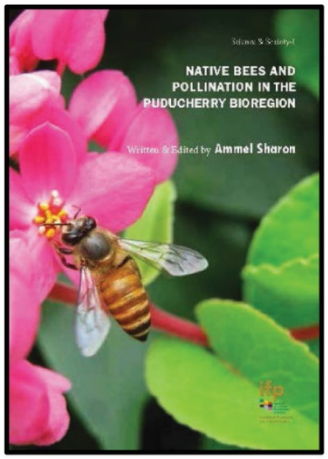

Native Bees and Pollination in the Puducherry Bioregion. Ammel Sharon, Krishnamurthy Anupama, Hélène Guetat-Bernard, Srinivasan Prasad, Jean Lazar, Varadharajan Amuthavalluvan, Ayyanar Indhu, Shakti Narpavi, Julien Andrieu, Frédéric Landy and Nicola Gallai. The *Institut Français de Pondichéry*, 11 Saint Louis Street, Puducherry. 2022. 55 pages. Price: Rs 200; €10. e-Copies are freely downloadable from https://www.ifpindia.org/bookstore/ss1/.

Flowers are natural wonders. They amaze us – humans – by their tantalizing fragrance (e.g. *Hedychium coronarium*, Zingiberaceae, an Eastern Himalayan native) and stunning wholeness (e.g. *Saussurea obvallata*, Asteraceae, an Alpine Himalayan meadow native)[1]. Pollination, the mechanism of pollen transfer to the stigma resulting in the fertilization of the female gamete and seed setting[2], often involves an intermediary, say, insects or wind. Pollinating insects have been scientifically pursued since the 18th century. For example, Carl Linnaeus[3] described *Macroglossum stellatarum* (Lepidoptera: Sphingidae) in 1759. Today, we know it is a stylish pollinator of some Eurasian Rubiaceae. Pioneering the study of plant sexuality, Christian Konrad Sprengel (1750–1816) clarified that the central function of flowers is to 'attract' insects. He proposed that Nature favours cross-pollination based on entomophily observed in *Salvia* (Lamiaceae)[4]. *Salvia* pollination by the Hymenoptera (e.g. Apidae, Halictidae, Megachilidae and Xylocopidae) is elegantly engineered by a 'staminal lever mechanism'[5]. *Salvia* pollination is a fascinating example to explain co-evolution. Sprengel's term 'cross-pollination' was later recognized as 'pollination syndrome'[6]. Today, we have a wider and deeper understanding of entomophily. We know that even species of the Sciaroidea (Diptera) are pollinators[7]. We know that insect vision differs from that of humans; they perceive colours differently, and their power of olfaction is extraordinary. Also, pollinators get a variety of floral rewards for affecting pollination. We are getting to know the subtler patterns of interactions in entomophily thanks to highly sophisticated molecular–ecological tools and methods[8].

This book has been published by *Institut Français de Pondichéry* (IFP), under a new series titled 'Science & Society'. The title, incidentally, speaks of the re-imagined vision of the IFP – to take science to ordinary people. The other reinforcing element is that a Tamil edition of this book has been concurrently published (https://www.ifpindia.org/bookstore/ss1_tam/), which powerfully relays the commitment of IFP to the local people and their right to know quality science.

The IFP is a grand, 67-year-old research institution in India, well-known to professionals. It works quietly – with no fanfare – tucked away in a peaceful quarter of the seaside Puducherry, powered by Indian and French scientists (ingeniously designated as '*les ingénieurs*'), who dig deep into India's society, culture and civilization. To interpret the country's complex social fabric meaningfully, the IFP inquires into India's ecology, propelled by an understanding that an ancient and highly diverse culture is shaped by its biophysical environment. The IFP will turn 70 soon. Therefore, I would like to offer my homage to the Institute, before reviewing this book. The IFP was established under the Treaty of Cession of French Territories in India in March 1955 because of the vision of the then Prime Minister, Jawaharlal Nehru (Figure 1). It has been zealously pursuing Indian culture and society using scientific methods on the themes like indology, ecology, social sciences and the recently established geomatics. IFP's flagship 'transversal' programme is a matrix of interdepartmental cooperation that inquires concepts such as Indian forests, coasts and labour. IFP is also enabled by human effort. Therefore, I cannot avoid referring to a few celebrated names that empowered the institute: Ganapathi Thanikaimoni (1938–1986; palynology), Vispy Minocher Meher-Homji (currently in Mumbai; bioclimatology and plant geography), François Gros (1933–2021; Tamil language and literature), Nãvalpãkkam Rãmãnûja Ŧãtçãriyãr (1928–2017, Samskrit language and literature) and southern Indian historians Yéllavã Subbarayulu (currently in Puducherry) and Noburu Karashima (1933–2015).

This book refers to the inter-relationships between pollinating Apioidea ('bees'; Insecta: Hymenoptera) and the sustainability of biodiversity and farming in Puducherry

Figure 1. Jawaharlal Nehru, Prime Minister of India, visiting the IFP (1955). Source: https://www.ifpindia.org/organisation/

and its neighbourhood. It is the outcome of a project, 'Protection of pollinators and agroecological transitions in Pondicherry region', a multidisciplinary research exercise executed between January 2021 and March 2022. This project was funded by CNRS (*Centre national de la recherche scientifique*, Paris, France) with supplementary funding from the National Bank for Agriculture & Rural Development (Mumbai) and the *Institut Français India* (Embassy of France, New Delhi). The details presented in this book refer to farming practices and consequent environmental changes, using pollinating Apioidea as indicators, seeking answers to the following questions: Are the Apioidea adapting to changes in climate and habitat? Do farmers and apiarists are clear about pollination that regulates plant reproduction? The findings are presented under the following sections: (1) The Puducherry bioregion, (2) What is pollination? (3) Let's talk about honeybees, (4) Bees in hives, (5) Humans and bees, and (6) How to help pollinators select crops and blooming seasons in Puducherry?

In chapter 1, the authors mention that Puducherry bioregion has gained 116,000 ha of woodland (*c.* 12% of the landscape), suffered a loss of 53,000 ha of woodland (*c.* 6%) in a few other parts and lost to built-up segments of 12,000 ha (*c.* 1%). This inference is illustrated using a newly generated composite overlay of two Landsat images originally produced by the US Geological Survey in 1988 and 2017 (p. 4). Based on this, the authors consider the Puducherry bioregion as a dynamic and rapidly changing landscape, primarily influenced by climate vagaries and human intervention. The intent of the book is delineated as follows (p. 6): 'In this book, we consider both and observe their worrying impact on pollinators, particularly honeybees. We also suggest concrete measures to ensure their well-being and ours', which is realistic.

Chapter 2 answers 'What is pollination?' In the first part it discusses the structure of flowers. The authors raise a provoking question: 'Why does all this variety in flowers matter?' In this context, they mention, in passing, how the variety in flowers matters in the context of pollination and pollinators. Their remark (p. 10): 'This behaviour or associative learning, …, encourages us to pay attention to the small, crucial and co-dependent ways of biological life, and the consequences of environmental disruption' is thought-provoking. However, I felt this remark should have been worded simply because of the intended popular readership. Their reference to 'associative learning' in insects (the Apidae, in particular) necessitates a simpler but more detailed explanation because it is a key hymenopteran behaviour. Social Hymenoptera transmit messages from accidental cues, on the one hand, to deliberately orchestrated signals on the other. Flower colour is a vital cue 'smartly' picked up by the Hymenoptera; they recognize nectar by their 'super' specialized visual and olfactory capacities[9]. Associative learning is a previously experienced stimulus that is 'stored' in memory by the Hymenoptera for retrieval and use in their future behaviour[10]. Refer to 'proboscis extension response' in *Apis mellifera* (Hymenoptera: Apidae)[11]. Learning and associative learning are unique traits of the Hymenoptera, making them the 'superstars' of the Insecta and probably the entire Animalia. The second part, 'Are pollinators declining?' (pp. 15–16) reports the interviews conducted by the authors with local farmers. The respondents mention that, 'the bees have become less numerous', although 'than when?' lingered in me. The authors hint at 'rapid changes in land use', 'injudicious application of insecticides', 'quick and abrupt changes in climate patterns' and 'introduced honeybees (e.g. *A. mellifera*)' as the reasons explaining the farmers' comments. With regard to *A. mellifera* population in India, the authors state (p. 16): '…in some parts of North India that its (i.e. *A. mellifera*) aggressive hunger might be crowding out local pollinators', which struck a chord in me. This remark makes sense because exotic bees have been empirically shown to affect native bee populations[12]. The section 'What's in it for farmers?' includes relevant remarks to farmers, in the context of pollinating insects to crops, such as *Anacardium occidentale*, *Arachis hypogaea*, species of *Gossypium*, *Eleusine coracana*, *Pennisetum glaucum*, *Sesamum indicum*, *Ricinus communis*, and species of *Musa*, widely cultivated in the Puducherry region. The succeeding section, 'Economic value of insect pollinators', speaks of the economic evaluation of pollinators. It should provide elementary economic information to farmers.

Chapter 3, 'Let's talk about honeybees', includes basic information about the body design of honeybees, activity in a honeybee colony, and a list of honeybee species that commonly occur in Tamil Nadu and Puducherry, supplemented by good-quality images. I was not sure whether the readers would precisely understand the sentence, 'It (i.e. taxa of the Apidae) has two big compound eyes, one on each side and three small, simple eyes in front'. A neat line sketch of the frontal view of the head of *A. cerana*, for example, showing the compound eyes and the small, simple eyes (ocelli), would be helpful. Chapter 4, 'Bees in hives', speaks of the variety of hives from historical to modern times, again amply supplemented with quality digital images. Chapter 5, 'Humans and bees', summarises the dialogues the authors had with the farmers. It includes a section 'Irular and bees' (note 1), which interested me, wherein one interviewee comes out strongly on the impact of changes to farming practices consequent to the Green Revolution launched in India in the 1960s. Another interviewee shares his (identified as a male) strong opinion favouring organic-farming methods, which would, in turn, encourage pollinating Hymenoptera. The narrative by Antony (p. 42) is an eye-opener. Based on qualitative details, this section reveals a few pivotal points that the local Government authorities need to take cognizance of and investigate these claims rigorously and impartially to make the necessary changes in supporting the farming community and reinstating hope in them. The last chapter, 'Select crops and blooming seasons of plants foraged by bees in Puducherry', includes many useful tips and hints to farmers of Tamil Nadu and Puducherry, which will be relevant to farmers throughout India.

Given that this book is intended for popular readers, I am convinced it will serve its purpose. I would expect that the IFP would take my suggestions – all minor – into cognizance when bringing out the next edition by incorporating the changes. Overall, this 'small' book executed through cooperation among 11 people left me feeling good. The words of Teresa Amabile and Steven Kramer, '…small but consistent steps forward, shared by many people, can accumulate into excellent execution, …' (The power of small wins. *Harvard Business Review*, 2011, https://hbr.org/2011/05/the-power-of-small-wins; re-accessed on 5 January 2023) reverberated in me.

Notes

1. The Irular community lives harmoniously with its immediate flora and fauna in Tamil Nadu and Puducherry. However, unfortunately, its rich knowledge of Nature and eventual skills are being rapidly lost in a globalized, homogeneous world because of advancing technology and intensified economic

thinking. Importantly, the Irulars lead a contented life. In grandiloquent terms, 'they live sustainably, utilizing bioresources within their means'.

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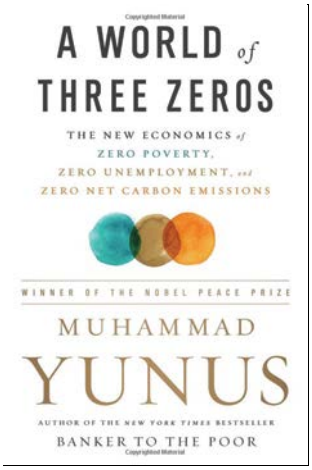

A World of Three Zeros: The New Economics of Zero Poverty, Zero Unemployment, and Zero Net Carbon Emissions. Muhammad Yunus. Hachette India. 2018 (available in Hardcover, Paperback and eBook): 288 pages (Hardcover). Price: US$ 28, ISBN: 978-93-5195-205-3.

Nobel laureate Muhammad Yunus is on a mission to make the world an inclusive and sustainable place for every stratum of society. His success in the social business of microcredit has impacted approximately 300 million people worldwide. In this book, he shares his experiences with his social enterprise 'Grameen Bank' and professes that the global crisis of poverty, unemployment and carbon emissions can be addressed using the tool of social business. He proposes a new set of lenses for reimagining the world's economic engine, where everyone can realize his/her creative potential.

Almost all reformist debates in the 21st century begin with the drawbacks of modern capitalism. The author also begins with some economic data and reports on the global rise in economic inequality, claiming that it causes social upheaval and is a source of conflict between nations. He mentions that this is not just a problem in developing countries but also in developed countries where wealth concentration among the counted number of rich is greater than the millions of people at the bottom of the economic pyramid. The author cites Adam Smith's invisible hand and claims that while it has stimulated innovation and economic growth, it has failed to benefit everyone. He asserts that while charity and welfare programmes may be well-intended efforts to mitigate the damage caused by capitalism, the only permanent solution is a change in the system itself. Since inequality and climate change are due to human activities, he optimistically professes that humans could address these issues only with new economic thinking. While quoting the story of Grameen Bank, the author places emphasis on the exclusion of poor people from the financial system and introduces readers to the working model of microfinance and microcredit. In the concluding remarks of the first part, while defining the word 'social business', he says that contrary to traditional businesses, whose sole purpose is profit maximization, social businesses offer new economic thinking by keeping human problems as the sole purpose of businesses.

Beginning the second section of the book with suggested ways to end poverty, the author mentions that redesigning the international framework, rather than a series of local or regional reforms, could solve the global food problem, which has been one of the impediments to the prosperity of poor people. He has also criticized the global semi-free trade, which is responsible for the surging oil and food prices. He has also mentioned some dysfunctional agricultural choices like feeding cattle rather than humans, resulting from increasing global meat consumption, responsible for making even basic foods expensive.

Youth unemployment has always been a major story for any nation. The author considers that the world's persistent unemployment is due to the long-held narrative that people are born to work for a limited number of companies and that our education system has been shaped to reflect this narrative, with young generations never being told that they have two career options: job creators or job seekers. He emphasizes the importance of simplifying a career in entrepreneurship by stating that anyone, regardless of nationality, creed, caste or colour, possesses entrepreneurial traits and can become an entrepreneur; however, people must be made aware of their creative potential.

Addressing global climate change and a vision of zero net carbon emissions, the author starts by mentioning the damages that unattuned resource usage has done. He opposes nuclear power generation anywhere in the world, stating the tragedies caused by nuclear power plants in places such as Chernobyl and Japan. He illustrates the potential of green tech social businesses to mitigate environmental damage using the example of Grameen Shakti, a pioneer of the renewable energy business that he has launched in Bangladesh. The author mentions that it is not only social businesses that can solve the global environmental problem