

Experiments in Animal Behaviour: Cutting-edge Research at Trifling Cost. Raghavendra Gadagkar. Indian Academy of Sciences, CV Raman Avenue, Sadashivnagar, Bengaluru 560 080. 2021. xi + 328 pages. Price: not mentioned.

The ongoing COVID-19 pandemic has seen a global increase in awareness of scientific research and public outreach by scientists, leading to improved engagement between science and society. However, we are still only scraping the very top of a hardened layer of ignorance, indifference and rejection of scientific thought and practices among the multitudes of our diverse social tapestry. There is an ongoing discussion among scientists for the need to inculcate an enthusiasm for studying science among young people and in the last decade, India has definitely seen a rise in interest for taking up science as a career choice among high-school and college-level students. The summer research fellowships initiated by the three science academies of India – Indian Academy of Sciences, Indian National Science Academy and National Academy of Sciences, India, and other outreach events have been instrumental in inculcating a positive outlook towards careers in science among the youth. In addition, the establishment of Indian Institutes of Science Education and Research (IISERs) has created opportunities for studying science in an open, interdisciplinary and research-orientated environment, breaking silos and attracting young minds to science education. However, in a growing economy like India, funding for research and development remains well below 1% of the GDP, raising concerns for the growth of scientific research and slowing the pace of scientific endeavours in the country.

There has been a steady demand by scientists and enthusiasts of science for an

increase in the national funding for science to 2% of the GDP, but we are far from attaining this dream.

While one can fret about this lamentable situation and blame the ‘system’ for a lack of support to facilitate world-class research in the country, some can see the glass half full and lay out a path to positivity.

This book by Raghavendra Gadagkar is one such case in point. Using examples of research in animal behaviour across taxa, ranging from insects to mammals, he elucidates how high-quality research can be performed at little cost, with nothing but ingenious experimental design, scientific reasoning and a lot of passion. As Gadagkar mentions in the opening paragraph of the first chapter, ‘...my goal will be to motivate readers not only to think about the design but also to come up with alternatives and improvements. Motivated readers can indeed replicate some of these experiments even if they end up replacing the study animal or the behaviours of interest with their own favourite choices’. With its lucid and simple language and easy storytelling style, this book is an inspiration to not just researchers, but anyone who is interested in the scientific endeavour.

The book has 16 chapters, of which the first 10 discuss varied research using social insects – bees, ants and wasps as the model systems. Gadagkar begins with a classic experiment, by the Nobel laureate Niko Tinbergen, one of the founders of the field of ethology. Tinbergen’s experiments to answer the question ‘How do digger wasps find their nests’ is almost childlike in its simplicity and deserving of a standing ovation for its elegance. Having initiated the reader to this textbook example of a field experiment in ethology, Gadagkar embarks on a journey of raising a series of intriguing questions ranging from colour vision in bees to finding the shortest path in ants to politics in wasps. His selection of examples ranges from experiments leading to a Nobel Prize to those leading to Ph.D.s, and are tied by a common thread – they are all inexpensive, have a simple, logical and elegant, sometimes audacious design, and can, in most cases, be adapted by anyone interested in experimenting with ethology. As the readers progress through the chapters, they will not only be treated to a plethora of intelligent experiments, but also get an overview of the field of sociobiology, spanning themes like navigation, physiology, cognition, cooperation and competition. ‘Tinbergen strolled around the woods and his curiosity about how the wasps ma-

naged to find their nest hole among so many others, was aroused. He framed hypotheses and proceeded to test them, designing the simplest possible experiments using what was readily available’, writes Gadagkar in the very first chapter. This ‘quick and dirty’ method is the central theme of this book, that is reiterated chapter after chapter.

Having taken the readers through the complex and dynamic world of social insects, Gadagkar picks a selection of vertebrates – fishes, frogs, snakes, cuckoos and dogs. In each chapter, he also chooses a theme from evolutionary biology, spanning the great breadth of knowledge in the field. If you have ever owned or even spent some time before an aquarium, you might have observed fish chasing each other around or nipping each other. Fighting or aggression is a common theme in the animal world, and is perhaps one of the most widely studied subjects in ethology. Scientists try to understand how animals fight, what morphological features help them to fight, in what context they fight and, most importantly, why they fight. Perhaps we are so interested in animal aggression because this also helps us to hold a mirror to ourselves? After all, aggression in various forms, conflict and war have been a signature of the human society since time immemorial. Using examples from the world of fishes, Gadagkar elucidates the concept of winner and loser effects, and their implication in animal behaviour.

The colourful feathers and songs of male birds, the antlers of male deer, the songs of crickets, and many other such ‘secondary sexual characters’ evoke wonder in humans and scientists alike. The sexual displays and ornaments of animals led Charles Darwin to define a new theory, known as the theory of sexual selection, which has been the focus of much discourse in the fields of ethology and evolution. While many would not consider frogs to be the most beautiful creatures on earth, to a female frog, the call of the male frog is indeed the most attractive piece of music. In chapter 12, Gadagkar relates an intriguing story, of scientific exploration and adventure, by a team of scientists working on a rather ‘ugly’ frog in Panama, to understand the intricacies of the evolutionary see-saw that strikes a balance between the complexity of male song, female choice and predation by bats.

Snakes are perhaps one of the most feared and least understood animals of the world. Yet, they can be rather beautiful

too. Indeed, the coral snakes are spectacular in their colouration. In chapter 13, Gadagkar introduces the concept of mimicry using the example of these snakes. He uses research from India and USA to elucidate some of the existing debates in the field and how they have been addressed by researchers. This chapter is followed by one on birds, with an excellent discussion on brood parasitism. This is the phenomenon by which a species uses another to provide care to its offspring, the classic example being the cuckoo. Using extensive research by Nick Davies and Michael Brook on the European reed warblers and their parasites, the common cuckoo, Gadagkar weaves a fascinating story of exploration and adventure, addressing seven different questions pertaining to the cuckoo–reed warbler story.

The transition from non-caring parents to ones that show care, but eventually quarrel with their offspring is a rather smooth one, as Gadagkar describes using the theory of parent–offspring conflict, proposed by Robert Trivers in 1974, and uses stray dogs to show how we can demonstrate this phenomenon in the field. This chapter is a story of the dynamic mother–pup relationships in dogs, based on work done of Manabi Paul for her Ph.D. Gadagkar puts together the story like connecting pieces of a jigsaw puzzle, and the chapter is a pleasure to read, irrespective of whether one is a dog-lover or not.

In the last chapter Gadagkar provides an eloquent criticism of the current academic system that values research based on how expensive it is, creating unnecessary competition for the already limited resources. India is a country that boasts of a rich biodiversity and is home to several unique ecosystems. Much of our biodiversity remains unexplored, and only a few have been explored yet by behavioural biologists. Animal behaviour is a fascinating field of research which does not necessarily require large funding and complicated equipment. Gadagkar, through each and every chapter in this book, highlights how one can carry out cutting-edge research on diverse taxa and explore the fascinating world of animals through in-depth explorations of their behaviour, using simple methods, with nothing but a notebook, pen and passion. The most expensive equipment in many of the cases described in this book would have been a pair of binoculars or a camera, and today, a smartphone can suffice for much of the documentation required in the field.

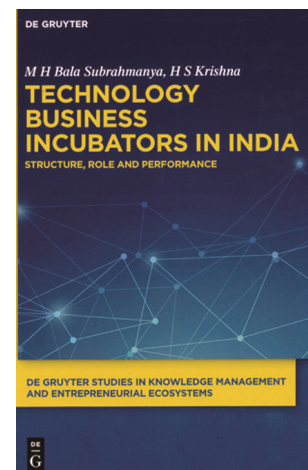
Many of the research questions described in the book are those that a child might ask, and can be addressed using the rigour of science. Gadagkar uses many examples of research carried out in India, alongside those carried out in the Global North, and this is done on purpose – to highlight how world-class research can be carried out in a country where funding is low. Every researcher need not join the race for funding; some can follow their passion and be leaders in their own right. The last chapter is my personal favourite in this book, as a teacher as well as a scientist.

I have been sharing each of the chapters with my students, friends and colleagues as they were published as standalone articles in *Resonance*. This book is a must have for every teacher and student of biology, and has the special privilege of being extremely readable for anyone interested in science. One can use the wisdom of this book to observe animals (and plants) in one's own garden, and we can, in principle, have a scientist in every home. I urge everyone to pick a copy of this book, or download the freely available e-book and share it widely, especially with young people, who might be enthused to look around themselves and enjoy nature with the thirst of a scientist. Someday we might have a generation of scientists leading India in the field of animal behaviour, revealing to the world nuances of the private lives of the many species living around us.

Note: I would like to declare that Prof. Raghavendra Gadagkar was my Ph.D. supervisor and this book has reference to some of the work I carried out during my Ph.D. Moreover, a chapter in the book is based on work from my current research group at IISER Kolkata. I have, nevertheless, tried my best to provide an objective review of the book, from the perspective of an ethologist, a teacher and a general reader.

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Technology Business Incubators in India: Structure, Role and Performance. M. H. Bala Subrahmanya and H. S. Krishna. Walter de Gruyter GmbH, Berlin/Boston, 2021. xiii + 154 pages. Price: €86,95.

This book deals with technology business incubators (TBIs) in India which is an important and emergent research topic. The authors need to be commended on undertaking research on a topic that is challenging.

The book examines the currently prevalent structure of TBIs in India, their role and finally evaluates their performance. The presence and functioning of TBIs in India is important in the context of the country adopting the ‘Atmanirbhar Bharat’ policy. The book is timely and examines the current state of affairs by analysing sixty-five TBIs in Bengaluru, Hyderabad and Chennai, which are three of the important hubs that nurture entrepreneurship in India.

The book is divided into seven chapters. The salient feature of the first chapter is the origin and current status of TBIs in India (as of 2020). It also describes the current policies followed for TBI promotion in the country.

The second chapter summarizes, clarifies and analyses a vast body of literature that exists on ‘technology business incubation’. The authors have exhaustively reviewed the literature, giving the readers a glimpse of the prior art of innovation and entrepreneurship. This chapter also includes details of the origin of the TBI concept, TBI models currently prevalent in the world, their typology and functions. It provides a comprehensive conceptual framework for studying TBIs taking into consideration the entire start-up journey based on the three complementary frameworks,