rences. The reactions (schemes) have been selected with proper consideration and relevance. The style of presentation is lucid. Certainly this book will give the general reader and practising chemists a very good introduction to the subject and a feeling of importance of eco-friendly procedures, leading to a common awareness and motivation towards development of green technology.

However, a few chapters (like 5–7) are rather brief and there is scope for addition of recent important works in these areas. Particularly, use and importance of ionic liquids in eco-friendly procedures cannot be ignored. Similarly, chapters on microwave and ultrasound and renewable raw materials need more elaborate discussions, as these are important in modern green technologies. These may be considered in the next edition of the book.

On the whole, I feel this is an excellent introductory book for first-hand knowledge of green chemistry as well as eco-friendly alternatives of chemical methods. I believe, this book will meet the long-awaited need of a wide section of readers interested in green chemistry.

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Model Systems in Behavioural Ecology. L. A. Dugatkin (ed.). Princeton University Press, 41 William Street, Princeton, New Jersey 08540, USA. 2001. 551 pp. Price: US $ 35 (paperback).

'Diversity' is the word that immediately comes to mind on reading this immensely interesting and intellectually stimulating book. Edited by Lee Alan Dugatkin, himself a well-known behavioural ecologist working on fish, this book attempts to examine the utility and success of the 'model system' approach (studying single species over extended periods of time to explore specific questions) in behavioural ecology. This is achieved through twenty-five articles, each written by a leading researcher in the field.

The book is refreshingly different for two reasons: firstly, it is written in a relatively informal, autobiographical style, giving the reader an insight into how the scientist in question came to work on that particular species and formulated the specific scientific question. Secondly, it covers an enormous diversity of taxa: from dung beetles to dolphins, butterflies to bonnet macaques. Both the personal, narrative style of the articles and the diversity of taxa explored make this an excellent book for students starting on their research careers, for scientists and teachers working in related fields and interested in understanding the developments in behavioural ecology, and also for established behavioural ecologists who have been unable to keep up with the literature!

Although most of the articles are lucidly written, some of them use a lot of technical terms (such as ideal free distribution, evolutionarily stable strategies, marginal value theorem, dynamic optimization models) without adequate explanation. A behavioural ecologist would have no difficulty understanding what they mean, but the first two categories of readers (who stand to benefit most from this book) may find them difficult to comprehend. I suggest that later editions of this book (if any) carry a glossary or appendix that explains these basic concepts: this would make some of the chapters more comprehensible to the non-initiate.

There are two very different paths that scientists have followed in getting to the particular species being studied: a question-based or a taxon-based approach. The former involves finding a species with the particular behaviour and ecology that makes it a suitable system to test specific hypotheses (Paul Sherman and wood ducks), whereas the latter involves studying a particular species or group because it is interesting (Connor and dolphins). Of course, the two approaches end up merging: Sherman's early studies got him involved in wood duck conservation, while Connor discovered the formation of 'super-alliances' in dolphins, raising interesting questions about their social behaviour.

In spite of the diversity of taxa, the book is characterized by two broad themes: the evolution of mating strategies and the evolution of sociality. Most of the authors have examined their specific systems in the context of three major theories that served to revolutionize the study of animal behaviour in the seventies and actually spawned the field of behavioural ecology: the theory of kin selection, optimization theory and the application of game theory to animal behaviour. Together, they provided a powerful theoretical framework that triggered an explosion of studies aimed at testing them.

Geoff Parker and Manfred Milinski were among the first to use optimization models to successfully explain mating strategies in dung flies and foraging strategies in sticklebacks respectively. More recently, Milinski has tested the applicability of mate-search models based on optimization to the mating strategies (more correctly, rules of decision-making) of female sticklebacks. Whereas Parker's work was mainly based on observations of dung flies in the field, Milinski has used carefully controlled laboratory experiments to test the applicability of optimization theory to behaviour: both approaches have provided support for the use of optimization strategies by animals as diverse as dung flies and fish, in both feeding and mating behaviour.

Sexual selection has been the subject of innumerable studies spurred on again by the development of a rigorous quantitative genetic framework in the eighties and nineties. The studies of Moeller (on the barn swallow) and Wilkinson (on stalk-eyed flies) provide interesting examples: both use manipulative experiments to pinpoint the cues used by females for mate choice and demonstrate their correlation with fitness benefits. Wilkinson's serendipitous discovery of the relation between meiotic drive and female preferences illustrates how careful observations of a given species can lead to the discovery of new phenomena that require new theories to explain them.

Barry Sinervo's article (in my opinion, the best in this book) on the effect of local neighbourhoods and ecological factors on the evolution of alternative male reproductive strategies in lizards is a brilliant example of a combination of careful observations of individual behaviour in the field, coupled with interpretation using game theory. The story of sex change in the blue-headed wrasse (a coral reef fish) by Robert Warner is a beautiful example of the utility of analysis of a single species on several levels and from different pers-

pectives: the intricate inter-relationships between ecology, demography, mating system, resource allocation and individual behaviour are revealed in this study. Similar relationships are also brought out in the study of Joan Silk on bonnet macaques, Harcourt on gorillas and Caro and Kelly on cheetahs. These studies also provide important input to conservation and management programmes, particularly for highly endangered species such as gorillas and cheetahs, and endangered ecosystems such as coral reefs.

Most of the studies described in this book owe their success to the fruitful combination of theoretical and empirical approaches, to analysis at several levels and to the use of techniques drawn from several disciplines: DNA fingerprinting for paternity analysis in birds (Westneat), acoustic and vibrational playback techniques to examine the function of communication signals (Gerhardt in frogs, Hoelldobler and Roces in leaf-cutter ants and Uetz in spiders). The most spectacular and exciting example of an integration of different techniques and levels of analysis is undoubtedly the article by Kamil and Bond on virtual ecology. Starting from a mechanistic study (using operant conditioning paradigms) on the process of search-image learning in blue jays, they describe, in this fascinating article, how the switch in the technology of stimulus presentation (from old-fashioned slides to computer-generated images) enabled them to do virtual ecology: live jays could now pick (kill) one of several digital moth images (differing in degree of crypsis) offered simultaneously on the screen. This allowed them to literally carry out natural selection using live predators and virtual prey!

The importance of the benefits of collective hunting in driving the evolution of sociality is the theme of three of the mammalian studies (Bekoff on coyotes, Scott Creel on wild dogs and Boesch on chimpanzees). These studies demonstrate the practical difficulties in actually measuring the costs and benefits of collective hunting, which in turn result in plenty of controversy! Both Bekoff and Boesch emphasize the importance of careful observations of individual behaviour over long periods of time. They caution against an exclusive 'test-of-hypothesis' approach, particularly when dealing with species that possess highly complex nervous systems (such as apes, dolphins and whales). In particular, Boesch's observations on the complex interactions between individual chimpanzees (some of the best descriptive writing is in this chapter) in the troop during and after a hunt, providing a social mechanism (enforced by females) against cheating by non-hunting males, as well as the fact that females are, in some sense, always cheaters, since they never hunt, surely should provide plenty of food for thought.

Although behavioural ecology has evolved into a highly integrative and multidisciplinary science in the past thirty years, there is one aspect of behaviour that has rarely been integrated into its framework: the neurobiological mechanisms of individual behaviour. There are some exceptions, such as the studies by Carl Gerhardt on acoustic communication and Michael Ryan on sexual selection in frogs (the latter theme is not presented in this book). Interestingly, the role of sensory biases and that of phylogenetic constraints (on structure and physiology) in shaping the evolution of behaviour is often met with scepticism, to put it mildly (the article by Hudson Reeve exemplifies this response)! The reason for such controversy is entirely unclear to me. As I understand, they are fairly independent levels of analysis: the fact that an animal is structurally constrained from, say, producing an 'optimal' communication signal (due to its phylogenetic history) does not mean that it will not optimize *within the range of signals or behaviours that it is capable of producing*. There is no controversy between the universality of an optimizing strategy and the fact that behaviours may be phylogenetically constrained – they can both be true and they are both interesting! This kind of controversy is reminiscent of the behaviourist/ethologist divide that characterized the study of animal behaviour earlier this century. Interestingly, again, the behaviourists focused on general rules of learning, while the ethologists performed comparative studies of relatively stereotyped behaviours: the rules of learning that the behaviourists proposed are indeed universal, but learning is surely phylogenetically constrained, and some behaviours are not learned.

The study of the physiological mechanisms that produce behaviour and their ontogeny has evolved in parallel with behavioural ecology into a field known as neuroethology. The synthesis of ideas and findings from neuroethology with those of behavioural ecology has not happened yet, but I predict that it will and must: after all, both disciplines try to explain the same behaviour! The study of animal behaviour must and will go back to the original (sensible!) framework proposed by Niko Tinbergen, who said that one must examine behaviour from four angles to understand it: causation (individual physiology), ontogeny (individual development), survival value (fitness consequences) and evolution (phylogenetic history).

A final comment on Dugatkin's 'Closing Thoughts': although I agree that it is exciting that findings from behavioural ecology are being employed in examining medical issues from an evolutionary perspective (Darwinian medicine), I cannot help but feel a little alarmed. As long as such studies involve *post facto* analysis of medical records, there is no problem. If they are eventually used to drive medical policies, however, there is reason for concern.

How can we be sure that findings made on fish or birds or even primates can be uncritically applied to human behaviour or physiology? I am not debating the intimate phylogenetic relationship between, for example, apes and humans: but, speaking as a comparative ethologist, can we effectively unravel the enormous influence of environment, language and culture on our physiology and development as individuals? Without a lot of careful research on human populations and a comparison with a closely related species, such as the chimpanzee, can we even begin to guess? How then, can doctors and policy-makers justify decisions? Even if we did know the true answers, would that be acceptable?

As an example, there was a serious proposal (luckily vetoed) by a government in an industrialized nation that, since women are statistically and significantly more likely to, *on average*, live longer than men, all working women should pay higher taxes than men! Although this is not behavioural ecology, I hope it makes the point! It illustrates the typical (mis)use of a statistical argument to make categorical rules for individuals. Given our ignorance, as scientists, of the interplay of so many factors in shaping physiology and behaviour, and the even greater ignorance of the scientific process among the general public, I think we need to be cautious.

The spectre of eugenics should surely haunt us still.

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Restoring the Abundance: Regeneration of Indian Agriculture to Ensure Food for All in Plenty. Jitendra Bajaj and M. D. Srinivas. Indian Institute of Advanced Study, Rashtrapati Nivas, Shimla 171 005. 2001. 48 pp. Price not mentioned.

This is a very readable book, which traces the history of Indian agriculture during the past few centuries and offers a prescription for the future. The first chapter gives a glimpse of the glory of Indian agriculture in the past, as evidenced by the very high productivity of the soil. For example, the then British administrators reported an yield of 13 tonnes of paddy per hectare in the Coimbatore area of Tamil Nadu.

In the second chapter, the authors point out that productivity declined continuously until the end of the British rule. The worst affected area was 'the heartland of India – the great Indo-Gangetic plains', which according to the authors witnessed unprecedented destruction. In 1903, the nationalist scholar, Romesh Dutt stressed that while priority was given by the British Government to railways, irrigation was neglected. This was also the view of Sir Arthur Cotton, who bemoaned the neglect of irrigation and navigable canals.

Quoting Angus Maddison, the authors point out that during the colonial period the Punjab and Sind alone received attention from the point of view of bringing land under irrigation. Consequently, these two states produced large quantities of wheat and cotton, both for export and domestic consumption. Neglect of agriculture and particularly irrigation, led to both famines and declining per capita GDP until 1947. In the post-independence period, progress has been uneven in relation to both crops and regions. Also, a large proportion of the Indian population still remains malnourished. Productivity is still low per units of land and water. Though we have an impressive livestock wealth in quantitative terms, their productivity is very low largely due to lack of feed and fodder. The authors stress, 'our people and animals have been living at an average level of consumption that would be unacceptable anywhere else in the world'. Wherever agriculture has progressed, as in Punjab, Haryana and western Uttar Pradesh, both rural and urban poverty has declined.

In the last chapter, the authors present their vision and prescription for the regeneration of Indian agriculture. Criticizing the targets set in the vision document of the 88th Session of the Indian Science Congress held at the Indian Agricultural Research Institute, New Delhi in January 2001 the authors feel that we must produce at least 400 million tonnes of food grains by 2015. This will call for a growth rate of 4.7% per year and an average productivity of 3.2 tonnes per hectare. This can be achieved by restoring the traditionally high production and productivity of the Indo-Gangetic plain. The authors conclude that the regeneration of the Indian economy can be accomplished even within a decade 'through the bounty of Ganga'.

The diagnosis of the importance of the Ganga and Gangetic plains to India's food security is in my view, correct. In a paper by S. K. Sinha and me (*Curr. Sci.*, 1979, **48**, 425–429), we had given an estimate of the absolute maximum food production potential in India, including the Gangetic Plain. Since the book has a sub-title which includes the goal 'Food for All', it is important to point out that inadequate purchasing power rather than inadequate availability of food in the market, is the major cause of endemic protein-calorie undernutrition and hidden hunger (caused by micronutrient deficiencies) today. Agriculture in India is not just a food-producing enterprise. It is the very backbone of our livelihood and ecological security systems. Therefore, it is not enough if we produce more food in the Gangetic plain. It is important that agricultural regeneration, which includes crop and animal husbandry, fisheries and forestry and agro-forestry, takes place in every part of the country. This is vital for poverty eradication and household food security. With increasing urbanization, there is a clear shift towards diversification of food habits.

The draft of the Tenth Five-Year Plan stresses that to achieve a 4% growth rate in agriculture, there will be need for a 8% growth rate in horticulture, animal husbandry (large and small ruminants and poultry) and inland and marine fisheries. The famine of food at the household level can be conquered only by fighting the dearth of jobs or sustainable livelihood opportunities, in both rural and urban areas. This will call for increased investment in minor irrigation, greater attention to post-harvest technology and a small farm-management revolution through conferring on small-scale producers, the advantages of scale both at the production and post-harvest phases of farming. Indian agriculture, which used to be described as a gamble in the monsoon, is now becoming a gamble in the market. The attention should shift from just the factors of production to the producer. There is need for proactive advice to farmers on land use based on potential demand for both home consumption and exports. More than 50% of the population of the Gangetic Plain, identified by the authors for priority attention, is below the age of 20. Youth in this area will be attracted to farming only if agriculture becomes economically rewarding and intellectually stimulating.

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