



The Forgotten Pollinators

Stephen L. Buchmann
and Gary Paul Nabhan

Illustrations by Paul Mirocha
Foreword by Edward O. Wilson

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*Forgotten Pollinators Campaign,
Arizona-Sonora Desert Museum*

WITH A FOREWORD BY EDWARD O. WILSON

ILLUSTRATIONS BY PAUL MIROCHA

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*To the entomologists and botanists from Steve's years
as a student: Phillip A. Adams, C. Eugene Jones, Jr.,
Robbin W. Thorp, Herbert G. Baker and Irene
Baker, and E. Gorton Linsley. May your pollinator
gardens flourish.*

*And to three scientist writers who have helped us
remember the links between agricultural fields and
the surrounding wildlands: Amadeo Rea, ethnozool-
ogist; Efraim Hernandez Xolocotzi, agroecologist;
and David Ehrenfeld, dean of conservation biologists.*

I tracked down my father, who had wandered a little distance from the garden and was sitting against a tree trunk. In his fingers he carefully stretched out something that looked like a wasp, still alive. It was as broad as my hand, and had a yellow “8” on each clear wing, as plain as if some careful school child or God had painted it there. My father looked like he’d just had a look down Main Street, Heaven.

He told me, “There aren’t any pollinators.”

“What?”

“No insects here, to pollinate the garden. Look at this thing. How would it know what to do with a Kentucky Wonder bean?”

I couldn’t know if he was right or wrong. I only faintly understood about pollination. I did know that the industrious bees did the most of it. “I guess we should have brought some bees over in our pockets too.”

He looked at me like I was his spanking newborn baby; as if he loved me terribly but the world would never be what any of us had hoped for. “Rae Ann, honey,” he said, “you can’t bring the bees. You might as well bring the whole world over here with you, and there’s no room for it.”

“I know.”

Barbara Kingsolver

TUCSON, ARIZONA

FOREWORD

Great truths are sometimes so enveloping and exist in such plain view as to be invisible. One of them is the dominance on the land of flowering plants and insects. In addition to their overwhelming biomass, nearly a quarter million species of plants and three-quarters of a million insects have been described by biologists to date, together composing a full two-thirds of all kinds of organisms known to exist on the planet. Other terrestrial and freshwater groups, from protozoans to vertebrates, pale by comparison.

The joint hegemony of these two great groups is not an accident. It is the result of coevolution, the process in natural selection during which species adapt to one another and thereby build rich ecosystems. The interaction between plants and insects has been going on a long time. It began over 100 million years ago with the origin of the flowering plants and accelerated with their ascendancy in the world's vegetation during the early Cenozoic era some 40 million years later. Much of their coevolution was mutualistic: Species—more often whole complexes of species—came to seal obligatory partnerships with their insect counterparts. Such relationships, construed broadly, are among the central topics of ecology. Ants, for example, among the most abundant of insects, spread the seeds of plants, protect them from herbivores, and enrich the soil in which they grow. Insect detritivores such as termites and woodboring beetles convert dead vegetation into nutrients that can be reabsorbed by the roots of living plants. And, as Stephen Buchmann and Gary Nabhan so clearly and evocatively remind us, a majority of flowering plants must have insects to reproduce.

There is a welded chain of causal events that leads directly to our species: if plants, including many food and forage crops, as well as

natural floras, must have insects to exist, then human beings must have insects to exist. And not just one or two kinds of insects, such as the friendly and lovable honeybees, but lots of insect species, vast numbers of them. The reason is that millions of years of coevolution have finely tuned the relations between particular plants and their special pollinators. The shapes and colors of the flowers, their scent, their location on the stalks, the season and daily schedule of their pollen and nectar offerings, as well as other qualities we admire but seldom understand, are adjusted precisely to attract particular species of insects; and those specialists in turn, whether beetles, butterflies, bees, or some other group, are genetically adapted to respond to certain kinds of flowers. In lesser numbers the same is true of the interactions between plants and species of birds, bats, and other vertebrates dependent on diets of pollen and nectar.

Nature, we learn, is kept productive and flexible by uncounted thousands of such partnerships. The connections are fragile, and we are reminded by melancholy case histories reviewed by Buchmann and Nabhan that when one partner is extinguished, the other is at the very least put at risk—and sometimes doomed, if it happens to be adapted to no other partner. No phenomenon in nature illustrates more vividly the principle that conservation measures must be directed at ecosystems, not just individual species. If the last pollinator species adapted to a plant is erased by pesticides, or habitat disturbance, the plant will soon follow. And as these and other populations decline or disappear, the consequences spread through the remainder of the food net, weakening other interspecific relationships.

Those unconcerned about the natural world, and I hope *their* numbers are dwindling by persuasion, will do well to consider the consequences for humanity of the decline of pollinator complexes. Eighty percent of the species of our food plants worldwide, we are informed, depend on pollination by animals, almost all of which are insects. One of every three mouthfuls of food we eat, and of the beverages we drink, are delivered to us roundabout by a volant bestiary of pollinators.

The evidence is overwhelming that wild pollinators are declining around the world. Most have already experienced a shrinking of range. Some have already suffered or face the imminent risk of total extinction. Their ranks are being thinned not just by habitat reduction and other familiar agents of impoverishment, but also by the disruption of

the delicate “biofabric” of interactions that bind ecosystems together. Humanity, for its own sake, must attend to the forgotten pollinators and their countless dependent plant species. In the following chapters Buchmann and Nabhan make a compelling case for more focused research on pollinator complexes and increased attention to their status as an integral part of future conservation planning and restoration ecology.

Edward O. Wilson

MUSEUM OF COMPARATIVE ZOOLOGY

HARVARD UNIVERSITY

ACKNOWLEDGMENTS

It has now been nearly five years since we brought together the first body of conservation scientists to address the dire consequences of having ignored plant/pollinator interactions in most discussions of biodiversity and agricultural stability. At a daylong symposium called "The Conservation of Mutualisms," we focused on the disrupted relationships between rare desert succulent plants and their pollinators, many of which have declined dramatically in abundance. The symposium's theme was considered important enough to attract cosponsorship from the IUCN Species Survival Commission, the International Organization for Succulent Plant Study, Bat Conservation International, and the Pew Scholars Program on Conservation and Environment. Hueblin, Inc., a distributor of products made from cultivated century plants—that is, tequila—helped underwrite travel for participants from three Latin American countries, out of its concern over the decline of wild century plants and their wild pollinators.

We are particularly grateful for the stimulus imparted by the participants in that first symposium, many of whom responded instantly to Steve's concept of "the forgotten pollinators." Many of them encouraged us to pursue this issue further: George Rabb, Ted Fleming, Vince Tepedino, Merlin Tuttle, Cathy Sahley, the late Maricela Sosa, Hector Arita, Abisai Garcia, Ted Anderson, Alberto Burquez, Luis Eguiarte, Robert Bye, Jr., among others. The editors of *Species* and *Conservation Biology* kindly printed highlights of that meeting in their journals, and these notices attracted additional responses from scientists around the world.

Since that time, we have had the benefit of financial and moral support from the Arizona-Sonora Desert Museum, the Wallace Genetic and Wallace Global Funds, the Geraldine R. Dodge Foundation, the Stocker Foundation, and Island Press. We are grateful for the collaboration of Charles Savitt, Barbara Dean, Barbara Youngblood, Lisa Magnino, Robert Wallace, Charlotte Fox, Scott McVay, and Victoria Shoemaker in seeing to it that this book is well integrated into a larger Forgotten Pollinators Campaign for enhanced public awareness and educational outreach. We thank our fellow writer/biologist and Tucson denizen, Barbara J. Kingsolver, for permission to quote her charming story about why you can't always bring the pollinators with you to newly established gardens.

Four people deserve special attention for blessing the campaign with their talents. Paul Mirocha's illustrations not only brighten the jacket illustration and pages within this book, but are a key element of the Forgotten Pollinators campaign's attempt to capture people's imaginations with the wonder and natural beauty and grace of pollinators worldwide. Mrill Ingram, our campaign coordinator, has given us valuable insights, advice, logistical support, and creative management skills since March 1995. David Hancocks, our museum's executive director, fully sanctioned the use of the museum's resources to fully explore the public interpretation of plant/animal interactions on the ground and through the media. In honoring us with a foreword, Edward O. Wilson, Pellegrino Professor of Science at Harvard University, has demonstrated that this topic should be an essential component of future discussions about global biodiversity and invertebrate conservation, causes he has so eloquently championed as a senior "ecostatesman" for decades.

We are also grateful to the campaign's board of advisers, informal consultants, and student interns: Robert Michael Pyle, Vince Tepedino, Peter Bernhardt, Judith Bronstein, Elizabeth Donnelly, Steve Walker, James Cane, Sergio Medellin, Phil Torchio, Beverly Rathke, Mark Dimmitt, Melody Allen, Merlin Tuttle, Andrew Matheson, Eva Crane, Nick Waser, Brien Meilleur, Peter Feinsinger, Gene Jones, Lucinda McDade, Bruce Pavlik, Steve Prchal, Michael Gregory, Carol Cochran, Cyndy Henzel, Rachel Levin, O. T. Kizer, Margaret McIntosh, Sarah Richardson. A special thanks to Cristina A. Bramley for tireless assis-

tance with typing and innumerable last-minute format changes and editing as the manuscript went from our often non-cross-pollinating DOS and Macintosh computers to the reviewers and editorial staff at Island Press. We extend a special thanks to Don Yoder for improving our manuscript with his impeccable copyediting skills, and to Christine McGowan and Bill LaDue at Island Press.

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We especially want to thank the first cohort of Desert-Alert volunteers (coordinated by Cynthia Henzel) from the Arizona-Sonora Desert Museum. Should you be interested in volunteering for fieldwork, working alongside professional ecologist mentors, on rare desert plants and their pollinators, call the Arizona-Sonora Desert Museum in Tucson and ask for the Desert-Alert field course schedule. Stephen Buchmann's electronic mail (E-mail) address is buchmann@ccit.arizona.edu. Recently we added an electronic mail address for our Forgotten Pollinators public awareness campaign at the Arizona-Sonora Desert Museum. Our address there is: fpollen@azstarnet.com. By the time you read this, that address should be an active "listserv" on the Internet for those interested in pollination biology and our Forgotten Pollinators Campaign at the Desert Museum. We look forward to hearing from you and hope you will join our efforts through the Forgotten Pollinators Campaign—you may also wish to experience our pollinator gardens and examine related exhibits through a personal visit to the Arizona-Sonora Desert Museum a few miles west of Tucson, Arizona.

The best times to see the wildflowers along with the birds and the bees are in March/April and again in July/September following our summer monsoons when the desert truly smells like rain.

A special thanks to Mahkdzir Mardan for introducing us to the world of giant honeybees in peninsular Malaysia. We are indebted to Salleh Mohd Noor ("Pak Teh") and his honey hunting family for sharing his traditional honey gathering experiences with us, along with his passion for preserving these lowland rainforests and their Tualang trees.

Finally, we wish to acknowledge the many botanists, zoologists, farmers, beekeepers, honey hunters, restoration ecologists, and naturalists who have never forgotten the importance of plants and their pollinators. This book is based lovingly on their work. Any factual errors, omissions, or misstatements remain entirely our own and are not necessarily the views of our respective institutions, collaborators, or affiliated environmental organizations. Nor do we endorse any products or services listed in the appendixes.

The
Forgotten

Pollinators

INTRODUCTION

Remembering the Pollinators

It is late in the fall—nearly winter solstice—but because the day is sunny, it is not too late to find a yellow and black bumblebee working one of the last blooms in our garden this year. It alights on a wandlike branch of a desert fairy duster, and comes under the spell of its brilliant flowers, a patch of brightness in a landscape otherwise gone to seed. The fairy duster's stamens are as red as a clown's nose, and the bumblebee clambers over, around, and through them in a manner that is anything but bumbling. It is there to gather nectar, a sweet liquid diet that is increasingly scarce at this time of year. And yet, from the flower's perspective, the bumblebee itself is a scarce resource; it has produced plenty of nectar and pollen, but until that creature landed in its midst, its own reproduction was in no way assured.

The brilliance and the showiness of flowers is but a visual reminder of the fact that pollinators are so often in scarce supply. It is worth their costly investments in advertising—petals serving as scented billboards—to attract insects to their midst. And not just any floral visitor will do; certain pollinators are more effective, and more allegiant, than others. The diversity of life in a place is not simply a random assortment of things; it is a fairly predictable set of organisms connected by certain ecological processes. Pollination services are among the most highly interactive processes involving both flowering plants and animals. When the pollinators foraging and nesting in wildland habitats provide pollination services to adjacent agricultural croplands, backyard gardens, or

orchards, we say that these agricultural landscapes have benefited from the services offered by surrounding natural communities.

During the Persian Gulf War in the arid Middle East, one of us was sent out into another desert—the Sonoran Desert—to observe animal competition for scarce resources. In this case, the scarcest resource of the season was not fossil fuel in the form of crude oil, but nectar, the highly refined fuel used by hummingbirds. Along a stretch of dry streambed hardly the size of a football field, Costa's hummingbirds had been in residence all winter long, but they were now being invaded by other migratory hummingbirds arriving from Mexico. Each clump of chuparosa bushes was heavily laden with blood-red flowers, and each floral patch became a defensible territory.

Just before dawn, the whiz and whirr of the hummers' wingbeats would begin, and continue well into the day. Each would gain a foothold over a particular bush by chasing away other birds, or even butterflies. Then it would hover and flick its tongue into a tubular flower full of nectar. One hummingbird would make its way around a bush, darting toward one flower, then zigzagging up to another, then more, until it caught sight of an adjacent shrub laden with blooms. It would feed upon the floral sugars of the adjacent shrub for a while, then stop to roost on a perch atop the highest branch, resting between feeding excursions. And yet the rests would never last long, for another hummingbird would enter the scene, and a high-speed aerial chase or "dog fight" would begin once again.

The relative barrenness of the surrounding Sonoran Desert, and its paucity of bird life, underscores an essential but often unrecognized feature of that patch of chuparosa bushes. For migratory nectar feeders, it is an oasis in the desert, a nutrient-rich island in a sea of no-calorie sand. For the chuparosa bushes, hummingbirds are not the only pollinators available, but they are among the most allegiant and efficient ones; they seldom "waste" the chuparosa pollen sticking to their beaks and feathers on other kinds of flowering plants, as honeybees often do. Nor do the diminutive frenetic birds slit the floral throats of the chuparosa blossoms as do the nectar-robbing black giant desert carpenter bees, whose tongues are too short for legitimate front door entry. Eliminate all hummingbirds from this oasis, and the density of shrubs—even their very spacing—would no doubt change.

This is a book about one of the worlds' most vital processes linking plants and animals—a process that not only keeps us fed and clothed but feeds our domesticated animals and their wild cousins as well. Even more important, it keeps the verdant world, that delicate film of life around us known as the biosphere, running with endless cycles, feedback loops, and checks and balances. That ecological process is *pollination*—linking plants and animals. In fact, the range of animals active in moving pollen from one plant to another is bewildering in its diversity. In turn, many families of seed plants have diversified into their present array of species under the evolutionary influence of the myriad animal pollinators on this planet. And all these transactions between pollen-producing plants and pollen-moving animals make up a significant portion of what biological scientists are now calling *biodiversity*.

And yet, as the twentieth century nears its close, most North Americans lack any mental *image* for this “biological diversity” that scientists deem so important. Although this recently coined word has been splattered across headlines in innumerable newspapers, magazines, and radio and television broadcasts during the past decade, poll after poll confirms that few Americans understand (or care?) what ecologists and other scientists actually mean by biodiversity. Similar polls indicate that few Americans know that pollen plays a role in plant reproduction, for most of them regard it as a nuisance, an allergenic dust. And fewer still seem to know that the current rate of species loss constitutes a biodiversity crisis of unprecedented proportions. Scientists have barraged the public with mind-numbing numbers, species/area curves, equations, doomsday predictions. But they often fail to convey a sense of just how much we all depend on this flamboyant diversity of lifeforms, or how it is responsible for what we eat, drink, and wear. When people do finally hear of the biodiversity crisis, too often it sounds as though it is happening far away, in some exotic rainforest, and not in our own suburban backyards, our neighborhoods, our vegetable gardens, our agricultural croplands, in our supermarket produce department or at the local fast food burger, taco, or pizza joint.

But the truth of the matter is this: a pollination crisis has now become obvious in rural as well as urban settings not only in North America but on other continents as well. It is not merely an issue for rainforest activists, vegetarians, or beekeepers. It is an issue that can help us find