

## ZOOLOGY

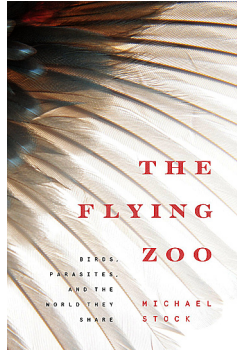
**The Flying Zoo: Birds, Parasites, and the World They Share**

By Michael Stock. 2019. University of Alberta Press. 260 pages, 29.99 USD, Paper

Michael Stock's book, *The Flying Zoo: Birds, Parasites, and the World They Share*, provides an intriguing glimpse into the lives of birds and their parasites, which are usually looked upon with disgust and dismissed as worthless vermin. However, parasites may provide benefits to their hosts, and Stock's narrative breathes new life into the world of these often-misunderstood organisms. The author asks "How has this weird association between one organism (a bird) and its fellow travelers (parasites) become normal? What special adaptations have parasites had to evolve to be able to find, colonize, and survive in or on their hosts? ... How have hosts evolved to survive with their 'zoological garden'?" (p. 4). These questions, and many more, are examined and explored with vigour and enthusiasm.

The book is divided into 10 chapters: A World on a Bird; Lice: It's a Beautiful Life; Fleas: The Circus in the Zoo; Tough Ticks; Mites: Little Things Mean a Lot; Flying Zoo Flies; The Worms that ate the Bird; Oddities in the Flying Zoo; Flying Zoo Behaviour; and Environmental Impacts: The Future of the Flying Zoo. Also included are a Notes section, Further Reading References, and an Index. More than 30 highly detailed pen and ink illustrations of the parasites in question are also dispersed throughout the book.

The book is a joy to read; the author crafts a fascinating journey into the lives of birds and their parasites using current research cases, vivid descriptions, and subtle humor. Co-evolutionary themes are commonplace and connect ecology, biology, adaptation, and survival into a seamless narrative. The reader travels the world, from Madagascar to the Americas, exploring the various interactions between parasite and host. Some amazing information comes to light from Stock's research: who knew that fleas could sing or that there is a specialized moth that drinks the tears of sleeping birds? One of the perks of the book is that the author defines various biological terms (sometimes breaking down the Latin or Greek root words), a major help to those first encountering the term or a refresher for seasoned naturalists and biologists.



All of the classic parasitic groups are covered, including fleas, ticks, lice, flies, and worms. However, peripheral species are also addressed, such as bed bugs (but for birds), moths, leeches, and strange critters called tongue worms. Figure 1.1 on p. 3 illustrates the parasitic relationship with birds well: it shows a Common Pigeon (*Columba livia*) surrounded by various parasitic species that may occur on and within a single bird, from roundworms, flukes, and tapeworms occurring inside the bird to mites, ticks, fleas, and lice occurring on the outside, each occupying a specialized niche (hence the idea of a "flying zoo"). One of the more fascinating topics Stock explores is the niche theory, which states that in order to reduce direct competition, species evolved to occupy different habitats or feeding behaviours. For example, a single bird may support several species of lice, but these lice live in different parts of the bird, such as on various locations of the wing (either on the feathers or inside the quill), on the head, or near the skin. In addition, these lice evolved different body shapes in order to avoid being detected or removed by the bird during the preening process.

It is unwise to assume parasites are worthless creatures with no value, and Stock provides several examples. Worms, such as blood flukes, have evolved ways to not be attacked by the host bird's immune system by down-regulating the immune response. Humans with auto-immune diseases may benefit in the future when we figure out how flukes and other parasites alter host immune systems (p. 150). Leeches, in another example, have a protein anticoagulant in their saliva called hirudin. The anticoagulant is now commercially produced and used to treat people with cardiovascular problems (p. 166). In addition, sometimes parasites provide advantages to their hosts. For example, wild Mute Swans (*Cygnus olor*) have a mature community of co-evolved helminths (worms). Mute Swans in a zoo environment, on the other hand, are not exposed to their usual worm parasites and were infected with two rare tapeworm species causing major infections and significantly diseased birds. The normal worm parasites are apparently a benefit to the swan by preventing harmful helminths from infecting the host. The co-evolved relationship between parasite and host seems to lead to a peaceful co-existence (p. 143). In another example, feather mites may benefit hosts by eating bacteria and fungi trapped in preen gland oil. These bacteria and fungi, in large numbers, may make a bird look unhealthy or diseased, but the

mites, by consuming these organisms, allow a bird to appear to have bright and healthy plumage, aiding in their reproductive success (p. 182).

Co-evolution between hosts and parasites is not novel. A few “rules” have been established by researchers exploring the idea. The first, known as Fahrenholz’s Rule, claims “that parasite evolutionary histories, or phylogenies, should mirror the histories of their hosts” (p. 142); that is, hosts that are related evolutionarily may harbour the same parasites. A second rule, called Manter’s Rule, states “that long associations between hosts and parasites should lead to strong host specificity” (p. 142) and that “parasites should speciate more slowly than their hosts” (p. 24). The third rule, Eichler’s Rule, states that “a large taxonomic group of hosts ... should have more genera and species of parasites than a small taxonomic group” (p. 24). The fourth rule, Szidat’s Rule, claims “more recent or specialized host groups should have more recent or specialized parasites while more primitive or generalized hosts should have more primitive or generalized parasites” (p. 24). Finally, Harrison’s Rule states that “large-bodied species of hosts should

have large-bodied parasites” (p. 24). Indeed, Stock explores these relationships throughout the book.

Overall, the book is a must-read for those interested in the intricate and interwoven world of birds and their parasites. The author emphasizes that it would be a mistake for anyone interested in avian biology to ignore that parasites are a real and significant part of the lives of birds. Parasites influence many aspects of the lives of our feathered friends, from sexual selection to healthy co-evolutionary relationships. A bird parasite may be harmful, beneficial, or indifferent, and any single parasite can fulfill any one of these roles to all three. Host-parasite studies will continue to lead to more questions and puzzles, especially with the looming climate change crisis, and Stock has provided a good starting point on this journey with his book *The Flying Zoo*.

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