The Glasgow Naturalist (2022) Volume 27, Part 4, 86-93

Book Reviews

The Inside Out of Flies

Erica McAlister
Natural History Museum, London, 2020. 256 pages, hardback with numerous colour photographs, line drawings and graphics. ISBN 9780565094898. £14.99

This is a most interesting book containing a vast number of facts presented in a broadly popular science manner. It follows the author's earlier prize-winning *The Secret Life of Flies*, also produced by the Natural History Museum, London. It continues her mission to inform readers of the extraordinary variety of form, life-style and diversity of the Diptera. Compared with more familiar insects, they have not only received less attention but suffer also from a negative profile, varying from being a bit of a nuisance to carriers of many of the world's deadliest diseases. This is balanced by their useful roles as pollinators and miniature waste disposal units. The vast majority of fly species, of which there are currently estimated to be 160,000, are neither good nor bad from an anthropocentric perspective. They can all provide information to ponder or simply admire.

The main chapters are devoted to a separate body part - heads, legs, wings, abdomens, antennae, etc., in a kind of entomological beauty contest. There is indeed considerable attractiveness and an occasional element of weirdness in the images chosen. The author explains that all the structures result from evolutionary processes, the products of selective pressures, and each has a purpose. They can be explained in terms of their functional morphology and witnessed by observing behaviour in the living insect. A welcome frankness is provided by admissions to not knowing why some are the way they are, awaiting future investigation.

This might make the book seem rather earnest but it is written in a light accessible style. To deal with the scientific background to the various chapters, the sources are not given in an academic manner. A name check and date for the latest research in the text can sometimes (though not always) be found in the reading list at the end. The interesting work on the appearance of flies' wings under ultraviolet light on p. 185 is not credited to the researchers in the text or caption, although the reference can be found hidden in the picture credits on the last page of the book. But, it's better to just read the text and not worry about who first discovered all the various phenomena.

There is a considerable sprinkling of errors, not all typographical. These show signs of hasty work by a copy editor and perhaps having to meet the annual publishers' deadline for the Christmas market was a factor. For example, the nice photograph of the piercing mouthparts of the stable fly, p. 114, has its caption copied into that of the more typical muscid spongy apparatus, p. 132. The photograph of eggs of a blowfly on p. 20 is labelled "maggots". Slightly confusing is a paragraph, p. 273, on the enlarged antennae seen only in males in some species (and so explained as sexual dimorphism linked to mating behaviour) repeated verbatim, p. 274, following a statement on its occurrence in both sexes in a few other flies, which is not so explicable. The caption for the house fly (*Musca domestica*) painting on p. 7 contains a word that does not exist, "*labiisl*", supposedly quoted from its description by Linnaeus in 1758. This is an example of using a mistranscribed text from the internet, something modern authors need to be wary of. The original source has "*labiis*", a word that does exist in Latin and the quote is actually for the genus *Musca*, not the species *M. domestica*. Later, p. 10, Linnaeus is credited with introducing mouthparts into his higher classificatory divisions but in fact it was his star pupil Fabricius who did this, enthusiastically developing his master's great work.

This reviewer has a long-standing interest in Diptera and, despite trying, could not "unlearn" sufficiently to be able to judge how successful the book might be in encouraging an interest in flies. There are no fly larvae with thoracic legs, unlike beetles in which some groups do and some do not, so as when and how did this defining characteristic of Diptera arise in evolutionary history? The book does not mention this absence of feature in such terms. The commonly held view can be queried (p. 192) that cranefly legs are deciduous (= autotomous) and so have an escape mechanism akin to lizards shedding their tails. There is no doubt that craneflies lose legs, accidents do happen, and they are often seen flying about with fewer than six. Some research has shown that they cannot readily release themselves when a leg is trapped (Nentwig, 1982). The ramifications of this cannot be pursued here and claims that craneflies have an evolved weakness in the base of the legs to allow them to escape, if it is actually true, would have to be reconciled with real-life observations.

The publisher's blurb "At every juncture she uncovers unique and surprising science lessons encapsulated in the form and function of the humble fly" is readily endorsed by this reviewer. In writing *The Inside Out of Flies* Erica McAlister will encourage more naturalists to engage with these insects. As well as setting out science lessons to be absorbed, she poses questions that seek answers. Following the previous title, *The Secret Life of Flies*, this book should be successful and is recommended for adding to the naturalist's library.

REFERENCE

Nentwig, W. (1982). Why do only certain insects escape from a spider's web. *Oecologia* 53, 412-417.

E. Geoffrey Hancock

Entangled Life

Merlin Sheldrake
The Bodley Head, London, 2020. 358 pages, hardback with colour illustrations and line drawings. ISBN 9781847925190.
£20.00

Entangled Life is an extraordinary book with an ambitious remit to explain "How Fungi make our worlds, change our minds, and shape our futures". It examines and illustrates the role of fungi at many levels, e.g. mutualism with algae as in lichens; symbiosis, past and present with plants in the ecosystem; interactions with the animal kingdom, including humans. Although there is much detailed and up to date scientific information, it is written with a touch that is light, anecdotal and almost journalistic. This, surely, must widen the readership and, indeed, the book appears to have been selling out! For the more academic reader, there are 100 pages of notes, bibliography and index, allowing a follow-up of points of special interest. This allows the main text to flow well within each story line.

The author, although only 33 at the time of publication (2020), is well equipped to take us on this journey. He has a Ph.D. in tropical ecology from Cambridge which followed a pre-doctorate in ecological studies in Panama at the Smithsonian Institution, U.S.A. This allowed him to interact with an older generation of mycologists and fungal ecologists to whom he gives due respect in the text.

The introductory chapter, almost a book in itself, fills out background information about life-styles and life-cycles of fungi, particularly ectotrophic mycorrhizal fungi. The symbiosis of fungi and algae in lichens, the interaction of fungal hyphae and mycelial networks with plant roots in the soil, and the amazing battery of biochemical ability possessed by fungi are all examined. Subsequent chapters fill out on these topics.

The first of these examines the "lure" of fungi. Fungi produce smells. These interact with the rest of the biological world from bacteria to plant roots, nematodes, and the noses of vertebrates. The mutual and detrimental aspects of these relationships are examined along with detail of mycelial growth. Illustrations are delightfully made throughout with ink made from *Coprinus* toadstools. These concepts are followed up in "living labyrinths". Do fungi figure things out? This looks at the pathways and networks of fungal hyphae, and their interactions with the environment and each other. Examining the properties of the transfer of substances is difficult but the author reveals some extraordinary results confirming the extent and complexity of fungal networks. "The Intimacy of Strangers" follows on from this, taking an in-depth look at everything to do with lichens. Recent research is detailed and quite fascinating. Lichens are little complex biospheres with survival and ecological properties to astonish. Horizontal DNA acquisition is looked at here.

We move on to rather a quirky chapter "Mycelial Minds". Quite a number of fungi produce psilocybin and related compounds. The effects of one of these, LSD, on the human mind is examined, but we are grounded again by fascinating facts, this time, relating to the fungus *Ophiocordyceps unilateralis*, which reacts with carpenter ants. Other examples are given including a fungus which uses a virus to infect insects and renders them a consumable host to the fungus. The historic use of "magic mushrooms" is traced, although the conclusion is that the insect interaction is the likely evolutionary winner from a fungal perspective.

The next two chapters were my personal favourites. The first, "Before Roots", traces the progression of plant life from water to dry land. The interactions between green algae, photosynthetic bacteria and fungi appear to have made the colonisation of land possible. Lichens are one type of interaction, but 90% of land plants have a symbiotic association with fungi. The trading balance between fungi supplying water plus minerals and land plants supplying carbon plus lipids is discussed in terms of geological timescales and the perspective of carbon dioxide levels in the ocean and atmosphere. Trees seem to be one of the evolutionary outcomes made possible by mycorrhizal relationships. The results of modern radioactive tracing and DNA analysis are discussed and the knock-on effects for agriculture, horticulture and forestry are examined. This follows on to "Wood Wide Webs", a title from a phrase coined as understanding of the connectivity within the forest and woodland habitats began to be appreciated. Non-photosynthetic plants are described and their connections via mycorrhizal fungi to green plants. The general connectivity within the soil is far from simple. The role of viruses, bacteria, fungal networks and roots is discussed in terms of multiple connections, flow rates and general balance – all unseen by the overground observer. Lab experiments can be done, but who gains what in woodland ecology? This is seriously tricky to assess. Dr Sheldrake gives full credit to those grappling with these issues and gives a good analysis of experimental process and progress.

We now look at rotters in "Radical Mycology". We are informed that trees represent 60% of living biomass. Lignin is a tough, complex material and fungi, mainly white rotters, are the main recycling force. The biochemical adaptabilities of fungi are prodigious; cigarette butts, TNT, oil spillages - you name it, fungi can rot it. This may be the answer to breaking down plastics. Indeed, we are informed that fungal mycelia may also replace plastic. Companies in the U.S.A. are making all sorts products with mycelium from common wood-rotting fungi such as turkey tail. The next chair you buy from Ikea might be made from mycelium and packaged with mycelium. The future may be fungus, treated, of course. It wouldn't do to be picking oyster fungus off the table leg.

There are several topics in this book that I haven't detailed, for example home brewing and DNA stirring up fungal taxonomy. These are looked at again in the final chapters, "Making sense of Fungi" and "Epilogue". In addition, these chapters examine cultural attitudes to

fungi and are substantially philosophical and reflective in content.

There is so much information in *Entangled Life*. It is true to its title. Life on earth is truly entangled. Reading this book meant a lot to me. My own Ph.D., a lifetime ago, was on mycology - fungal volatiles. This made me fully appreciate what an excellent collation and synthesis of old and new material Merlin Sheldrake has accomplished. It has been hard to locate recent research gathered in such an encompassing fashion. I feel it does, however, cater for a wide readership, not just a fungiphile like me. Not an easy achievement. It is assuredly a most thought- provoking and educative book and, yes, I just had to have my own copy to reread and follow up on all these innovative ideas.

Alison Moss

What is a Bird? An exploration of Anatomy, Physiology, Behaviour and Ecology

Tony D. Williams (Editor)
Princeton University Press, 2020. 368 pages, hardback with colour illustrations. ISBN 9780691200163.
£30.00.

My old professor used to say that defining a mammal was easy – "they're warm, they're hairy and they smell"- but defining a bird was more difficult. Flying and laying eggs obviously cover far too many other creatures; even having feathers seems no longer exclusive. Only a number of traits in combination will answer the question posed by the title, so the value of this large format, profusely-illustrated volume - part coffee-table book and part encyclopaedia - really lies with the subtitle.

Six authors from the U.S.A. and Canada have contributed 10 chapters. The first is a general overview of birds and bird biology by the editor; it forms a brief trailer to the topics that will be covered in more depth within the book and also includes some evolution and taxonomy. The second is devoted largely to feathers but with a nod to the unfeathered parts of the bird such as the beak, claws and bare skin. Feather types and distribution are covered, as well as the function of feathers in flight and display; there is considerable attention paid to feather colouring, including how factors such as sunlight can radically change a bird's appearance, and how different colours predominate in (e.g.) birds using the jungle floor as opposed to those in the canopy. Cleaning, moulting and replacement are briefly reviewed. Chapter 3 is devoted to bones, muscle and brain. Coverage of the skeleton is rather short and the reader might well ask if bones are modified for different life-styles (the size of the sternum in relation to the degree of aerial habit; the skull and the concussive effects of woodpecker-ing). Muscles are restricted to the flight muscles and the muscles of the syrinx, while the section on the brain chiefly deals with special senses with some space given over to sex and seasonal differences in the brain. Chapter 4 (entitled "Physiology") is a rapid grand tour of other body systems including the urinary, respiratory, circulatory, immune, alimentary, excretory and endocrine systems.

The next five chapters depart from the "structure and function" theme and deal with various key behaviours and ecology. Chapter 5 ("Getting around") deals with the mechanics of flight and the required high rate of metabolism, as well as flightlessness and swimming. It also touches on behaviours such as flocking, formation flying, flight displays and sleeping. Some of this is expanded in Chapter 6 "(Migration and Navigation") which looks at migration patterns, the cues that migrants use and the physiological demands and risks of migration; it ends with some often-neglected behaviours such as prospecting, dispersal and irruptions. Chapter 7 ("Food and Foraging") deals with the wide range of bird diets, including insects, fish, carrion, fruit and nectar through to blood, leaves and mineral-rich soil. It also considers how birds find their food source, including smell and echolocation, and behavioural issues such as piracy, tool use and hoarding. Chapter 8 ("Social behaviour and communication") deals with mating systems, social dynamics, birdsong and problem solving. Chapter 9 ("Reproduction") covers a wide range of topics including seasonality and cycles, territoriality, nesting, eggs, incubation and parental care.

Finally, Chapter 10 ("Human dimensions") contains many diverse topics, such as birds in myth, symbolism, art and fashion - at the Feather Market in Port Elizabeth, South Africa, I once learned that ostrich-feather adornments for ladies went out of fashion because the motor car had less headroom than the carriage. Birds not only inspire the technology of flying machines, but also walking robots and bullet trains. We hunt birds and they hunt for us; they give us diseases and we render some of them extinct.

Because of the multi-author approach, information sometimes spans several parts of the book and should perhaps have been gathered together by the editor. There are many examples of this. There is a description of the superb hearing skills of owls on p. 109, but you have to wait until pp. 224 or 249 to discover why. In fact, the most successful nocturnal owls have asymmetric ears (one is placed higher than the other, and the skull is lop-sided when viewed from in front) so that they can detect a sound source in the vertical plane, as well as the more normal horizontal one; we do the same by "cocking our head". In Chapter 3 (pp. 122-123) there is a section on the hippocampus and spatial memory, but the practical application of this - "now, where did I hide that nut?" - is dealt with on p. 197 and again on pp. 246-247.

In a similar vein, I feel that ideas that would interest the reader are omitted (perhaps because the different authors assumed they were dealt with elsewhere) and I sometimes felt that an extra sentence or two was needed. For example, there are two pages given over to the structure and function of the bird alimentary system in Chapter 4 ("Physiology"), whilst there is a whole chapter on diet (Chapter 7 – "Food and Foraging"). In the latter we learn that the red knot (*Calidris canutus*)

changes its diet markedly during the year, but we never discover that the size of the knot stomach doubles between summer (when the birds eat easily digestible arthropods on the tundra) and winter (when they eat less digestible bivalves and gastropods in northwest European waters such as the Wadden Sea); researchers from Texel have shown that changes in stomach size can occur in less than a week to keep pace with migratory movements. Indeed, there is no discussion of whether gut morphology differs according to diet, though this is a considerable biological theme. It is interesting to know that the eggs of parasitic cuckoos have thicker shells than the eggs of their unfortunate hosts, but R.B. Payne (no relation) would doubtless make the more important point that, while non-parasitic cuckoos lay large, round eggs, parasitic cuckoos of the same body size have evolved to lay small, oval-shaped eggs more in keeping with the species they are targeting. I found one misidentification; the beautiful double spread photo on pp. 142-143 is captioned as "European bee-eaters" (*Merops apiaster*) but the birds are actually a group of little bee-eaters (*M. pusillus*).

If I have made something of a meal of the last two paragraphs, it is mainly because it defines where the book sits in the spectrum of bird literature. This is a book which would suit those readers who want to journey beyond the usual identification guides that dominate the market. It is quite different. On the other hand, it is too broad-ranging to be a specialist text-book, though I found that, if I wrote down a list of topics I would expect to see, many of them appeared in some form or another. What it does do (or did for me, anyway) is to act as a stimulus to hit the search engines for any topic I wanted to know more about. Is this the definition of a "primer" these days? If so, this book is a good one. It is accessible and well-written throughout and contains magnificent photos and diagrams. If you are interested in birds, want to learn more about their general biology, and have a robust book shelf, you should seriously consider it.

Tony Payne

Florapedia: A Brief Compendium of Floral Lore

Carol Gracie
Princeton University Press, 2021. 201pages, hardback with numerous line drawings. ISBN 069121140X.
£9.99

This neat pocket-sized book, full of fascinating information, would make an ideal Christmas present for those friends who enjoy digging the garden or watching gardening shows, walking in the countryside, or visiting the Chelsea Flower Show, in fact everyone on your Christmas list.

Carol Gracie calls *Florapedia* "A Brief Compendium of Floral Lore". The simple dictionary definition of "lore" is "knowledge and stories" so this title captures the essence of the book but is only half the story. The stories are delightfully varied in every way, from the sublime to the everyday, and illustrate the author's extensive research and field-work as a botanist. There are entries on plants, insects, trees, artists, explorers, gardeners, emperors (Napoleon) and more.

In fact, *Florapedia* is a very difficult book to categorise, given the diversity of its range and the scholarship of its entries, but apart from being arranged alphabetically, its organisation is totally random. Whether reading linearly or not, the reader finds themself inadvertently dipping in and out, and reaching for Google's help to follow through an intriguing snippet.

Carol Gracie has worked as an educationalist for over 30 years at the New York Botanic Gardens, and she has published a number of field guides, including a seminal work on the spring wild flowers of North East America. Gracie's experience is based in the Americas, north and south, but most of the information is universal and there is plenty here for the European reader. And it is likely the book will stimulate the British reader to think up their own examples.

Some entries link the two continents, for example, the father and son horticulturalists, John and William Bartram. John became George III's botanist for the American colonies, and his own garden in Philadelphia became a "mecca for visiting botanists from both the colonies and Europe." This garden was taken over by the state of Philadelphia in 1891, making it the oldest botanical garden in the U.S.A. John discovered a tree species, which his son later named *Franklinia alatamaha* (Theaceae) after his father's good friend, Benjamin Franklin. Extinct in the wild since the early 19th century, all later specimens have grown from seeds collected by William.

Gracie contends that, because they do not move, plants have had to evolve more imaginative means of reproduction. Take, for example, the blood root poppy (*Sanguinaria canadensis*, Papaveraceae). To preserve their pollen, the flowers only open when it is sunny, i.e. when its pollinators are around. A single leaf wraps itself protectively round the flower stalk but after pollination the leaves become attractive ground cover, and ants disperse the ripened seeds. Another example she includes is the corpse flower (*Amorphophallus titanum*, Araceae) which many Scots held their nose to see when it flowered in the Royal Edinburgh Botanic Garden in 2019.

The common and scientific names "Dutchman's breeches" and *Dicentra cucullaria* (Papaveraceae) are descriptive of the flowers, writes Gracie of this plant which grows in the U.S.A. and Europe. This entry is illustrated by a delightful drawing of a bee hanging from a curved stem, weighed down by four flowers, looking like washing drying in the wind, in particular, four pairs of the sort of voluminous pants an 18th century Dutchman might have worn. The book contains more than 50 black and white line drawings by Amy Jean Porter, one drawing every few pages. They are clear and lively, with a lightness of touch.

I wonder how Ms Gracie picked the 100 or so vignettes. I imagine she could write another and another compendium without any duplication. Where is Humboldt, where is Olmsted? Where are the humming birds, the kniphofias, the gingko bilobas, the honey possum?

But *Florapedia* is not a leaky dictionary; it is a wonderful idiosyncratic, botanical pot pourri. It is an "amuse bouche" that leaves you wanting more, amazed by the marvel of plants. In her introduction Carol Gracie writes that she hopes "the short entries in this book [will] instill an appreciation" of flowers. She achieves her wish totally.

Marion Shawcross

Note: This is the first of a series of short, alphabetically-arranged books by this publisher. Recent additions include *Birdpedia*, *Treepedia*, *Fungipedia* and *Dinopedia*. These are inexpensive hardbacks and would make very suitable small gifts or stocking-fillers.

Tony Payne (Book Review Editor)

Wasps: The Astonishing Diversity of a Misunderstood Insect

Eric R. Eaton

Princeton University Press, 2021. 256 pages, hardback with numerous colour photographs. ISBN 0691211426. £25.00.

Eric R. Eaton is a professional entomologist who has worked for Cincinnati Zoo, Chase Studio, the Smithsonian Institution, universities in Portland State and Massachusetts, and for the West Virginia Division of Natural Resources. Eric is also the author of the *Kaufman Field Guide to Insects of North America* (2007) and co-author of *Insects Did It First* (2018). He is a leading authority on wasps. His writing is empathetic to his study organisms, and the humans with whom he is sharing their wonder. His writing is highly accessible and his passion for his subject is always evident.

This is not a field guide, but a general introduction to wasps. Be warned, the main body text and image captions are tiny; so, make sure you have good light and necessary magnification before you settle down to read. The book is compact, the text is in bite-size chunks and the individual chapters are typically covered in just one or two pages. A well-curated selection of facts and insights into the vast subject of wasps is presented. There is not much of a narrative to drive you through the pages, but there is plenty to be gleaned from thumbing through and dipping into and out of the text. The overall feel of the book is like a more detailed Dorling Kindersley work.

The overarching themes of the book are wasps in the greater contexts of natural ecosystems, human enterprise and culture, and coexistence with people in urban, suburban, and rural environments. The book begins by defining what a wasp is, and sawflies are also included within this definition. The chapters that follow cover wasp evolution, anatomy, metamorphosis, beauty, ecology, diversity, behaviour, mimics, enemies, wasps and people and finally wasp families. Not all the 83 current wasp families are described but there are good summaries of the major family groups. The book introduces wasps from all corners of the world, from miniscule fairy flies to gargantuan tarantula hawk wasps. Throughout the book, there are more detailed profiles of particular wasp species, and spotlights on unique behaviours or relationships to other organisms.

The book is promoted as "the ultimate visual journey into the beautiful and complex world of wasps" and is indeed very visual. It is lavishly and exquisitely illustrated with photographs, artwork and informative infographics. There are over 150 colour images showcasing wasp diversity of form and function.

Whilst some online reviewers have complained about the use of technical language, many of the terms are explained in the text and there is also a helpful glossary at the end of the book. Many tantalising subjects are touched on that you may be compelled to explore further, as the book aims at breadth rather than depth. For those hungry for more detail there is a compact but useful reference list to consult, including both journal publications and websites.

As soon as I have finished this review, I personally am off to investigate "acarinaria" and their occupants - pockets in the exoskeleton of bees and wasps that house mites. Having now learnt that in some instances these parasitic mites act as bodyguards, protecting their hymenopteran hosts from other parasites, I need to know more!

As is indicated by the title, "misunderstood insect", Eric's aim is clearly to help turn public opinion with respect to this much maligned insect group. He says as much to Marc Bekoff, of *Psychology Today*, in an interview he gave following the book's publication in the U.S.A. in March 2021. You can read the full interview at https://www.all-creatures.org/articles2/ar-wasps-misunderstood.pdf. When asked about his audience Eric stated "*Wasps* is aimed squarely at non-experts, including those who may have spheksophobia, the clinical fear of wasps. Knowledge is power, and if the book conveys anything, I hope it communicates how neutral most wasps are in relation to people, if not outright beneficial to our everyday lives". Whilst not principally aimed at those who are already converted with respect to the wonder, diversity, and invaluable wider ecological and societal contributions of wasps, the breadth of subjects covered in the book means that even seasoned insect enthusiasts will learn something.

Wasps are amazing, mostly solitary creatures that thrive in nearly every habitat on Earth, and their influence on our lives is overwhelmingly beneficial. It is good to know that someone is doing their utmost to dispel the biases and hysteria typically associated with these fascinating animals; highlighting the positive

relationships they share with humans and the environment to a wider audience. Enjoy!

Jeanne Robinson

Turtles of the World: a Guide to Every Family

Jeffrey E. Lovich & Whit Gibbons
Princeton University press, 2021. 240 pages, hardback with colour photographs and maps. ISBN 9780691223223. (Also available as an ebook).
£25.00

This is a beautifully illustrated book, with one or more stunning colour photographs on nearly every page. Written by two eminent American turtle biologists, it is pretty up to date and highly informative. After a 40-page introduction summarising key aspects of turtle biology (evolution, anatomy, physiology, distribution, behaviour, feeding, reproduction, growth, ecology, cultural significance and conservation), the "meat" of the book (about 180 pages) is the systematic account, describing each turtle family in turn, usually to species level. The basic structure is that each family is given a two-page introduction, including fact boxes on distribution, genera, habitats, size, activities, reproduction and diet. Detailed accounts of each genus follow with more fact boxes and illustrations. The book ends with a set of appendices: glossary of technical terms, a list of conservation organisations, bibliography of books and cited journal articles, and a summary of turtle classification. There is also an index.

An important theme running through the book is the conservation status of turtles around the world, a topic which the authors have addressed in research papers. The bottom line is that over 50% of known turtle species are in the threatened categories, a highly alarming situation. The causes are well known: climate change, habitat loss and over-exploitation head the list. Doing something to reverse the declines is a hard task, often requiring solutions tailored to the situation of particular species.

I mention that the book is pretty up-to-date, following the classification agreed by the Turtle Taxonomy Working Group (TTWG) in 2017. To illustrate the hazards of modern scientific book-writing, this is already superseded. I recently received notice of the 2021 edition of the TTWG checklist, also called *Turtles of the World*, which makes significant changes. Do not confuse the two books: the TTWG checklist is highly technical and aimed at professionals in the field. Newcomers to the field should also appreciate that the term "turtle" also embraces tortoises and terrapins; this book covers all the living shelled reptiles.

So, who is Lovich & Gibbons' book aimed at? This is not particularly clear. There is no preface outlining the authors' intentions, and I found the text a slightly odd mix of technical detail and occasional flippancy. For example, the paragraphs (p. 35) on parental care and sex determination are misleading or unhelpful: what does exceptions to temperature-dependent sex-determination "being rampant" mean? And the claim that "turtles are good parents" falls completely outwith normal definitions of parental care.

I also found some of the design and editorial decisions surprising. The figures are un-numbered and often do not identify the species shown. In-text literature references are quite sparse and frustrating to any reader who wished to follow up the sources of particular details. The lay-out plan means that, where a genus includes only a single species, a fair amount of detail is given (though some accounts are very brief and filled out with pictures), whereas the level of species detail provided for multi-species genera (e.g. *Testudo*, with five species) is very limited. It would appear that the intended readership is mainly American: for example, for species threatened with extinction, listing under the U.S. Endangered Species Act is mentioned, but equivalent legislative protection in other jurisdictions is not covered.

British readers have no terrestrial or freshwater species to see live, unless they visit a zoo with a good reptile collection, though we can count the leatherback sea turtle as a regular visitor to our coastal waters. However, this should not stop us wanting to learn about these fascinating and ancient animals. Despite my minor criticisms, I can thoroughly recommend this beautifully produced and interesting book to start your journey into turtle biology.

Roger Downie

Sharks of the World. A Complete Guide

David A. Ebert, Marc Dando & Sarah Fowler
Princeton University Press, 2nd Edition, 2021. 608 pages, hardback with colour illustrations, colour photos and diagrams. ISBN 9780691210872.
£40.00.

There have been many books on sharks. Most are popular accounts with lavish photos of gnashing teeth and flailing fins. This is not one of those books. This is a shark lover's bible – a complete guide to every shark species known. It was originally published as the *Field Guide to Sharks of the World* in 2005 and subsequently an updated version as *Sharks of the World: A Fully Illustrated Guide* in 2013. Knowledge of sharks is changing so rapidly, with many new species being discovered or recognised, that another revised version was needed. It is now the most comprehensive reference guide available to the world's sharks and a mighty tome at over 600 pages. It covers more than 535 shark species with updated species accounts and the latest taxonomic revisions; it is packed with colour illustrations, photographs and distribution maps of every species. An overview of shark biology, ecology and conservation is provided. The writing style is authoritative, aimed at shark specialists, but still very accessible to the interested layperson. Although the page format is large, the printed font is rather small. This enables a lot of information to be packed in, but you may need your reading glasses!

The introduction is quite short and outlines how best to use this guide; it also defines what a shark is and how they align with the other orders of cartilaginous fish, including many extinct orders. The nomenclature for shark topography (i.e. morphology) is illustrated in detail for features of the body, fins, head and teeth together with a summary of how shark species are named is given. A short section on the evolution of fishes and sharks follows. Since shark evolutionary history goes way back to the Devonian "Age of Fishes" (well before the dinosaurs appeared), incorporates a "Golden Age of Sharks" in the Carboniferous, and incorporates several mass extinction events to the present day, there is a lot to cover in a mere four pages. A beautiful timeline illustration of shark evolution is provided set against the evolution of other major faunal groups. This would make an amazing wall chart. However, the species diagrams here are only thumbnail size, which is a little disappointing – especially for the figured *Megalodon*, the largest shark ever known to exist. One is left wanting to know more about shark evolution, including some of the more bizarre shark-like fish from the past such as the whorl-toothed *Helicoprion* and the weird *Akmonistion*, with its strange spiny dorsal appendage - the latter better known in Glasgow as the "Bearsden Shark".

A lengthy section of 40 pages follows on shark biology and here the guide really excels with beautiful coloured cutaway diagrams illustrating the body structure (inside and out), skeleton, movement, respiration and circulation, skin and scales, senses, feeding and digestion. Shark life histories, behaviour, genetics, and current research priorities are also covered. This section is a book in itself and a real "tour de force". Even if you are already familiar with the anatomy and physiology of sharks it is still a joy to browse. Never have bones, blood, brains and guts seemed so fascinating. Here you can delve into many of the evolutionary inventions of elasmobranchs: the light-weight cartilaginous skeleton; the development of jaws and diversification of teeth; the conveyor belt tooth replacement system; ram ventilation of the gills; thunniform swimming modes; laminar flow dermal denticles; bioluminescence; osmoregulation using metabolic wastes such as urea; heat-exchanging blood vessels and a primitive form of endothermy; olfactory, pressure and electro-sensing; plankton feeding megabeasts; intestinal spiral valves; internal fertilisation, uterine feeding (and cannibalism) and viviparity.

In recent years electronic tagging of sharks has increased knowledge of the migration patterns of many species for feeding or breeding purposes. The great white shark is now known to migrate from California to Hawaii but regularly stops off halfway between to feed at a deep-water fish and squid "café". Great white sharks have also been tracked crossing from South Africa to Western Australia. Disappointingly, the authors have dropped the "great" moniker from its common name but, at the risk of being accused of populism, I prefer to make the white shark great again! The adoption of new genetic analysis techniques, using small fin clips or environmental DNA in water samples, is casting new light on shark breeding behaviour (e.g. by checking paternities of young), as well as revealing the occurrence of cryptic species. Surveys using eDNA may be far more effective than traditional labour-intensive visual surveys.

The section on "Sharks and People" is a cornucopia of detailed information covering shark legends (which feature notably in Mediterranean and Polynesian culture), shark fisheries, shark tourism and shark conservation. It highlights many of the problems sharks face worldwide from overfishing, fisheries bycatch, finning etc. Sharks have been targeted commercially for their meat, fins, liver oil, cartilage and skin and it is a depressingly familiar story of over-exploitation. Basking sharks were still being hunted for their oil in the west of Scotland just a few decades ago. The negative portrayal of sharks in the 1975 horror film *Jaws* did not help their image and shark conservation only began to be considered in the 1980s. Many species are now protected, and finning is banned in many countries, but fisheries management and regulation remains a challenge. The growth of shark tourism has helped encourage conservation work. However, the conflict between sharks and recreational swimmers and surfers remains, although actual shark attacks are relatively rare.

The largest part of this book, a whopping 490 pages, consists of a key to the four orders and 36 families of extant sharks and individual accounts for all 535 known species. Each family group of sharks is illustrated initially with beautiful colour plates depicting the various species, as if in life, all to the same scale and each orientated at similar angle to allow easy comparison. As in any modern field identification guide, each plate is accompanied by an opposing page of text bullet points summarising the distribution and key identification features. A common name is given for every species, accompanied by the proper scientific name, but only the latter is tagged on the plates which can be a little annoying for the non-specialist. Along with the family portraits each family is discussed with regards to its identification, biology, and conservation status. A synopsis of information on each individual species is also provided in a standardised format with one or two species per page. This includes line drawings of the body viewed laterally (or dorsally for compressed species), drawings of the head and mouth area from below and (for many species) notes and diagrams of the teeth. The drawings are augmented with notes on species identification, measurements, distribution, habitat, behaviour, biology, and status. World distribution maps are provided for each species, and for fisheries scientists the three-letter Food & Agriculture Organisation (FAO) code is given.

Among the species accounts you can get down to the details of some of the more peculiar sharks: strange frilled sharks with protruding gills and tricuspid teeth; hammerhead sharks with their weird head structure; lanternsharks with various bioluminescent species and the world's smallest sharks under 20 cm at maturity;

sleeper sharks such as the Greenland shark which may live for over 100 years; sawsharks (not to be confused with similar looking sawfish, allied to the rays); huge plankton feeding whale sharks, basking sharks, and megamouth sharks; cookiecutter sharks which bite chunks of flesh from whales, seals, or other large fish; the zebra shark whose young mimic the banded colouration of sea snakes; and the amazingly camouflaged wobbegongs, to name but a few. There are numerous more "ordinary" sharks and some of their common names tell a story in themselves. As well as great white sharks, tiger sharks, crocodile sharks, and requiem sharks, which all sound ominous, there are angel sharks, shy sharks, nervous sharks, and pyjama sharks, which sound quite innocuous. The shy shark habitually covers its eye with it tail when captured. The phallic catshark is possibly proud of its name but the flaccid catshark may not be quite so pleased! One should be careful not to let the bignose shark hear you say its name… as it is also a very big shark up to 3 m in length with big teeth too!

While the comprehensive scope of this book will appeal mostly to fishery scientists and conservationists, it indispensable to any shark enthusiast wishing to learn more about sharks and to gain a worldwide perspective on this fascinating and ancient group of fish.

Myles O'Reilly