

transect surveys, collect scats and perform other time-consuming work. This group of trained and dedicated people served as a strong and diverse base of supporters who would be critical in future fieldwork and advocacy when the troubles began.

Tiger deaths in Nagarhole Park, where he was working, appear to have been the turning point for Karanth, when he went from being a tiger biologist to becoming a tiger conservationist. A coincidental series of five tiger deaths in 1990 led to the rumour that it was Karanth's research methods that were responsible. Fanned by the tabloid press, these deaths reverberated across India and brought down on the research project the larger national controversies regarding forest exploitation, forest dwellers and miners, and the multi-level rough-and-tumble politics of India.

At this point the book pivots from the dreamy, familiar prose of a hard-working field biologist tirelessly following fascinating animals, into a passionate, detailed examination of the political ecology of tiger conservation in India, with the author's work at its core. This is a tale of deep frustration featuring tigers killing people, the burning of Karanth's research camp, self-serving politicians, swirling local to national politics, the tabloid press and its lack of interest in the facts of tiger conservation, and the rent-seeking and self-aggrandizement of individuals, government agencies, and social and non-governmental organizations. It is also the story of a country changing from highly rural to increasingly urban with improved economic circumstances, and the evolving social view of tigers and tiger conservation that came with this transition.

This tale is told blow by blow, person by person (with those who impeded Karanth's work named only with initials), incident by incident, political interference by political interference, and lost opportunity by lost opportunity. The author has a long memory and has faced a panoply of impediments woven in and around the kaleidoscope of Indian politics. He has particular scorn for what he calls 'forest bureaucrats', and those who feed off large international projects while not actually helping tigers.

To Karanth, any hope of long-term tiger survival requires an understanding that people and tigers can coexist at the scale of a country or state, but not at the scale of a single protected area. This means that for tigers to thrive, people living within protected areas need to voluntarily relocate—a topic that was anathema to many but not to Karanth, who worked with many parties to find land and resources to initiate the gargantuan task of voluntary resettlement of forest-dwelling peoples in protected areas in south-western India. This intervention comes with high political and social costs, but Karanth maintains it is the only

fair solution to help forest-dwelling peoples with limited access to governmental services, and to allow tigers to live their tiger lives. Supporting his argument, Karanth presents evidence of this dual benefit from the limited voluntary resettlement project he was able to help initiate before this effort was largely shut down by opponents.

Realizing that tiger conservation requires a broader perspective than work in a single protected area, Karanth shifted his research from individual tigers to populations. In particular, he pursued transparent and statistically robust means of determining changes in tiger population size. Even readers with limited interest in tigers will know that much is made of press releases issued by conservation organizations and governments about increasing tiger numbers. The end of the book, however, contains a scorching critique of the Indian government for ignoring, diluting and replacing the peer-reviewed methods that Karanth and colleagues have developed with the government's sloppy, opaque methods, based on data that are kept secret. The result is, as Karanth argues, a complete lack of confidence in the Indian government's numbers of tigers, which in turn results in a lack of ability to determine which conservation methods are effective and which are not.

The author ends the book reminding us that India is the country with the most tigers and the greatest potential to increase and maintain the number of these magnificent creatures in the wild. Despite the problems and setbacks, India remains the wild tiger's best hope. Karanth argues that realizing this potential will require attention to creating and increasing tiger source populations that are connected across the country. It will also require social support built on sustainable tiger tourism, and finally, dismantling of the government bureaucracy that has 'smothered' tiger conservation (p. 221).

Decades of service at the frontline of tiger conservation in India have forged Ullas Karanth into one of the world's premier tiger biologists. The major value of this book is the telling of his story and its potential as a teaching tool that lays out in great detail the real politics of conservation of large animals that can be in conflict with humans. Much of the literature that is used to teach students about conservation comprises scientifically sanitized technical papers and reports that fail to convey Karanth's reality of death, birth, mobs, graft, vendettas and the sort of noble stubbornness that characterizes his life's work. This is a grand story, well told. Despite being deeply pessimistic in many parts, the book ends with a passionate conviction that tigers can survive and that India will be the key player ensuring that survival. Tigers stalking through grasslands,

the light glinting off their rippling striped coats, won't know the work of Karanth, but those of us who want to live in a world rich with tigers have much to thank him for.

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### **Mycorrhizal Dynamics in Ecological**

**Systems** by Michael F. Allen (2022), 300 pp. Cambridge University Press, Cambridge, UK. ISBN 978-0-521-53910-4 (pbk), GBP 39.99.

In 1991, Michael Allen published *The Ecology of Mycorrhizae*, a fascinating overview of the mutualistic symbiosis between many fungi and almost all plants. It was published when the significance of mycorrhizal associations was on the verge of becoming more widely recognized and appreciated, and a good read for me as a young researcher in fungal ecology. Since then, voluminous research has resulted in a remarkable increase in knowledge and awareness of the ecological significance of this ubiquitous symbiosis, attracting an increasing interest not only from students and scientists, but also from land-use managers and the public. Hence, I was thrilled to read Allen's monumental work compiling and discussing the current state of knowledge in his new publication *Mycorrhizal Dynamics*, 3 decades later.

The book's premise to explain about mycorrhiza and its significance in the entire ecosystem is very appealing by its connections to theories and accounts of natural history, although I think that some of the more detailed sections may pose greater demands on its readers.

As Allen so effectively conveys, mycorrhiza is no longer described as something odd or of limited importance, as it was in the textbooks of my school days. Instead, mycorrhiza has stepped forward as a basic premise for the existence of plants and terrestrial ecosystems as a whole. It is now recognized as the prerequisite for life's conquest of land 400 million years ago. The subsequent co-evolution of mycorrhizal plants and fungi makes them as tightly intertwined with each other as we are with our gut microbiomes; in both cases, very different types of organisms act as biological and functional units. A thought-provoking perspective is that plants can be considered (merely) as the outcome of a long-standing, successful entrepreneurship with symbiotically associated mycorrhizal fungi in their roots and photosynthesizing cyanobacteria in their foliage. The largely invisible, intimate physiological integration between mycorrhizal plants and fungi, together with fungi being

microscopic and located below ground, are the reasons why mycorrhiza has only recently begun to be fully appreciated.

I find it hard to imagine anybody better qualified to synthesize and narrate the overwhelming amount of information on the subject than Michael Allen. In addition to 50 years of research experience of nearly all aspects of mycorrhiza, and having explored the phenomenon in most corners of the world, Allen conveys the current state of knowledge spiced (one might say truffled) with his own experiences in a most curious and captivating fashion. Starting with the early remarkable suggestion of mutualism between ghost pipes and fungi in the late 19th century, the text is pedagogically structured from basic ideas of mycorrhiza and its function to overall perspectives of its ecological significance, both in distinct ecosystems and at the global scale.

Allen invites us to adopt an understanding of mycorrhiza as a dynamic and complex system, in which plants are interconnected with multiple fungi through mycelial networks, and are not to be perceived as single units. His evolutionary and ecological approach makes for a good story line, and I particularly appreciated

that the text elaborates on both perspectives—the phytocentric as well as the often-overlooked mycocentric view of mycorrhiza—and in this context also reflects on what an individual means in the realm of fungi. Allen succeeds in revealing how single mycorrhizal associations are integrated through multiple, interconnected networks of diverse plant and fungal compositions, and all the way up to the global scale. He demonstrates how mycorrhiza is a key component in the regulation of atmospheric carbon and also explains how it can play a key role in land management.

I agree with one of Allen's insightful concluding sentences, stating that 'In the world of mycorrhiza, imagination may be the single most useful tool!' (p 253). This may seem to detract from the book's extensive scientific content, but it is an apt description of the difficulties we experience when trying to fully grasp or convey the scope of mycorrhiza. The challenge is not only to acknowledge the significance of mycorrhiza, but to transform and integrate its scope into our understanding and perception of nature as a whole—which is made all the more challenging by the fact that mycorrhiza is invisible, being microscopic and located in the soil.

Overall, the book provides an excellent overview with an exhaustive level of detail, shifting between microscopic and global scales, and offering simplified concepts to help us appreciate complex natural histories, with mycorrhiza as a cornerstone of ecosystem functioning. It also provides a much-needed introduction to the effects of climate and environmental change on mycorrhiza, and suggestions for how we can integrate mycorrhizal knowledge into management of forests and agricultural land to mitigate unwanted effects.

*Mycorrhizal Dynamics* is a great read and has helped me to broaden and update my understanding of the subject. There are few books of its kind, and I recommend it as a valuable resource for researchers and in higher education, and as a worthwhile reference for anybody interested in mycorrhiza. Last but not least, the list of 700 references provides an invaluable resource for those wanting to explore the topic further.

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