Introduction

CHAPTER 1

OPEN ANY BOOK about biology and you will see that interactions are central to the science of life. Mutualism, parasitism, symbiosis, cooperation, collaboration, association: these words describe how organisms interact with one another, in ways that grade from intimate relationships such as parasitism and symbiosis through to looser associations. Perhaps only rarely do species have absolutely no interactions at any stage of their life-cycles, even if that interaction comes only indirectly, through other members of the web of life. Interaction is therefore a ubiquitous feature of the business of life, from the cell-bound mitochondria that once were free-living bacteria, to the tapeworms that gnaw at the guts of their hosts, to ants which farm aphids to gather plant sugars for food.

Open a different book and the topic is human society, with its history, its achievements and injustices, its social structures, its political systems and power struggles, and its economics. Here is interaction of a different kind, one human with another, one social group or community or country vying with another, down the ages; the tense game of balancing mutual cooperation and need against the tendency to dominate, override, eliminate.

Where do these two domains meet? The answer is nowhere; or at least nowhere in terms of academic discipline. Biology is traditionally concerned with how life is organized, how it develops and evolves at both the individual and the population levels. Human society is the sphere of the humanities and social sciences, and tends to deal with humanity apart from other life; in general, history and sociology have humans at their centres. Yet is this separation not weird? The domains of biology and the humanities cannot remain separate; indeed they are already not doing so, rather it is the academic disciplines which lag behind real life. As we look forward we see the human population threatening increasingly to extinguish other life-forms over the coming decades. Yet, paradoxically we will rely more and more upon (some of) these species, as food security becomes less certain and the means of feeding the 9.2 billion people projected by 2050 seems ever more challenging. In reality the spheres of biology and the humanities overlap in fundamental ways. To understand and improve how humans interact with other organisms, and how the raw materials of the Earth are utilized and conserved, we must see our historical, humanistic selves as part of biology in the widest sense. In a complementary fashion, we must understand how other organisms and their societies are organized and will be organized in the future; and this is at least partly a function of where they have come from, their histories on a human-dominated planet.

This book aims to describe biological diversity from a new perspective. Most biodiversity books treat the organisms, the domains of life, as topics largely

Biological Diversity: Exploiters and Exploited, First Edition. Paul Hatcher and Nick Battey.

separate from humans—or with humans as rather distant onlookers. We take the opposite approach, attempting to capture the diversity of life with the human connections as integral to it. We revel in the history of interaction between one organism and another, with humans as central players, fashioning and manipulating other species for their own ends. Yet we also see organisms exploiting humans as part of the web of potential. Thus we divide our subjects roughly into exploited and exploiters, aware that, depending on where one is standing, exploiter can be exploited and vice versa. The book is therefore a selection of topics from which we believe the reader can discover general principles about humans and our companion species seeking to sustain themselves here on Earth.

Our choice of organisms and the systems in which they live may seem arbitrary; it is probably idiosyncratic. We talk about things we think are interesting, and this is inevitably a reflection of our background, the students we have taught (their feedback has been crucial), and aspects of the subject of biological interactions we consider important. The first ten chapters deal with animals and plants which seem to us to give more than they take. This is not a precise, scientific determination, but rather an initial judgement that these organisms have been heavily exploited by humans or/and by other species. Thus the *Sargassum* seaweed, floating in giant rafts in the warmer regions of the North Atlantic Ocean, harbours a unique and bizarre fauna that has survived by adapting to life on and around the weed. Cephalopods have extraordinary life-cycles and dispersal around the oceans, and humans have developed sophisticated ways of tracking and catching commercially important members of the group, such as squid. We have also become fascinated with our largest invertebrates, the giant squids. Bee society is one that has grown up in close conjunction with humans; we discuss the factors which lead bee populations in many parts of the world to be either threatened or dangerous, both suggesting an interaction with humans which is not in balance. The silk moth is an organism of intricate beauty, requiring detailed knowledge of its biology as well as particular economic conditions for successful silk cultivation. This has meant that numerous attempts to export the technology around the world have failed; yet silk is a product valued especially, perhaps, because of its biological rather than synthetic origin.

Sugar cane carries on its sharp leaves and sucrose-rich stems a historical burden of slavery which, while well-known, is not very often discussed in relation to the peculiar physiology and agronomy of the crop. Legumes are members of a plant family that have been particularly exploited by humans because of their valuable seed protein and oil; their ability to grow in marginal lands; and for the nitrogen with which they enrich the soil through their symbiotic association with the bacterium *Rhizobium*. The grapevine gives us wine. The development of its cultivation and production technologies (particularly in the New World) is an object lesson in how to exploit to the maximum what is basically a pretty unpromising plant. Salmon is a fish whose complex life-cycle makes it vulnerable at many different steps to the vicissitudes of a human-dominated environment. Yet it has been farmed very successfully, even though this is far distant from the wild salmon pursuing its strange instincts to occupy both the marine and the freshwater waters of the world. There is an unavoidable pathos associated with the fate of many organisms whose natural behaviour and life history we marvel at, while we destroy them. Then we discuss the oak, great bastion of the navy in times gone by, the symbolic heart of many countries and societies around the world, with a

special history of exploitation by humans and by a rich variety of animal types. The rabbit is the final exploited organism: both exploiter and exploited, when we had grown tired of it we unleashed upon it the terrible disease myxomatosis.

Then we turn to the exploiters. Mosquitoes, and the malarial plasmodium parasite they carry, are a major target for world health organizations. Total malaria eradication by 2015 is the stated objective, and we examine the biology behind the problem and explore the difficulties associated with meeting this challenge. In the marine environment, the humble barnacle, along with other encrusting organisms, causes serious problems for humans in ships. The solutions to these will increasingly require an understanding of the life-cycle and behaviour of these biofoulers. Back on dry land, bracken is an example of a plant that has changed from being a useful resource, exploited in the manufacture of soap and glass, and for thatch and bedding, to a problematic weed that invades disused land, out-competing other species, and creating a potential health hazard because of its toxic and carcinogenic properties. This example shows how in the course of a few hundred years an exploited resource can itself become the exploiter. Locusts, on the other hand, have been a ravaging exploiter of epic proportions since biblical times. They are still a serious problem, particularly in Africa, and we discuss the fascinating biology of these insects and the way this knowledge can be employed in attempts to predict and control locust plagues. In the chapter on plague we consider modern bubonic plague, which erupted in the nineteenth century, left a legacy of disease foci throughout the world, and has since been exploited as a bioweapon. We also explore the assumption that this was the same plague as the Black Death, which killed up to a third of the population of Europe in the mid fourteenth century.

Red kites show how an organism with a largely unchanging behaviour pattern has, over the past 500 years in Europe, changed its interaction with human society: from valued scavenger and urban waste remover, to pest, to object of conservation focus. Mistletoes are parasitic plants, so there is apparently no question of their status; they exploit other plants for both resource (photosynthates) and habitat (attaching to and sometimes living entirely within their hosts). But recent research has emphasized how mistletoes are actually key members of plant and animal communities, having evolved close associations with birds, mammals and their host plants. There is also evidence that they enrich their habitats disproportionately to their abundance. All in all, while sometimes a significant pest, they are in many cases as much exploited as exploiter, to be valued as mutualists rather than disparaged as parasites. Wolves are creatures with deep psychological ties to humans. We are not sure whether to value or fear them, and they are much misunderstood, their sophisticated sociology perhaps making them uncomfortable reminders of our own animal natures. We arrive at the present day with a human society uncertain as to whether to preserve or eliminate the wolf; but is that the real wolf, or the one we imagine?

We recognize the danger of our approach. We cover a lot of ground, and we have aimed to provide accurate, detailed and contemporary, yet accessible, accounts of our subjects. We have, however, wanted to avoid becoming bogged down in the minutiae. To this end, we give hints for further reading, with references: either reviews or books that expand upon what we talk about, or key papers that have advanced the area. Our main intention has been to avoid cluttering up the text with a rash of citations. Boxes are used to expand on topics of interest, and those that lead on from the main subject of each chapter. Finally, in

relation to format, it is not necessary to read the book in any particular order, and we would encourage readers to dip in and out as time and inclination allow. Each chapter is self-contained, although we have ensured that links are made to other chapters wherever possible.

We have been fortunate to be able to work closely with Steven Appleby on his illustrations. The mysterious chemistry of Steven's brain has allowed him, for each chapter, to capture an essence from amongst our cascade of facts. This process of artistic distillation from biology has created an unusual dimension to our project: the concept of exploiters and exploited has been realized via the world of Steven Appleby, and so has, for us at least, become very distinctly etched.

We await the specialists and their criticisms, but we have been heartened by many of the supportive and instructive comments we have had from specialists during the reviewing process. Ultimately, it's a matter of judgement, getting the balance right for our intended audiences: biology undergraduate students, higher level school students, and anyone interested in the world around them and how human beings interact with it. In the end, we believe that the end we seek—understanding, through a broad and detailed picture—justifies our means. We hope you will agree.