chance'. Stochastic analysis deals with models which involve uncertainties or randomness. A physical phenomenon is usually governed by certain laws. To analyze a phenomenon one uses these laws to derive certain mathematical equations. These equations contain one or several parameters. Due to various uncertainties in the environment, measurement errors, lack of information, etc., it is difficult to find the 'true' values of these parameters. This leads to uncertainty in the system even though the governing laws are deterministic. One way of circumventing this difficulty is to replace the 'true' values of the parameters by some kind of average and hope that the behaviour of this averaged model would be 'close' to that of the original one. This may work in some cases while in many cases the model may not be robust enough to accommodate this kind of averaging mechanism. In other words, the behaviour of the averaged model may be fundamentally different from that of the original one. There may be some physical systems which are governed by probabilistic (or stochastic) laws of motion rather than deterministic ones, though this may be a debatable issue. It may be questioned at a philosophical level whether randomness really exists in nature. Indeed Einstein raised this issue in the context of quantum mechanics and remarked "God does not play with dice". Though this philosophical issue may not get resolved in one way or the other, it is certainly true that stochastic models quite often lead to a better understanding of many physical phenomena. In fact, Einstein in his doctoral thesis developed a stochastic model to describe the irregular movement of pollen, suspended in water, observed by the botanist Robert Brown in 1928. This random movement, known as Brownian motion, is due to the buffeting of the pollen by water molecules which results in a dispersal or diffusion of the pollen in the water. Probably this was one of the first stochastic models to de-

scribe a supposedly deterministic physical phenomenon. This was just the beginning of a beginning. Now the range of application of Brownian motion includes thermal noise in electrical circuits, certain limiting behaviour in queueing and inventory systems, random perturbations in a variety of physical, biological, economic, and management systems. Stochastic models are all pervasive today in almost all branches of science. The latest application of stochastic analysis includes modeling of stock prices. This application which may be termed as 'mathematization' of the field of finance has grown at a rapid pace in the last decade and is still growing at a dizzying pace.

The present book under review is the proceedings of a six-day seminar on *Stochastic analysis, random fields and applications* held at the Centro Stefano Franscini in Ascona, Switzerland during September 16–21, 1996. The seminar focused on stochastic analysis with an emphasis on stochastic partial differential equations and measure-valued diffusions, and applications to mathematical finance and other topics. There are totally 20 papers in these proceedings. It is rather difficult to give a thorough review of each paper. Instead, we present a very brief review of each paper focusing on the essential flavour of the paper.

We begin with Mathematical finance which is the hottest topic on the circuit today. In this topic there are three papers. The paper by Barucci *et al.* 'On a semigroup approach to no-arbitrage pricing theory' deals with a semigroup approach to option pricing theory. Under no-arbitrage condition the price of an option is known to satisfy a certain parabolic pde. In this paper, the authors study an analytic semigroup associated with the Cauchy problem of this pde. The next paper in this topic by Fischer *et al.* 'Risk minimizing strategies under partial observation' studies risk-minimizing strategies in a portfolio selection problem in a financial market with incomplete information. They use stochastic filtering techniques to determine risk minimizing strategies. The paper by Delban *et al.* 'A compactness principle for bounded sequences of martingales with applications' establishes a compactness result for a sequence of martingales which is bounded in a certain function space. They have devised a new technique to obtain this result. A novel point of this paper is that this technique is used to get a new proof the optimal decomposition theorem in mathematical finance. In the broad category of Stochastic analysis there are 13 papers. The first paper by Ben Hariz *et al.* 'Central limit theorem for the local time of a Gaussian process' uses expansion in terms of Hermite polynomials to prove a functional central limit theorem for the local time of a real stationary Gaussian process. The next paper by Benachour *et al.* 'Explicit solutions of some fourth order pde via iterated Brownian motion' employs probabilistic method to solve a deterministic pde. The authors have given an explicit stochastic representation of the solution of a fourth-order pde. The third paper in this category by Buckdahn *et al.* 'Ergodic backward SDE and associated SPDE' studies stationary solutions of a certain class of backward SDE and establishes its connection with a certain class of second-order linear pde. The paper by Chenal *et al.* 'Law of iterated logarithm for parabolic SPDE' extends the classical functional law of iterated logarithm of Strassen type to parabolic SPDE. The paper by Hirsch *et al.* 'Multiparameter Markov processes and capacity' is a survey article which is based on the contribution of the authors on this topic. It first gives the definition of symmetric multiparameter Markov processes and introduces the associated capacities. It then gives many illustrative examples and states many interesting results. The paper by Khoshnevisan *et al.* 'Iterated Brownian motion and its intrinsic skeletal structure' surveys some recent results on iterated Brownian motion. The emphasis of the paper lies on the intrin-

sic skeletal structure which is used to develop the associated stochastic calculus. Leandre's paper 'Stochastic Wess–Zumino–Witten model for the measure of Kontsevitch' studies various aspects of infinite-dimensional stochastic calculus. The paper by Privault 'Independence of multiple stochastic integral' deals with the necessary and sufficient conditions for the independence of single and multiple stochastic integrals. The paper 'Existence of invariant measures for diffusion processes on Banach spaces' by Rockner *et al.* establishes the existence of invariant measures for Banach space-valued diffusion processes with unbounded drifts. The next paper in this category 'On some new type of infinite-dimensional Laplacians' by Scarlatti deals with infinite-dimensional stochastic analysis. The author studies a new class of infinite-dimensional Laplacians and highlights its main properties. The paper by Truman *et al.* 'Stochastic pde of Schrodinger type and stochastic Mehler kernels – a path integral approach' deals with stochastic mechanics. It presents a rigorous path integral derivation of stochastic Mehler kernel formulas. It also presents applications to stochastic pde of Schrodinger type. The paper 'Probability and quantum symmetries in a Riemannian manifold' by Zambrini deals with stochastic geometry. It exploits the theory of diffusions to get some novel quantum symmetries on a Riemannian manifold. The last paper in this category 'Statistical manifolds, self-parallel curves and learning processes' is by Burdet *et al.* The authors introduce a new type of stochastic geometry called information geometry which relates differential geometry to probability theory. They have analyzed some special spaces called statistical manifolds. This analysis has been used to study Boltzman machine..

There are two papers in Random fields. The first paper 'Generalized random vector fields and Euclidean quantum vector fields' by Becker *et al.* studies random vector fields in the framework of Euclidean quantum fields. It discusses a 'no-go theorem' which provides some understanding why Euclidean quantum field theory has been relatively less successful in the vector case than in the scalar case. The next paper in this type 'A microscopic model of phase field type' by Bertini *et al.* introduces and analyzes a microscopic and stochastic model of phase field type and discusses its macroscopic limits.

Finally there are two papers in engineering applications. The first 'Random production flow. An exactly solvable fluid model' by Cirput *et al.* deals with manufacturing systems. A stochastic model is developed to analyze a failure-prone manufacturing system. Fluctuations of the buffer flow of parts is analyzed using a fluid model. The authors have derived an exact characterization of the output process delivered by a production dipole composed of two machines separated by a single storage zone. The next paper in this category 'Heavy traffic and optimal control methods for a communication systems' by Kushner deals with the optimal control problem of multiplexing-type communication systems with heavy traffic. The heavy traffic limit is derived as a controlled reflecting diffusion and the ergodic control problem is analyzed.

The proceedings is a good reference material for researchers in the area of stochastic analysis and applications.

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Selected papers of C. R. Rao, Vol. 4, New Age International (P) Limited, Publishers, 4835/24, Ansari Road, Darya Ganj, New Delhi 110 002, 1999, pp. 393, Rs. 750.

Calyampudi Radhakrishna Rao, known in scientific circles as C. R. Rao, is one of the foremost statisticians of the century. His research spans a period of about fifty-five years. His contributions cover a phenomenally wide spectrum of areas of statistics—statistical theory, methodology, applications, pedagogy and foundations. Within statistical theory, his contributions span many areas—estimation theory, linear models, multivariate analysis, design of experiments, to mention a few. His contributions to many areas are of fundamental importance. Theorems, inequalities, methods, statistics (in the technical sense of the term—'measurable functions of the sample quantities'), distance measures, characterizations, etc. are associated with his name. His magnum opus consists of over 350 papers and 13 books. At 80, he is still prolific in writing.

Under the auspices of the Indian Statistical Institute, where for many years C. R. Rao worked and directed its research activities, colleagues S. Das Gupta and others have been putting together a selection of his articles. This volume is the fourth in the series and one more is expected to be published.

This collection of volumes does not form the complete works of C. R. Rao, but only a selection. The volumes as well as articles within volumes have been arranged in chronological order and the volume under review covers the period of publication from 1975 to 1985.

The major topics in this collection of articles are linear models, matrix theory (generalized inverses) with statistical applications, characterization of distributions, variance components, and analysis of diversity. There are 39 articles in the volume.

The articles had appeared in a variety of journals. They have not been reproduced here by a photo-offset process, but have been typeset afresh. This gives the volume an attractive uniform look. On the other hand, such a procedure is liable to introduce plenty of typographical errors; I must admit however that I found very few such errors.

Although many of these articles have other authors as well, the left-side page headers have only 'C. R. Rao'. The title pages of individual articles do not carry authors' names and so the coauthors have been ignored again. The coauthors are mentioned only in the *Contents* pages.

When a series of volumes like this is published, it is useful to include lists of contents of the other volumes, at least the earlier volumes. This has not been done.

Complete works and collected works of leading contributors to various fields of arts and science are published not merely for historical interest, but also because of their continued interest among contemporary scholars, who may find the original sources inaccessible. From the latter point of view, I wonder how useful is a chronologically organized series of volumes as opposed to topic-wise series. To produce the latter, it would be necessary to have a complete view of all the articles and to plan the entire series all at once; this probably is a more difficult task and cannot be done sequentially with huge gaps between volumes, as has been the case here. Indeed, the advantage of the sequential and chronological scheme is that it could be open-

ended and could accommodate a few more volumes of articles by Professor Rao to be published, one hopes, over the next few decades!

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Pattern formation in viscous flows by Rita Meyer Spasche, Birkhauser Verlag AG, Klosterberg 23, CH-4010, Basel, Switzerland, 1999, pp. 224, sFr. 98.

The Couette–Taylor system consisting of fluid flow between two rotating cylinders is a popular research topic both in experimental and theoretical fluid mechanics. The experimental setup was conceived by M. Couette, a French physicist, more than a hundred years ago to deduce the viscosity of the fluid from measurements of torque exerted by the fluid on the inner cylinder. Let Ω_1 and Ω_2 be the angular velocities of the inner and outer cylinders. When $\Omega_1 = 0$ and Ω_2 is not large the fluid flow is nearly laminar (referred as Couette flow) and the torque is then proportional to $\nu\Omega_2$ where ν is the kinematic viscosity of the fluid. As Ω_2 is increased the flow eventually becomes turbulent. Later Mallock found that if $\Omega_1 \neq 0$ and $\Omega_2 = 0$ (i.e. allowing the inner cylinder to rotate but keeping the outer cylinder stationary) the Couette flow was not observable even when Ω_1 was low. In 1923 G. I. Taylor showed that an instability, manifesting in the form of a pattern of small counter rotating vortices superimposed on the basic flow, occurs when Ω_1 exceeded a critical value. This critical value was lower than any of the values used by Mallock. This means that for certain initial conditions which are close to the Couette flow the system evolves to a state different from Couette flow. Ever since this flow system has been referred as Taylor–Couette flow. As Ω_1 is further increased a hierarchy of successive instabilities: azimuthal travelling waves, twisting regimes, quasiperiodic regimes and so on leading step by step to fully developed turbulence. When both the cylinders are rotated in opposite directions richer routes to turbulence are observed.

Thus, the Taylor-Couette flow although simple in nature generates a variety of easily observable flow patterns ultimately leading to turbulence. In fact many good experimental results were obtained in the 1960s. The recent progress in powerful computers, numerical techniques and the theory of dynamical systems has made it possible to make a much more detailed theoretical studies than was possible in the 1960s. Added to this, progress in measuring and analysing velocities of fluid particles has led to a greater interaction between people working in experiment and theory. This has been further stimulated by the remarkable agreement between theoretical predictions and experimental observations especially when the height of cylinders is large enough. For instance, extremely careful numerical computations by Bolstad and Keller[1] have indicated the presence of some hidden vortices that were overlooked in experiments. Careful experiments and observations later did reveal these hidden vortices.

The book under review investigates a variety of stationary solutions to the Navier–Stokes equations that model the Taylor–Couette flow. Using Fourier decomposition in the axial direction and a finite difference scheme in the radial direction the resulting system of nonlinear equations are solved by a Newton iterative scheme. The method of continuation pioneered by

Keller[2] and his coworkers is used to explore the solution structure in the various parameter regimes. These results of the author and her collaborators which were otherwise scattered in journals and proceedings have now been compiled into this book. This is definitely welcome and is a handy reference to people working in this area. For mathematicians this book is a nice supplement to that of Chossat and Iooss.[3]

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8. HINGDON, A.	*Engineering mechanics*, Vol. 1. Ch. 3, pp 79–104, 1968, Prentice-Hall.
9. RAMA MURTHY, K.	*Convergence of state distributions in multi-type Bellman-Harris and Crump-Mode-Jagers branching processes*, Ph.D. Thesis, Indian Institute of Science, Bangalore, India, 1978.

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