

## NOTES AND SOURCES

A world of literature is distilled in this book. Each chapter could easily expand into a volume of its own—and many of them already have been. I don't pretend to cover these subjects exhaustively, but I offer a taste and synthesis of available research to show how cool, interesting, and thought-provoking the world of birds can be. While some of the themes presented are my own interpretations (for instance, that albatrosses can feel love) based on my personal field experiences with birds, the facts are facts. Major sources are listed below in order of appearance within each chapter. Even this is an abbreviated account; instead of including every reference, I have highlighted the most interesting studies and the scientists behind them, pointing the way for anyone interested in further reading.

### FLY AWAY HOME

I tracked down the lost racing pigeon's owner, Marty, by looking up its band digits on the American Racing Pigeon Union website (if you ever find a lost pigeon with bands, report it—its owner will thank you!), and interviewed him by phone in the spring of 2012. The subject of bird navigation is huge, and whole books have been written about how birds find their way—for instance, Miyoko Chu's well-researched *Songbird Journeys* (2007) and Scott Weidensaul's excellent exposition of migration, *Living on the Wind* (2000)—so this chapter only hits the highlights of homing behavior. Rosario Mazzeo reported the results of his shearwater experiment in the 1953 article "Homing of the Manx Shearwater." At least three books have been written about Bobbie the Wonder Dog. Ninja was featured on an episode of *Nature* originally aired on PBS in 1999. Yosemite black bear management protocols were outlined in a 1997 California Fish and Game document. Smallmouth black bass homing

experiments were described by R. W. Larimore in 1952. Homing behavior of garden snails was described in the 2010 BBC Radio 4 “So You Want to Be a Scientist” winning project, by sixty-nine-year-old grandmother Ruth Brooks, reported by *The Telegraph*. The white-crowned sparrow homing experiments were conducted by Richard Mewaldt in the 1960s and 1970s. Rupert Sheldrake’s article “The Unexplained Powers of Animals” was printed in *New Renaissance* in 2003. Andrew Blechman gives a thorough account of pigeon racing history (and other pigeon stories) in his 2007 book, *Pigeons: The Fascinating Saga of the World’s Most Revered and Reviled Bird*. Hans Wallraff, who conducted the tilting turntable experiment, reports on the map and compass in his 2005 book, *Avian Navigation: Pigeon Homing as a Paradigm*. Pigeons were tracked following roads by global-positioning-system technology in a 2004 Oxford University study by Tim Guilford and colleagues. The “sun compass” was discovered by Gustav Kramer in his 1951 starling experiments. Stephen Emlen conducted the planetarium tests with indigo buntings in 1967. Mel Kreithen was the first to demonstrate that pigeons can hear infrasound; he investigated their perception of polarized light and pioneered many studies of pigeon navigation. A neural basis for magnetic perception in pigeons was described in a 2012 *Science* article by Le-Qing Wu and J. David Dickman. Katrin Stapput performed the robin experiments showing the right eye’s sensitivity to magnetic fields, in 2010. Floriano Papi first proposed an “olfactory map” for pigeons in 1972; olfaction continues to be debated as it relates to navigation. Martin Wikelski published the right-nostril research in 2011. Jon Hagstrum correlated pigeon disappearances with infrasound in 2013. Coverage of the Birdmuda Triangle hit major media in August 2012 after racing pigeon disappearances in northeast England. Airborne pigeon hierarchies were described in a 2010 *Nature* paper. The South African Million Dollar Pigeon Race was moved to the Emperors Palace in 2013 after sixteen years at the Sun City Resort in northern South Africa.

## SPONTANEOUS ORDER

If you haven’t seen the starling flock video, type “murmuration” into YouTube and be amazed. Richard Barnes has exhibited solo shows of his

starling photos (titled *Murmur*) in Seattle, Boston, and New York galleries; Jonathan Rosen wrote the 2008 book *The Life of the Skies*. Jeffrey Goldstein is a professor at Adelphi University, specializing in complexity, emergence, and organizational behavior. Steven Johnson's *Emergence* was published in 2002. Peter Corning's 2002 paper was titled "The Re-emergence of 'Emergence': A Venerable Concept in Search of a Theory." John Conway's Game of Life has spun into an entire field of mathematical research on cellular automata—grids of cells that change by set rules—that continues to yield fascinating insights into physics, biology, and other fields. Craig Reynolds posted a mesmerizing demonstration of his Boids model at [red3d.com/cwr/boids](http://red3d.com/cwr/boids) (accessed March 2013), worth a peek as it closely mimics the real-life YouTube "Murmuration" video. Predicting the path of celestial bodies in one another's gravitational fields, given only present velocities and directions, is called the "n-body problem," which, so far, has not been solved exactly for more than two objects. The Italian researchers' starling flock model was described in "Empirical Investigation of Starling Flocks: A Benchmark Study in Collective Animal Behavior" (Michele Ballerini et al.), and the topological distance conclusion was reported in "Interaction Ruling Animal Collective Behavior Depends on Topological Rather Than Metric Distance: Evidence from a Field Study" (Michele Ballerini et al.), both papers from 2008. The Shakespeare story is omnipresent in popular accounts of starling introductions, but I know of no accurate primary source. Albert's swarm of locusts, however, is not an exaggerated tale; it was conservatively estimated from qualitative measurements to be a single stream of insects 1,800 miles long, 110 miles wide, and one-quarter to one-half mile deep (!), representing the largest single concentration of animals ever recorded (as described in Jeffrey Lockwood's 2005 book, *Locust*). Starling declines were reported by the Royal Society for the Protection of Birds in 2012. Andrea Cavagna et al.'s 2010 paper "Scale-free Correlations in Starling Flocks" describes the implications of flock correlation lengths, and flocks are discussed in terms of spontaneous magnetization in a 2012 paper, "Statistical Mechanics for Natural Flocks of Birds." George Miller's paper "The Magical Number Seven, Plus or Minus Two: Some Limits of Our Capacity for Processing Information" was originally published in 1956. Andrea Cavagna kindly answered several of my questions by e-mail.

## THE BUZZARD'S NOSTRIL

Anecdotes are from my experience attracting turkey vultures to my yard with a deer carcass in June 2000 (inspired by the “Meat-Eaters” episode of David Attenborough’s 1998 series *The Life of Birds*). John James Audubon’s original account of his vulture experiments was published in 1826 in *The Edinburgh New Philosophical Journal*. Among subsequent rebuttals were three articles by Charles Waterton (1832–1833) in *The Magazine of Natural History*. Darwin’s *The Voyage of the Beagle* was first released in 1839 as *Journal and Remarks*. John Bachman’s vulture studies were published in a sixteen-page pamphlet (1834) under the title “An Account of Some Experiments Made on the Habits of the Vultures Inhabiting Carolina, the Turkey Buzzard, and the Carrion Crow, Particularly As It Regards the Extraordinary Powers of Smelling, Usually Attributed to Them” (1834). Taxonomy of New World vultures is controversial: Many have argued that they are related to storks (for instance, Charles G. Sibley and Burt L. Monroe, Jr., in 1990), some believe they form their own order, and a recent DNA analysis (Shannon Hackett et al., in *Science*, 2008) suggests that New World vultures are related to raptors. Vulture digestion was described in an engaging 2008 *Audubon* magazine article by T. Edward Nickens. Kenneth Stager included an account of Union Oil workers’ stories about turkey vultures with descriptions of his own experiments in his 1964 monograph “The Role of Olfaction in Food Location by the Turkey Vulture (*Cathartes aura*).” The Panama chicken carcass experiment was performed by David Houston and published in 1986. Lab tests of turkey vulture sensitivity to different odors are described by Steven A. Smith and Richard A. Paselk in a 1986 paper titled “Olfactory Sensitivity of the Turkey Vulture (*Cathartes aura*) to Three Carrion-Associated Odorants.” Information about avian taste buds is given in Frank Gill’s *Ornithology* textbook (2007 edition).

## SNOW FLURRIES

The Duluth snowy owl sighting was first reported on the local birding listserv mou-net. Snowy owl totals for the 2011–2012 invasion were based on thousands of reports archived on eBird.com. The *New York*

*Times* story by Jim Robbins was published on January 22, 2012. I saw the Fern Ridge snowy owl on December 19, 2011. A snowy owl with chicks is painted on the wall of the Cave of the Trois-Frères in southwest France, along with other animals, where figures have been dated to about 13,000 B.C. Illinois birder Rick Remington photographed the encounter between the Chicago snowy owl and peregrine falcon. The 1,000 Washington snowy owls of 1916 are cited in the 2005 book *Birds of Washington*, edited by Terence R. Wahl, Bill Twiet, and Steven G. Mlodinow. The term *superflight* was first used by ornithologist Carl Boch to describe multispecies winter finch irruptions. Victor Shelford's influential 1945 paper was titled "The Relation of Snowy Owl Migration to the Abundance of Collared Lemmings." Studies of irruptive cycles for snowy owls have been mixed; for instance, Ian Newton (2002) reported a mean irruption interval of 3.9 years in eastern North America, but after their statistical analyses Paul Kerlinger et al. (1985) concluded, "We did not find evidence that snowy owl irruptions occur at regular 3- to 4-year periods." The same paper suggested that weather may be a cause of snowy owl irruptions, as other hypotheses don't seem to adequately explain or predict occurrences; nearly three decades later, the question remains unanswered. The Alberta study of snowy owl mortality was described in "Causes of Mortality, Fat Condition, and Weights of Wintering Snowy Owls" (Paul Kerlinger and M. Ross Lein, 1988). The Victoria Island snowy owl chicks were banded by David Parmelee. Karel Voous is quoted from the 1988 book *Owls of the Northern Hemisphere*. Mark Fuller, Denver Holt, and Linda Schueck conducted the pilot satellite tracking study of snowy owls in Barrow, Alaska, between 1999 and 2001. Snowy owls were tracked on sea ice by Marten Stoffel et al. in 2008 ("Long-Distance Migratory Movements and Habitat Selection of Snowy Owls in Nunavut"). Norman Smith works with Mass Audubon on the Logan Airport Snowy Owl Project; maps of satellite-tagged owl movements are posted on the Mass Audubon website (accessed March 2013). The April 1995 *New Internationalist* magazine article about nomads was called "The Facts." The "Out of Africa" theory of modern humans' origin is generally accepted, though dates continue to change; most recently, Fernando Mendez et al. (2013) pushed back the first exodus to 338,000 years ago, exceeding previous estimates. Aki Nikolaidis

and Jeremy Gray (2010) examined the DRD4-7R allele's relationship to ADHD disorder; a 2013 paper in *The Journal of Neuroscience* by Deborah Grady et al. linked it to longevity; multiple studies have also linked the allele to novelty-seeking, though others questioned this finding; and its impacts on risk taking were reported in Camelia Kuhnen and Joan Chiao's 2009 paper "Genetic Determinants of Financial Risk Taking."

## HUMMINGBIRD WARS

Elizabeth Jones at Costa Rica's Bosque del Río Tigre Sanctuary and Lodge described her hummingbird dilemma during my delightful 2011 visit there and in a subsequent e-mail interview. Paul Kerlinger first popularized the comparison of hummingbird weights to postage stamps. Bee hummingbird measurements are in Felisa Smith's "Body Size, Energetics, and Evolution," in volume 1 of the 2008 *Encyclopedia of Ecology*. Robert C. Lasiewski (1962) estimated the nonstop flying range of a ruby-throated hummingbird at 26 hours and 600 miles based on laboratory-measured calorie consumption. R. S. Miller and Clifton Lee Gass analyzed hummingbird predation and longevity in their 1985 article "Survivorship in Hummingbirds: Is Predation Important?" Eight-year-old broad-tailed hummingbirds were documented by William Calder and S. J. Miller in 1983, and the twelve-year longevity record is listed by the U.S. Geological Survey Patuxent Wildlife Research Center Bird Banding Laboratory. Bat falcon diets were published in 1950 by William Beebe—one of the past century's most colorful naturalists and the subject of an entertaining 2006 biography (he died in 1962). The Nano Drone was described in a February 17, 2011, *Los Angeles Times* article by W. J. Hennigan. Robert C. Lasiewski and R. J. Lasiewski (1967) measured a maximum heart rate of 1,260 beats per minute in a blue-throated hummingbird. The Sierra Nevada hummingbird study was reported by Mark Hixon et al. in 1983. The billion-heartbeat rule is *very* generalized, but it summarizes an interesting trend; Herbert Levine (1997) described the inverse relationship of body size and heart rate, and found a "remarkably constant" lifetime mean of one billion beats in a variety of species. Pace of life was reported in a fascinating 1999 paper by Robert V. Levine and Ara Norenzayan, "The Pace of Life in 31 Countries," and the 2007 study was

conducted by Richard Wiseman for his book *Quirkology*. Gerald Mayr described the German hummingbird fossils in *Science* in 2004.

## FIGHT OR FLIGHT

Anecdotes are from my three-month 2008–2009 field season with the Penguin Science project, a research collaboration among Oregon State University, PRBO Conservation Science (now known as Point Blue Conservation Science), H. T. Harvey & Associates, the U.S. Antarctic Program, and the National Science Foundation Office of Polar Programs in the Ross Island area of Antarctica. Apsley Cherry-Garrard's quotes are taken from his excellent 1922 memoir, *The Worst Journey in the World*. Charles Darwin's iguana-tossing experiment was chronicled in his 1839 book, *The Voyage of the Beagle*, and inspired David Quammen's insightful essay and 1988 book, *The Flight of the Iguana*. Galápagos National Park regulations and tolerant Galápagos wildlife behaviors are described from my own experiences while living there in 2006. For an example of research using flight distance as an indication of fear thresholds, and a good synthesis of flight distance as it relates to fearfulness in animals, see Theodore Stankowich and Daniel Blumstein's 2005 paper "Fear in Animals: A Meta-analysis and Review of Risk Assessment." Leopard seal attacks were reported in a *National Geographic* news story by James Owen on August 6, 2003. The "tend and befriend" theory is attributed to Shelley Taylor at the University of California, first described in a 2000 *Psychological Review* article and popularized by her 2002 book, *The Tending Instinct*. Robert Plutchik died in 2006 at age seventy-eight after a distinguished academic career, having published eight books and hundreds of articles; the emotional color wheel he developed in 1980 is still used today. Ivan Pavlov won a Nobel Prize in 1904 for his studies of dog saliva, and classical conditioning experiments are often called Pavlovian in his honor. Little Albert remains a well-known case study, though some suggest that John Watson exaggerated his results; for instance, see Ben Harris's 1979 critique, "Whatever Happened to Little Albert?" "Low-road" and "high-road" fear pathways were described by neuroscientist Joseph LeDoux, author of several popular books on the human brain. Swiss neurologist Édouard Claparède performed the 1911 amnesia experiment. The quail study was described in "Mothers' Fear of Human Affects the Emotional

Reactivity of Young in Domestic Japanese Quail” (Aline Bertin and Marie-Annick Richard-Yris, 2004). The New Zealand robin study was described in “Rat-Wise Robins Quickly Lose Fear of Rats When Introduced to a Rat-Free Island” (Ian Jamieson and Karin Ludwig, 2012). Physiologist Paul Ponganis measured 500-meter emperor penguin dives at Cape Washington, Antarctica. The implications of penguin fear, based on Penguin Science project research, were summarized in a 2011 *Science* article by Virginia Morell, “Why Penguins Are Afraid of the Dark.”

## BEAT GENERATION

Aniruddh Patel was featured in *New York Times* articles on December 14, 2008, and May 31, 2010, and Snowball’s story has made the rounds of major media. I learned about manakins deep in the jungles of Tiputini Biodiversity Station in eastern Ecuador, where researchers are focusing on their dancing behaviors. Patel et al.’s paper, “Experimental Evidence for Synchronization to a Musical Beat in a Nonhuman Animal,” and Adena Schachner et al.’s paper, “Spontaneous Motor Entrainment to Music in Multiple Vocal Mimicking Species,” were published in *Current Biology* in 2009. Patel went on to author a deep, scholarly book called *Music, Language, and the Brain* (2010), which argues that music and language are not independent and should be studied together. Steven Pinker’s “auditory cheesecake” hypothesis has attracted heavy criticism; while many evolutionary biologists explain music in terms of natural selection, its survival advantage remains unclear—except that it gives us pleasure (in a recent incarnation of this argument, Henkjan Honing calls music a “game” in his 2011 book, *Musical Cognition*). Human musical evolution is a complex subject; my main point, besides the inspiration of curiosity, is that our music and language may share more with parrots, and other animals, than we realize.

## SEEING RED

The world’s chickens have been counted by the Food and Agriculture Organization of the United Nations, the Global Livestock Production and Health Atlas, and other groups, though all totals are necessarily es-



timates. Per capita U.S. meat consumption is closely monitored by the Livestock Marketing Information Center. Thorleif Schjelderup-Ebbe's 1921 dissertation was first translated into English in 1927, according to Porter Perrin, who reviewed the term "pecking order" in 1955. Schjelderup-Ebbe's studies have been referenced by many—for instance in a 1988 Stanford essay, "Dominance Hierarchies," by Paul Ehrlich et al. Colin Allen wrote an in-depth review of transitive inference in animals in a chapter of the 2006 book *Rational Animals?* Joseph Malkevitch investigated tournament graph theory in a featured essay for the American Mathematical Society called "Who Won!" H. G. Landau's theorem was originally published in his 1953 article "On Dominance Relations and the Structure of Animal Societies." Randall Wise's red chicken contacts were reported in *Los Angeles Times* and *New York Times* articles in 1989, as well as in other media.

#### CACHE MEMORY

The full text of Lewis and Clark's journals, totaling nearly 5,000 pages, is archived at [lewisandclarkjournals.unl.edu](http://lewisandclarkjournals.unl.edu) (accessed March 2013). Lewis and Clark's supply list is on the *National Geographic* website. H. E. Hutchins and R. M. Lanner (1982) documented nutcrackers caching up to 98,000 seeds in one season (often burying several seeds in the same cache). Nelson Dellis has been featured on CNN and Fox News, in *Forbes* and *The New Yorker*, and in other media. Joshua Foer wrote a fascinating and highly readable book about the U.S. Memory Championship called *Moonwalking with Einstein* (2012). Johannes Mallow's records are listed on the World Memory Statistics website ([world-memory-statistics.com](http://world-memory-statistics.com); accessed March 2013). Stephen Vander Wall's five hypotheses about cache recovery are described in his 1982 paper "An Experimental Analysis of Cache Recovery in Clark's Nutcracker." Vander Wall continues to research caching behavior in various species, wrote the 1990 book *Food Hoarding in Animals*, and is an associate professor at the University of Nevada, Reno. Paul Reber, a psychology professor at Northwestern University, estimated the human brain's capacity at 2.5 petabytes in a *Scientific American* article on April 19, 2010. *Wired* mentioned in a February 2011 article by John Timmer that a

single human brain could perform the calculations of all the world's computers combined—a vague but interesting assertion. Martin Hilbert and Priscila López estimated the information contained in a single human's DNA (not the brain) at 30 zettabytes (30,000 exabytes) in a 2011 *Science* paper. The student vs. nutcracker study was mentioned by Richard Cannings in his 2007 book, *The Rockies: A Natural History*. Relationships between hippocampal volume and memory were discussed in a 2004 paper by Cyma Van Petten. Captive chickadee hippocampi were shown to shrink 23 percent in a 2009 Cornell University study by Tim DeVoogd and Bernard Tarr.

### MAGPIE IN THE MIRROR

The Eurasian magpie mirror test is reported in Helmut Prior et al.'s 2008 paper "Mirror-Induced Behavior in the Magpie (*Pica pica*): Evidence of Self-Recognition." Mirror tests with young children are described in Beulah Amsterdam's 2004 paper "Mirror Self-Image Reactions Before Age Two." The history of the word *magpie* is given in the *Funk & Wagnalls Wildlife Encyclopedia* (1974). Magpie superstitions are discussed in a 2008 BBC News Magazine article by Denise Winterman, "Why Are Magpies so Often Hated?" Sang-im Lee et al. inferred magpie phylogeny from mitochondrial DNA data in 2003. The paper by Won Young Lee et al. describing magpies recognizing human faces was published in *Animal Cognition* in 2011. The *Manchester Evening News* reported a magpie stealing car keys and tools in 2006, and *The Telegraph* reported a magpie stealing a woman's engagement ring in 2008. Marc Bekoff described the magpie funeral (along with other examples of animal emotion) in his 2009 paper "Animal Emotions, Wild Justice, and Why They Matter: Grieving Magpies, a Pissy Baboon, and Empathetic Elephants." A 2012 *Time* magazine article by Jeffrey Kluger profiled loyalty and friendship in dolphins and other animals, empathy in rats was described in a 2011 *Science* paper by Inbal Ben-Ami Bartal and coauthors, and mourning-like behavior was described in elephants in a 2006 *Biology Letters* paper by Karen McComb and colleagues. Gordon Gallup, Jr.'s pioneering mirror tests with chimpanzees were published in a 1970 *Science* paper. Studies of human self-recognition in patients with autism, schizophrenia,

Alzheimer's disease, and brain injuries are summarized from Gallup et al., "The Mirror Test," in the 2002 book *The Cognitive Animal*. Jens Asendorpf et al. conducted the 1996 study showing children may be influenced by others' behavior on the mirror test. The story of Phineas Gage was related in a 2010 *Smithsonian* magazine article. Michael Benton (1990) gave the figure of 300 million years for divergence of birds and mammals in a *Journal of Molecular Evolution* paper. Robert Epstein et al. trained pigeons to pass the mirror test (without apparent self-recognition) and reported their results in a 1981 *Science* paper.

## ARTS AND CRAFTINESS

I observed great bowerbirds during a six-month field season at Mornington Sanctuary in northwest Australia (see the chapter titled "Fairy Helpers"). The great bowerbird with a toy soldier was photographed by Tim Laman and accompanied a 2010 *National Geographic* feature about bowerbirds by Virginia Morell. Theft of colorful wire in great bowerbirds was studied and described by Natalie Doerr (2010). Richard Dawkins, author of the influential 1976 book *The Selfish Gene*, published *The Extended Phenotype* in 1982. John Endler's 2012 paper "Bowerbirds, Art, and Aesthetics" appeared in *Communicative and Integrative Biology*. As he points out, the *Stanford Encyclopedia of Philosophy* has a helpful, in-depth discussion of the definition of art on its website, revised in 2012. John Endler et al.'s 2010 paper about bowerbird forced perspective appeared in *Current Biology*, with a 2012 follow-up by Laura Kelley and John Endler ("Male Great Bowerbirds Create Forced Perspective Illusions with Consistently Different Individual Quality") concluding that this trait varies by individual. Denis Dutton's book *The Art Instinct* was published in 2010. Jared Diamond authored a paper about bowerbirds and the evolution of aesthetics in *Nature* in 1982. His study of bowerbird style (with conclusions about culturally transmitted visual taste) was reported in his 1986 paper "Animal Art: Variation in Bower Decorating Style Among Male Bowerbirds *Amblyornis inornatus*." Odoardo Beccari's quote is taken from a chapter in volume 2 of Samuel Lockwood's *Readings in Natural History* (1888), titled "The Bower Birds—Avian Aesthetics." The chimpanzee painting story is well documented in a Museum

of Hoaxes Web article called “Pierre Brassau, Monkey Artist, 1964.” Specific bowerbird taxonomy is unclear; these birds are thought to have descended from the crow family along with many other Australian birds, and are now perhaps most closely related to lyrebirds (Charles G. Sibley et al., 1984). Joah Madden described bowerbird brain sizes in his 2001 paper “Sex, Bowers, and Brains.”

## FAIRY HELPERS

I spent six months at the remote Mornington Sanctuary, a property of the Australian Wildlife Conservancy in interior northwest Australia, in 2010, as part of a multiyear study on purple-crowned fairy-wrens funded by the Max Planck Institute for Ornithology, under the able direction of Michelle Hall. Results of this research were published in a 2012 paper by Sjouke Anne Kingma et al., “Multiple Benefits of Cooperative Breeding in Purple-Crowned Fairy-wrens.” I highly recommend Richard Dawkins’s classic 1976 book *The Selfish Gene*, which outlines the case for altruism as a means of furthering genetic legacy. The concept of kin selection can be traced to Darwin; more recently, people such as J. B. S. Haldane have computed its effects precisely, and author-scientists such as E. O. Wilson have explained it to the rest of us (see his 1980 book, *Sociobiology*). Game theory is the study of strategy, completely separate from biology, but there are fascinating parallels; John Maynard Smith and other biologists have used game theory to enhance our understanding of evolution, from sex ratios to territoriality and animal communication—and altruism. Mathematicians Merrill Flood and Melvin Dresher originally formulated the prisoner’s dilemma in 1950, and political scientist Robert Axelrod reported on his iterated prisoner’s dilemma tournament in his 1984 book, *The Evolution of Cooperation*. Stephen Majeski argued that arms races are prisoner’s dilemmas in his 1984 paper, “Arms Races as Iterated Prisoner’s Dilemma Games.” Andrew Russell’s 2007 paper about maternal investment in superb fairy-wrens is titled “Reduced Egg Investment Can Conceal Helper Effects in Cooperatively Breeding Birds.” Martin Nowak’s 2011 book *SuperCooperators* explains his argument that cooperation should be considered a third tenet of evolution. The neuroscience of charity was reported in an article in

*The Economist* of October 12, 2006, “Altruism: The Joy of Giving.” Judith Lichtenberg, a philosophy professor at Georgetown University, wrote an insightful essay titled “Is True Altruism Possible?” in an online *New York Times* opinion page of October 19, 2010.

## WANDERING HEARTS

Anecdotes are from the Carcass Island and West Point black-browed albatross colonies in the Falkland Islands in 2012, when I worked as an onboard ornithologist for three cruises to Antarctica with One Ocean Expeditions. I heartily recommend Carl Safina’s book *Eye of the Albatross* (2003), which paints a convincingly realistic portrait of life from an albatross’s perspective. Gray-headed albatrosses were documented circumnavigating Antarctica in a 2005 *Science* paper by John Croxall et al. Brain scans of love-struck college students were analyzed by Andreas Bartels et al. (2001), who described three stages of love: lust, infatuation, and enduring love. Social monogamy rates in mammals and birds are given in the textbook *Animal Behavior* by John Alcock (ninth edition, 2009). Sexual monogamy rates of saltmarsh sparrows were measured by Chris Elphick et al. in 2009. The topic of bird divorce was explored by Susan Milius in an engaging 1998 *Science News* article. Divorce rates have been studied in New Zealand’s red-billed gulls by James Mills. André Dhondt and Frank Adriaensen reported blue tit divorces in “Causes and Effects of Divorce in the Blue Tit *Parus caeruleus*” (1994). Human divorce rates are the subject of much quibbling, but overall trends are definite: In the United States, divorce rates tripled between 1950 and 1980, then flattened and declined, and about 40 percent of today’s new marriages are projected to end in divorce. David Anderson has studied divorce in Nazca boobies, reporting a 38 percent annual rate (“Serial Monogamy and Sex Ratio Bias in Nazca Boobies,” 2007). Pierre Jouventin et al. reported a 0.3 percent divorce rate in wandering albatrosses from the Crozet Islands in a 1999 *Animal Behavior* paper. Genevieve Jones documented an 18 percent extra-pair paternity rate (illustrating the difference between social and sexual monogamy) in wandering albatrosses in 2012, after an earlier genetic study had estimated a 10 percent extra-pair paternity rate in 2006. The oldest known albatross is a female

Laysan albatross named Wisdom, who, as of 2013, was still raising chicks at age sixty-two; John Cooper et al. reported a wandering albatross estimated by band recovery to have been at least a half-century old in 2001, noting that “demographic studies need to continue for several more decades” before we learn how long they might live in the wild. Martin Gardner, in *The Annotated Ancient Mariner*, points out that Samuel Taylor Coleridge probably didn’t realize just how big an albatross is; a flopping twenty-pound bird with a twelve-foot wingspan wouldn’t so much drape around a sailor’s neck as drag heavily on the ground. Not all metaphors should be taken literally.