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TIM BIRKHEAD

BIRD SENSE

What It's Like to Be a Bird

With illustrations by Katrina van Grouw

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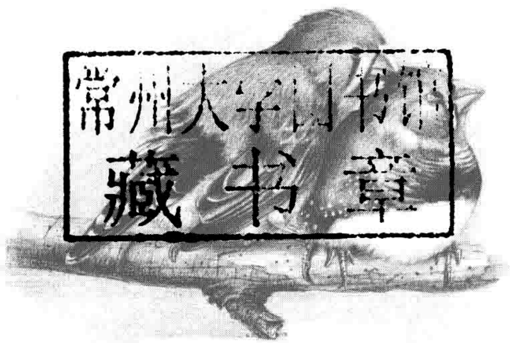

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Praise for *Bird Sense*

"The attempt to get at what a bird sees, hears, feels and thinks is more than worth the effort because there are so many intriguing facts and stories that the reader learns along the way. Remarkable in [its] celebration of birds." ***—The New York Times***

"A collective portrait of birds that is deeply stirring and inspires awe at our own species and its capacity for such intense curiosity."
—The Wall Street Journal

"Author of highly respected technical work on the social and sexual behavior of animals, Birkhead is also capable of making his and others' research clear, and even inviting. His skill lies in the way he poses his questions . . . *Bird Sense* asks another intriguing question: How do birds perceive their universe? What does the world look like to a bird?" ***—The New York Review of Books***

"This is a book to make one whistle, both at the sensational senses of birds and at the patient curiosity and cunning of those who study them." **—John Spurling, *The New Republic***

"The subtitle of British ornithologist Tim Birkhead's fantastic new book is 'What It's Like to Be a Bird.' In seven authoritative chapters, he delivers on the promise, covering sight, hearing, touch, taste, smell, birds' magnetic perceptions, and avian emotions."
—BirdWatching

"By reclaiming forgotten work . . . and highlighting the studies of contemporary scientists, [Birkhead] opens up a wealth of new material to bird-loving readers. Fresh and inquiring, *Bird Sense* is a gateway title on the inner lives of birds." ***—Booklist***

"[An] entertaining read perfect for birdwatchers and animal enthusiasts." ***—Publishers Weekly***

"An entertaining book guaranteed to bring pleasure to bird-watchers that will also fascinate students contemplating a career in ecology." ***—Kirkus Reviews***

"Birkhead provides fascinating information for birders and naturalists." ***—Library Journal***

"It's hard to imagine being a bird, moving with graceful and effortless flight. But that is just the beginning . . . Tim Birkhead's *Bird Sense* brings alive the many other surprising ways that birds differ from humans in how they experience the world around them."

—Bridget Stutchbury, author of The Private Lives of Birds

"Thoughtful, thoroughly researched and engagingly written throughout. By examining a bird's basic senses, Birkhead provides a real flavor of life from a bird's eye view." **New Scientist (UK)**

"This will be one of the seminal wildlife books of 2012 . . . Birkhead is the rare scientist who genuinely enthralls a non-technical audience. His new book will delight specialists and bedtime readers alike." ***—BBC Wildlife***

Preface

'Buggered' is how most New Zealanders describe their bird fauna, and it is. I've rarely been anywhere where birds are so thin in the air or on the ground. A mere handful of species – several of them flightless and nocturnal – have survived the ravages of introduced European predators, and now exist in tiny numbers, mainly on offshore islands.

The sun is already setting as we arrive at the lonely quayside. The faint purr of an outboard motor soon materialises into a small boat approaching from the island. Within minutes we are heading out to sea and into a blazing sunset. The mainland-island transition is magical: twenty minutes and we step out of the boat on to a wide, sweeping beach overhung with majestic pohutukawa trees.

Anxious to see our first kiwi we are out again as soon as we have eaten. The moonless night sky is splattered with stars – the southern Milky Way, so much more intense than that in the northern hemisphere. Our path takes us back down towards the shore and we are suddenly aware of the sea: phosphorescence! The tiny waves lapping the beach are glowing. 'You should swim,' Isabel says, and with no further encouragement we are all skinny-dipping, and ignited by bioluminescence we jump around like human fireworks. The effect is spellbinding: a visual extravaganza as elusive and astonishing as the aurora.

Ten minutes later we are dry and continue our kiwi quest into the adjacent woodland. With her infra-red camera, Isabel scans ahead, and there, hunched among the vegetation, is a dark, domed shape: our first kiwi. To the naked eye the bird is invisible, but on the camera screen it is a black blob, with an extraordinarily long, white bill. Unaware of us, the bird shuffles forward, foraging like a machine: touch, touch, touch. At the end of this long summer the ground is too hard for probing and coming across a cluster of crickets on the soil surface, the kiwi snaps them up as they attempt to hop, skip and jump away. Suddenly aware of us, the bird hurries off into the bush and out of sight. As we walk back to the house the darkness reverberates with the high-pitched squeals of male kiwis – 'k,wheee, k,wheee'.

Isabel Castro has been studying kiwis on this tiny island sanctuary for ten years. She is one of a handful of biologists trying to understand the bird's unique sensory world. Some thirty of the island's kiwis carry radio transmitters that Isabel and her students use to follow the birds' night-time wanderings and to pinpoint their daytime roosts. We have joined the annual catch-up to replace the transmitters whose batteries fade after a year.

In the brightness of the early morning sun we follow a transmitter's bleep through a forest of manuka trees and ponga (tree ferns) to a small swamp. Without speaking, Isabel indicates that she thinks our bird is in a dense patch of reeds and mimes to ask me if I'd like to catch it. Kneeling, I see a small opening in the reeds and with my face close to the muddy water I peer inside. With my head torch I can just make out a brown, hunched shape facing away from me. I wonder whether the bird is aware of me as kiwis are renowned for their deep day-time sleep. Judging the distance, I steady myself in the soggy ground and shoot my arm forward to grab the bird by its huge legs. I'm relieved: to have lost it in front of the research students would have been embarrassing. I gently pull the bird from its sleepy hollow, cradling its chest in my hands. It is heavy: at around two kilos the brown kiwi is the largest of the five (currently) recognised species.

It is not until you have this bird lying in your lap that you realise just how utterly bizarre it is. Lewis Carroll would have loved the kiwi – it is a zoological contradiction: more mammal than bird, with luxuriant hair-like plumage, an array of elongated whiskers and a long, very sensitive nose. I can feel its heart beating as I fumble my way through its plumage to find its minuscule wings. They are odd; each like a flattened finger with a few feathers along one side and a curious hooked nail at the tip (what does it use that for?). Most remarkable of all are the kiwi's tiny, all but useless eyes. Even if there had been one on the beach the previous night, the visual extravaganza of our bioluminescent cavorting would have been wasted on the kiwi.

What is it like being a kiwi? How does it feel plodding through the undergrowth in almost total darkness, with virtually no vision, but with a sense of smell and of touch so much more sophisticated than our own? Richard Owen, a nasty narcissist but a superb anatomist, dissected one around 1830 and seeing the kiwi's tiny eyes and huge olfactory region in its brain suggested – with little knowledge of the bird's behaviour – that it relied more on smell than sight. Skilfully linking form with function, Owen's predictions were elegantly borne out one hundred years later when behavioural tests revealed the laser-like accuracy with which kiwis pinpoint their prey below the ground. Kiwis can smell earthworms through 15 cm of soil! With such a sensitive nose, what does a kiwi experience on encountering another kiwi's droppings – which to me at least are as pungent as those of a fox? Does that aroma conjour up an image of its owner?

In his famous essay 'What is it like to be a bat?' published in 1974, the philosopher Thomas Nagel argued that we can never know what it feels like to be another creature. Feelings and consciousness are *subjective* experiences so they cannot be shared or imagined by anyone else. Nagel chose the bat because as a mammal it has many senses in common with ourselves, but at the same time possesses one sense – echolocation – that we do not have, making it impossible for us to know what it feels like.[1]

In one sense Nagel is right: we can never know *exactly* what it's like to be a bat or indeed a bird, because, he says, even if we imagine what it is like it is no more than that, imagining what it is like. Subtle and pedantic perhaps, but that's philosophers for you. Biologists take a more pragmatic approach, and that's what I'm going to do. Using technologies that extend our own senses, together with an array of imaginative behavioural tests, biologists have been remarkably good at discovering what it is like to be something else. Extending and enhancing our senses has been the secret of our success. It started in the 1600s when Robert Hooke first demonstrated his microscope at the Royal Society in London. Even the most mundane objects – such as a bird's feather – were transformed into something wondrous when seen through the lens of a microscope. In the 1940s biologists were amazed by the details revealed by the first sonograms – sound pictures – of birdsong, and even more amazed when in 2007 for the first time they were able to see – using fMRI (functional magnetic resonance imaging) scanning technology – the activity in a bird's brain in response to hearing the song of its own species.[2]

We identify more closely with birds than with any other group of animals (apart from primates and our pet dogs), because the vast majority of bird species – although not the kiwi – rely primarily on the same two senses as we do: vision and hearing. In addition, birds walk on two legs, most species are diurnal and some, like owls and puffins, have human-like faces, or at least, faces we can relate to. This similarity however, has blinded us to other aspects of birds' senses. Until recently it was assumed – with the kiwi as a quirky exception – that birds have no sense of smell, taste or touch. As we will see, nothing could be further from the truth. The other thing that has retarded our understanding of what it is like to be a bird is the fact that to comprehend their senses we have no alternative but to compare them with our own, yet it is this that so limits our ability to understand other species. We cannot see ultraviolet (UV) light, we cannot echolocate, nor can we sense the earth's magnetic field, as birds can, so imagining what it is like to possess those senses has been a challenge.

Because birds are so staggeringly diverse, the question 'What is it like to be a bird?' is rather simplistic and it would be much better to ask:

- What is it like being a swift, 'materialising at the tip of a long scream'?[3]
- What is it like for an emperor penguin diving in the inky blackness of the Antarctic seas at depths of up to 400 m?
- What is it like to be a flamingo sensing invisible rain falling hundreds of kilometres away that will provide the ephemeral wetlands essential for breeding?
- What is it like to be a male red-capped manakin in a Central American rainforest, displaying like a demented clockwork toy in front of an apparently uninterested female?
- What does it feel like copulating for a mere tenth of a second, but over one hundred times a day, like a pair of dunnocks? Does it wear them out or does it bring immense pleasure?
- What is it like being the lookout for a group of white-winged choughs, watching in the short term for predatory eagles; in the longer term for an opportunity to assume the breeder's mantle?
- What is it like, to feel a sudden urge to eat incessantly, and over a week or so become hugely obese, then fly relentlessly – pulled by some invisible force – in one direction for thousands of miles, as many tiny songbirds do twice each year?

These are the types of question I'm going to answer, and I'll do so by using the most recent research findings, but also by exploring how we arrived at our present understanding. We've known for centuries that we possess five senses: sight, touch, hearing, taste and smell; but in reality there are several others including heat, cold, gravity, pain and acceleration. What's more, each of the five senses is actually a mixture of different sub-senses. Vision, for example, includes an appreciation of brightness, colour, texture and motion.

Our predecessors' starting point for understanding the senses was the sense organs themselves – the structures responsible for collecting sensory information. The eyes and ears were obvious, but others, such as that responsible for the magnetic sense of birds, are still something of a mystery.

Early biologists recognised that the relative size of a particular sense organ was a good guide to its sensitivity and importance. Once the anatomists of the seventeenth century discovered the connections between sense organs and the brain, and later realised that sensory information was processed in different regions of the brain, it became apparent that the size of different brain regions might also reflect sensory ability. Scanning technology, together with good old-fashioned anatomy, now allows us to create 3-D images and measure with great accuracy the size of different regions of both human and bird brains. This has revealed, as Richard Owen predicted, that the visual regions (or centres, as they are known) in the kiwi's brain are almost non-existent, yet its olfactory centres are even larger than he thought.[4]

Once electricity had been discovered in the eighteenth century, physiologists like Luigi Galvani quickly realised that they could measure the amount of 'animal electricity' or nervous activity in the connections between sense organs and the brain. As the field of electrophysiology developed it became clear that this provided yet another key to understanding the sensory abilities of animals. Most recently, neurobiologists have used different types of scanners to measure activity in different regions of the brain itself to inform them of sensory abilities.

The sensory system controls behaviour: it encourages us to eat, to fight, to have sex, to care for our offspring, and so on. Without it we couldn't function. Without any one of our senses life would be so much poorer and much more difficult. We strive to feed our senses: we love music, we love art, we take risks, we fall in love, we savour the scent of freshly cut meadows, we relish tasty food and we crave our lover's touch. Our behaviour is controlled by our senses and, as a result, it is behaviour that provides one of the easiest ways of deducing the senses that animals use in their daily lives.

The study of senses – and bird senses in particular – has had a chequered history. Despite the abundance of descriptive information accumulated over the past few centuries, the sensory biology of birds has never been a hot topic. I avoided sensory biology as a zoology undergraduate in the 1970s, partly because it was taught by physiologists rather than behaviourists, and partly because the links between the nervous system and behaviour were known only for what I considered rather unexciting animals like sea slugs, rather than for birds.

Part of my motivation for writing this book, then, is to make up for lost time. I have also been encouraged by a change in attitude, not so much among physiologists but among my animal behaviour colleagues, who during recent decades have effectively rediscovered the sensory systems of birds and other animals. While I was writing this book I contacted several retired sensory biologists and was surprised to discover that they all had a similar tale: *when I was doing this research no one was interested, or they didn't believe what we had found.* One researcher told me how his entire career had been devoted to the sensory biology of birds and, apart from once being asked to write a chapter for an encyclopaedia of bird biology, had received relatively little recognition. On retirement he had burned all his papers, and then – to his simultaneous dismay and delight – I started asking him about his research.

Others told me how they had once planned to write a textbook on the sensory biology of birds but failed to find a publisher sufficiently interested. I cannot imagine what it must be like devoting your life to an area of research that few others find interesting. However, different areas of biology flourish at different times and I am optimistic that the sensory biology of birds is about to have its day.

So what's changed? From my own perspective, the field of animal behaviour has changed dramatically. I describe myself as a behavioural ecologist first and an ornithologist second: a behavioural ecologist who studies birds. Behavioural ecology is a branch of animal behaviour that emerged in the 1970s, with a tight focus on the adaptive significance of behaviour. The behavioural ecologist's approach was to ask how a particular behaviour increases the chances of an individual passing on its genes to the next generation. For example, why does the buffalo weaver – an African, starling-sized bird – copulate for thirty minutes at a time when most other birds copulate for just a couple of seconds? Why does the male cock-of-the-rock display in groups of other males and play no part in rearing his offspring?

Behavioural ecology has been extraordinarily successful in making sense of behaviours that to previous generations had been a mystery. But behavioural ecology has also been a trap, for like all disciplines its boundaries have restricted researchers' horizons. As the subject matured during the 1990s many behavioural ecologists began to realise that, on its own, identifying the adaptive significance of behaviour wasn't enough. Back in the 1940s, when the study of animal behaviour was in its infancy, one of its founders, Niko Tinbergen (later a Nobel Laureate), pointed out that behaviour could be studied in four different ways: by considering its (i) adaptive significance; (ii) causes; (iii) development – how the behaviour develops as the animal grows up; and (iv) evolutionary history. By the 1990s behavioural ecologists, whose entire focus during the previous twenty years had been on the adaptive significance of behaviour, began to realise that they needed to know more about the other aspects of behaviour and, in particular, the causes of behaviour.[5]

Let's see why. The zebra finch is a popular study species for behavioural ecologists, especially for studies of mate choice. Female zebra finches have an orange beak and males a red beak, a sex difference that suggests that the male's brighter beak colour evolved because females prefer a redder beak. Some, but not all, behavioural tests suggest that this is true and researchers assume that because *we* can rank the beaks of male zebra finches from orangey-red to blood-red, female zebra finches can do the same. They have never tested this assumption in terms of what zebra finches can actually see, yet it is widely assumed that beak colour is an important component of female choice.[6]

Another trait that female birds are thought to use in their selection of a mate is the symmetry of plumage markings, such as the pale spots on the throat and chest of male European starlings. Careful tests in which female starlings were 'asked' to discriminate between different levels of plumage symmetry (using images rather than live birds) revealed that, while they could identify males that were highly asymmetric in their spotting, their ability to discriminate smaller differences was not very good. In fact, to a female starling most males look much the same in this respect, demonstrating that they were unlikely to use plumage symmetry as a way of choosing a male.[7]

Behavioural ecologists have also assumed that the degree of sexual dimorphism in birds – that is, how different males and females are in their appearance – might be linked to whether they are monogamous or polygamous. To test this they scored species according to the brightness of the male and female plumage – based on *human* vision. We know now that this is naive, for the avian visual system is not like ours because birds can see ultraviolet (UV) light. Scoring the same birds under UV light revealed that a large number of species – including the blue tit and several parrots – previously thought to lack sexual dimorphism, actually differed quite a lot when viewed – as females would see them – with UV vision.[8]

As these examples illustrate, of all avian senses, vision – and colour vision in particular – is the area where the most spectacular recent discoveries have been made, mainly because this is where researchers have focused most effort.[9] Researchers now realise that to understand the behaviour of birds it is essential to understand the kind of worlds they live in. We are just beginning to appreciate, for example, that many birds other than kiwis have a sophisticated sense of smell; that many have a magnetic sense that guides them on migration, and, most intriguingly of all, that like us birds have an emotional life.

What we know about the senses of birds has been acquired gradually over centuries. Knowledge accumulates by building on what others have previously found, and, as Isaac Newton said, by standing on the shoulders of giants. Because researchers feed on each other's ideas and discoveries, and since they both collaborate and compete with each other, the more individuals there are working on a particular topic, the more rapidly progress is made. Progress is accelerated, of course, by intellectual giants: think Darwin for biology, Einstein for physics and Newton for mathematics. But scientists are human, too, and susceptible to human foibles, and progress isn't always rapid or straightforward. It is all too easy to become fixated on one idea – as we'll see. Research is full of blind alleys and scientists constantly have to judge whether to persist in what they believe to be correct, or to give up and try a different line of enquiry.

Science is sometimes described as a search for the truth. This sounds rather pretentious, but 'the truth' here has a straightforward meaning: it is simply what, on the basis of the available scientific evidence, we currently believe. When scientists retest someone else's idea and find that evidence to be consistent with the original notion, then the idea remains. If, however, other researchers fail to replicate the original results, or if they find a better explanation for the facts, scientists can change their idea about what the truth is. Changing your mind in the light of new ideas or better evidence constitutes scientific progress. A better term, then, is 'truth for now' – on the basis of the *current* evidence this is what we believe to be true.

The evolution of the eye is a good example of how our knowledge has progressed. Throughout much of the seventeenth, eighteenth and nineteenth centuries, it was believed that God in his infinite wisdom had created all life forms and had given them eyes to see with: owls have especially large eyes because they need to see in the dark. This way of thinking about the perfect fit between an animal's attributes and its lifestyle was called 'natural theology'. But there were some things that simply didn't look like God's wisdom: why males produced so many sperm, for example, when only one was needed for fertilisation. Would a wise God be so profligate? Charles Darwin's idea of natural selection, presented in the *Origin of Species* in 1859, provided a much better explanation for all aspects of the natural world than the wisdom of God, and as the evidence accumulated scientists abandoned natural theology in favour of natural selection.

Scientific studies usually begin with observations and descriptions of what something *is*. Once again, the eye provides a good example. Starting in ancient Greece, the early anatomists removed the eyes of sheep and chickens and cut them open to see how they were constructed, and made detailed descriptions of what they saw – and sometimes what they imagined they saw. Once the