## Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>THE ENIGMA OF THE STAR</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>PASTEUR WAS RIGHT</td>
<td>28</td>
</tr>
<tr>
<td>3</td>
<td>THE STING</td>
<td>54</td>
</tr>
<tr>
<td>4</td>
<td>THE MYSTERY OF WORM GRUNTING</td>
<td>76</td>
</tr>
<tr>
<td>5</td>
<td>TINY T-REX</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>YOU HAD ME AT 500 VOLTS</td>
<td>118</td>
</tr>
<tr>
<td>7</td>
<td>THE ART OF MAKING A ZOMBIE</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td>EPILOGUE</td>
<td>176</td>
</tr>
<tr>
<td></td>
<td>Acknowledgments</td>
<td>179</td>
</tr>
<tr>
<td></td>
<td>References</td>
<td>183</td>
</tr>
<tr>
<td></td>
<td>Chapter-Opening Captions</td>
<td>189</td>
</tr>
<tr>
<td></td>
<td>Illustration Credits</td>
<td>191</td>
</tr>
<tr>
<td></td>
<td>Index</td>
<td>195</td>
</tr>
</tbody>
</table>

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INTRODUCTION

If you ask me why I love my job as a scientist, I can’t help but think of the first scene in *The Princess Bride*. The movie opens with a grandfather (Peter Falk) about to read a book to his sick grandson (Fred Savage), and the skeptical kid asks, “Has it got any sports in it?” The grandfather replies, “Are you kidding? Fencing, fighting, torture, revenge, giants, monsters, chases, escapes, true love, miracles.” I might say as much about the biology covered in this book. In fact, I’d have to add a few words, like electrocution, zombification, deception, and centuries-old legends. Although true love may be absent, I’d argue it’s made up for by the beauty of the animals, which I have made a special effort to photograph so you can judge for yourself. I’d have to stop at miracles—I am a scientist, after all. That said, if there’s one word that best captures my own recurrent feeling about the process of discovery and the things I’m going to describe, it would be: “inconceivable.”

That may seem like an overly dramatic viewpoint for a scientist. But I’ve spent thousands of hours studying the brains and behaviors of unusual animals; I’m supposed to be an expert. Still, every time I investigate a new species, my best guess about what the animal can do and how it can do it is wrong. And I’m wrong in the best possible way; the animals are always able to do something unexpected and more interesting than I’d imagined.

This book is my personal account of those unexpected and interesting things discovered during a career spent investigating biological mysteries. These discoveries are presented much as they happened, as a chronological series of case studies, beginning with my first forays into research as an undergraduate working at the National Zoo in Washington, DC, where I was tasked with collecting and studying the famously enigmatic star-nosed
mole, a small mammal with pink, fleshy tentacles surrounding its nose. Like any good mystery, there were many false starts and blind alleys along the way, but that only made me more curious. What exactly is the star and what is it used for? How and why did such a bizarre structure evolve? After many failed attempts to solve this mystery, I tried to move on. But like an obsessed cold-case detective, I eventually returned to the star-nosed mole in graduate school. With help from my mentor and other scientists, we eventually cracked the case, so to speak—discovering many astonishing things about the mole’s brain and behavior, not to mention how and why the star likely evolved. Along the way I discovered that you and I share some surprising habits with star-nosed moles.

The experience with star-nosed moles gave me a taste for unsolved biological mysteries and extreme adaptations. It inspired me to investigate other strange creatures, like tentacled snakes, water shrews, electric eels, zombie-making parasitoids, and even humans with some seemingly magical traditions. Electric eels, for example, turned out to be one of the most underestimated creatures on our planet. That’s saying a lot, given their legendary status as electricians capable of generating hundreds of volts for both offense and defense. For centuries it was assumed that an animal with such impressive weaponry had no need for sophisticated behavior. As I soon discovered, electrical power is only half the equation. The other half is, as they say, “all in the delivery.” The eel’s behavior allows it to use electricity to rival weapons from science fiction (I should know; I tested the eel’s electrical weapon on my own arm). The eels demonstrate that even animals we have studied for centuries still hold secrets to be uncovered. And there’s another more specific lesson—where you find extreme anatomical traits, you can often expect to find equally extreme behaviors.

There’s more of course. If you want to learn about a predator that sets the ultimate trap—as if it can predict the future—or if you need to know the best strategies to avoid becoming a zombie, you’ll have to read on. Each of these cases reveals a masterpiece from evolution’s work. But there is more to learn from these animals than simply the details of particular adaptations, as wonderful as they may be. Just as studying one masterpiece in a museum
can teach us much about the artist, each of these specific systems can teach us generalities about animal behavior, brain organization, development, and evolution. This is an important and often unappreciated theme in science.

To mention just a few examples, much of what we know about how brain cells (neurons) conduct signals was figured out in squid, because they have giant nerve fibers, which evolved for super-fast escape from predators. The result was a giant leap forward in our understanding of all animal brains (not to mention the Nobel Prize for the scientists). Similarly, the means by which neurons most quickly communicate with one another (the electrical synapse) was discovered by studying the humble crayfish, which uses its fast-conducting neurons to escape predators (but as you’ll learn in chapter 5, it’s not always fast enough). On the predator side, venoms of snakes and snails are a rich source of potential therapeutic agents. Some venoms are already being used to treat chronic pain, and many others are being investigated for potential stroke and cancer therapies. Even a predator as strange as an electric eel has advanced science immensely, first by inspiring Italian scientist Alessandro Volta to invent the battery in 1800, and much later by allowing the isolation of a key molecule (the acetylcholine receptor) that is required for virtually all skeletal muscle activity. I could go on. In short, you can’t swing a stick without hitting a major scientific advance that resulted from studying diverse and specialized animals. That’s true because all animals play by the same evolutionary rules. The result is what Richard Dawkins has so elegantly called “The Greatest Show on Earth.” One of my goals is to showcase some great performances from that show.

But I have another goal as well. I hope the reader will learn something not only about these incredible animals, but also about the process of discovery. Like everyone else, I’m attracted to mysteries; that’s part of human nature. Whether it’s an unusual star in the heavens or an unusual star on a mole, outliers have always served as a beacon of sorts, compelling a much closer look. Over time I have found it’s not the mystery or the outlier that’s important, it’s the closer look. I say this because, as often as not, the most interesting thing about an animal is not evident from the outset of an investigation. Moreover, in my own experience, even the seemingly simple
species do something truly remarkable (keep this in mind when you read about “primitive” shrews, “common” moles, or even the lowly cockroach). I often think of an experiment as akin to looking through a pair of binoculars. You see something at the edge of your vision and you put them to your eyes to get a closer look. But you never know what will come into focus, or what else might be in the picture.

Today’s student in biology might be skeptical; after all, scientists have been taking “a closer look” at biological systems for centuries. Why should we expect new discoveries to abound? Part of the answer lies in what I like to call the “marvels of modern technology.” Our metaphorical binoculars have vastly improved. Just as the Hubble Space Telescope has, literally and figuratively, changed our view of the universe, similar advances in the technologies for research into neuroscience, evolution, and behavior have opened new vistas for investigation and discovery. It’s a great time to be a scientist.

And that brings up another reason for writing this book. I’ve had many adventures conducting research, but you would never know this from my formal publications describing the results. Scientists are trained to write a bit like Mr. Spock, delivering a series of facts in the third-person, using the passive voice and certainly not betraying emotions. There’s good reason for this when it comes to technical literature, which needs brevity and a certain uniformity of style. But it gives the wrong impression. Not only does this leave out much of the backstory, there’s also no mention of the sense of wonder when the clouds part and Nature reveals one of her secrets. One of my goals is to share those experiences and hopefully change some perceptions about how discoveries happen and what it’s like to do research. But most importantly, I hope this small window into some remarkable animals will convince you that Nature is far more interesting than we imagine—and something to be treasured.

P.S.: I’m going to describe some things that seem (at least to me) extraordinary. If you’d like to judge for yourself, then when you see a QR code in the book, use the camera in your smart phone to scan it, and it will take you to a movie showing the animals in action.
Index

Note: Page numbers followed by “f” refer to illustrations.

acetylcholine receptor, 3, 121
action potentials, 110
Adams, Michael, 159–60, 163
agar barriers, 21–22, 127
Alien (movie), 171, 173–74
alligator snapping turtles, 55–58
amphiuma, two-toed and three-toed, 23
Apalachicola National Forest. See worm grunting
barrel field, 33–34, 34f
bats: echolocation, 40, 94–96, 98, 134; feeding buzz, 138; moles and, 98; moths and, 94–95, 98
Bauer, Richard, 129
beetles: Anomala scarab, 152; ladybird (ladybug), 152, 176
Bonpland, Aimé, 119
brain structures. See neocortex; neocortical mapping; optic tectum
Bullock, Ted, 24
cane toad, giant, 156
“The Cask of Amontillado” (Poe), 161, 170–71
Catania, Liz, 116–17, 126, 140, 142, 164, 176–77
cerci, 157
cheetahs, 106
Churchill, Winston, 5
Coates, Christopher, 121–22, 122f, 139
cockroach, American (Periplaneta americana): antenna amputation and blood meal by wasp, 161–62; attack strategy of wasp against, 154–55, 159–60; defense strategies, 166–70, 167f, 169f; entombed with wasp egg, 162–63, 171–75; escape system, 157; horror movie of wasp and, 163–66, 165f; microbes in and on, 174; at National Zoo, 20; survival odds against wasp, 155, 170, 171–72; zombification of, 157–59, 162–63
coevolution between bats and insects, 94–95
conductance detection, 135–36
cortical magnification, 38–40, 39f
cortical maps. See neocortical mapping
crayfish, 3, 109–11, 110f, 111f
crossed inhibitory neurons, 67
Darwin, Charles, 79, 93, 120–21, 124, 145
Dawkins, Richard, 3, 75
Dehnel’s phenomenon, 101
desman, Russian, 53f
discoveries, serendipity, and preconceptions, 176–77
dogs, 52
diplocardia mississippiensis
Earthworms: Diplocardia mississippiensis (Apalachicola National Forest), 81; emergence and speed of crawl, 89–90; mole consumption of, 90; star-nosed mole and, 12–13, 15, 21, 47, 50. See also worm grunting
echolocation, 40, 94–96, 98, 134
eel, electric (Electrophorus electricus): about, 118–19; attack sequence, 123, 123f, 132–33, 133f; bat echolocation compared to, 138; circuit characteristics (voltage, internal resistance, and target resistance), 146–48; defensive leaping attack, 140–48, 143f, 145f, 148f; doublet hunting and fish twitches, 129–32, 130f, 131f; electric organ of, 124–25; For general queries, contact webmaster@press.princeton.edu
eel, electric (Electrophorus electricus) (cont.)
electroreception, high-voltage, 134–39, 135f, 136f, 137f; Faraday, Darwin, Volta, and, 120–21; fish muscle contraction and freezing response, 123–24, 126–28, 127f, 128f; Humboldt’s horse experiment, 119–20, 120f, 139–40, 144f, 145; low- and high-voltage pulses, 125–26, 125f; natural habitat of, 143; neuromasts, 129, 133; pain receptor neurons, activation of, 142; photography of, 121–23, 122f; science advanced by, 3; Tasers compared to, 126; vision, poor, 133–34
Eimer’s organs, 22, 29–32, 30f, 42, 47, 81
electrical synapses, 3, 109, 111
electric eel. See eel, electric
electrocytes, 124
electroreception: in amphibians, 23–24; in electric eels, 125, 134–39, 135f, 136f, 137f; in electric fish, 135–36; in fish, 124–25; in sharks, 10–11, 19–20; star-nosed mole and, 10–11, 19–22
Electroreception (Bullock and Heiligenberg), 22–24
emerald jewel wasp. See wasp, emerald jewel excitatory signals, 66
exoskeletons, 157, 168
Faraday, Michael, 120, 124
fish: C-start escape response in, 64–68, 66f, 74–75; electric organs in, 119, 124–25, 135; hearing in, 64–65; muscle contraction and freezing response to electric eel, 123–24, 126–28, 127f, 128f; water shrews and, 105–8, 106f, 107f. See also snake, tentacled
Foraging Theory (Stephens and Krebs), 49
The Formation of Vegetable Mould through the Action of Worms with Observations on Their Habits (Darwin), 79
fovea, 39–40
Galileo, 130–31
gamma aminobutyric acid, 159
ganglia, 159
gleophones, 91
Gould, Edwin, 9–11, 15, 20, 24
Gould, Stephen Jay, 45, 47
Graham, Charles, 41
Guinness World Record Certificate (star-nosed mole), 50f, 51
Hamilton, William, 48
handling time, 49, 63
hands, human, 32
Hawaiian Sugar Planters Association, 151–55
hearing: in bats, 40; in fish, 64–65; human, 60–62; primary auditory cortex, 113, 114f; stereo, 97; and vision in tentacled snake, 61–62
Heiligenberg, Walter, 24
Herzner, Gudrun, 174
Homalopsid Snakes (Murphy), 63
homunculus, 33, 33f
Hubble Ultra-Deep Field image of space, 177–78
Humboldt, Alexander von, 119–20, 120f, 124, 127, 129, 139–40, 143–45
hypotheses and preconceptions, 177
inhibitory neurons and neurotransmitters, 66–68, 159
insectivores, 8
instinct vs. learning, 72–75
Kaas, Jon, 35–36, 40
Kalmijn, Adrianus, 19–21, 127
Kaufmann, John, 93–94
The Killer Shrews (movie), 101
Kuralt, Charles, 78
lacewings, predatory, 152
ladybird beetle (ladybug), 152, 176
lamellated corpuscles, 31
leafhoppers, sugarcane, 152
learning vs. instinct, 72–75
Leitch, Duncan, 59, 112
Libersat, Frederic, 158–60, 163
light microscopy, 25
Lyden jar, 119
Manning, Anita, 166
mapping, neocortical. See neocortical mapping
Mauthner cells, 66–88, 66f, 70
McSchae, Bill, 10, 12–13
Merkel cells, 31
metabolism, in water shrew, 102, 109–10
mice, whiskers of, 32–35, 34f
microscopy, 25–26. See also scanning electron microscopy
mole, common (eastern American) (Scalopus aquaticus), 84f; about, 81–82; controlled experiments, 92–93; foraging strategy and stereo olfaction, 94–99, 97f; population assessment and capture, 82–84; star-nosed mole compared to, 81–82, 96; tunnel across road, 83f; vibrations of, 90–91; worm-eating test, 90
mole, star-nosed (Condylura cristata), 16f; “backward” development of star, 43–45, 44f; common mole compared to, 81–82, 96; cortical magnification and touch fovea, 38–40, 39f; description of, 5–6; early encounters with, 7–8; Eimer’s organs, 22, 29–32, 30f, 42, 47; electroreception and, 10–11, 19–22; evolution of star, and coast mole proto-star, 45–47, 47f; finding and trapping, in northern Pennsylvania, 11–18, 26–27, 28; front teeth, 50, 50f; Guinness World Record Certificate, 50f, 51; habitat and tunneling habits, 12; as insectivore, 8; mapping of somatosensory neocortex, 32–38, 33f, 37f; microscopy of embryo, 40–43, 42f; microscopy of star and Eimer’s organs, 29–32, 30f; National Zoo and, 9–11, 18–22; questions about, 6; range, 8; small prey and foraging speed, 48–51; underwater sniffing (olfaction) by bubble-blowing, 51–53, 53f; water shrew compared to, 104
mole-rat, naked, 39f
moles: coast, 45–47, 47f; Darwin on, 79; Eimer’s organs in, 81; European, 22; seagull encounter, 98–99, 99f
Montgomery, Steve, 166
moths, 94–95, 98
Murphy, John, 63, 68
National Zoo, 9–11, 18–22, 56–57, 103
neocortex: brain enlargement and speed, 115; cortical columns theory, 36; cortical magnification, 38–40, 39f; development, in star-nosed mole, 42–43; human compared to shrew, 113–16, 114f; shrews and early mammals, 112–14; visual (human), 40
neocortical mapping: about, 32–33, 33f; mouse whiskers, 32–35, 34f; star-nosed mole, 35–38, 37f; star-nosed mole embryo, 40–43, 42f; water shrew, 112–14, 114f
nerve fibers: fast conducting, 110–11; electric synapses, 3, 109, 111; electric eel and, 134, 142; human hand, 38; inhibitory, 66–68, 159; Mauthner, 65–68, 66f, 70 (see also neocortical mapping); in optic tectum, 60–61; pain receptor, 142; in squid, 3; wasp venom and, 159, 163
neurotransmitters, 159, 160, 175
New Caledonia, 152–53
night crawlers. See earthworms
nonnative species, risks of, 156
Northcutt, Glenn, 23–27, 35, 37
olfaction (smell): bubble-blowing underwater (star-nosed mole), 51–53, 53f; dogs, 52; early mammals and, 113–14; stereo, in common mole, 97–98; water shrew, 108
On the Origin of Species (Darwin), 79, 120
Ontogeny and Phylogeny (Gould), 45
optic tectum, 60–62, 62f
pain receptor neurons, 142
Pasteur, Louis, 34
Penfield, Wilder, 33
pit-vipers, 58–59
platypus, duck-billed, 11, 39f
Poe, Edgar Allan, 119, 161, 170–71
raccoon, 39f
Ramon y Cajal, Santiago, 177
rare enemy effect, 75, 93
rats, 20
Remple, Fiona, 48
resistance, internal and target, 146–48
Revell, Audrey, 80, 84–86, 87, 94

For general queries, contact webmaster@press.princeton.edu
Revell, Gary, 76f, 80, 84–89, 85f, 88f, 92–94
Roosevelt, Theodore, 100–102, 104–5
Sachs, Carl, 139, 143–44
Sagan, Carl, 130
salamanders: axolotl, 23–24, 26; electroreceptive, 23–24; hellbender, 23; two-toed and three-toed amphiuma, 23
scanning electron microscopy: about, 25–26; star-nosed mole, 29–31, 30f, 40–41, 42f; water shrew foot, 104f
Scheich, Hennick, 11
Schomburgk, Robert, 144–45
Scott, Ridley, 173–74
seagulls, 93, 98–99, 99f
sea lions, 107
seals, 107
sharks, electoreception in, 10–11, 19–20
Sherman traps, 13
shrew, water (Sorex palustris), 16f; about, 102–3; crayfish as prey, 109–11, 110f, 111f; finding and trapping, 14, 103; foot of, 104f; hunting strategies, 104–8, 106f, 107f; metabolism, high, 102, 109–10; neocortex and ancestral mammals, 112–16, 114f; Roosevelt on, 100–101, 104–5; speed, 105–6, 110–11; star-nosed mole compared to, 104; swimming adaptations, 103, 104f; underwater sniffing, 52–53, 53f, 108; vision, poor, 106; warm-bloodedness, 110–11; water movement and stationary detection, 107–8; whiskers, 107
shrews, 100f; about, 100–102; as insectivores, 8; masked (Sorex cinereus), 14, 16f, 116–17; red-toothed, 102; short-tailed, 14, 16f, 100–102
smell. See olfaction
snake, tentacled (Erpeton tentaculatum), 54f; body feint, 68–69; C-start escape response in fish and, 64–68, 66f, 74–75; fish attraction hypothesis, 57–58; fish turning toward strike, 62–63, 63f; instinct vs. learning, 72–75; J-shaped hunting posture, 55, 55f, 68; optic tectum and merging of vision and touch, 60–62, 62f; predictive strike, 69–72, 70f, 71f; water motion sensors, 58–60
snakes: brain structure of, 60; pit-vipers, 58–59; rattlesnake, 19
snapping turtles, 55–58
Society for Neuroscience, 48–49
somatosensory neocortex mapping. See neocortical mapping
Sopchoppy, Florida, 78, 80, 95f
squid, 3
star-nosed mole. See mole, star-nosed
stereo olfaction, 97–98
superior colliculus, 61
tasers, 126
temperature and speed, 110–11
tentacled snake. See snake, tentacled
Tinbergen, Niko, 93–94
touch: early mammals and, 114; primary somatosensory cortex, 113, 114f; star-nosed mole touch receptors, 31–32, 38–40, 39f; tentacled snake, optic tectum, and, 61; water shrew, 108
transmission electron microscopy, 25–26, 30
turtles: alligator snapping, 55–58; common snapping, 56; spotted, 10; wood, 15, 93–94
underwater sniffing, 51–53, 53f
University of California at San Diego (UCSD), 23–24, 41
University of Maryland, 8, 23–24
Vanderbilt University, 35–36, 57
Van Vleck, David, 22
venoms: emerald jewel wasp, 158–59, 160, 163, 175; rattlesnake, 19; short-tailed shrew, 14, 101; as therapeutic agents, 3
vision: in electric eel, 133–34; goggles, vision-shifting, 72–73; human, 39, 61–62; primary visual cortex, 113, 114f; in tentacled snake, 61–62, 70–73; in water shrew, 106
voles, 14
Volta, Alessandro, 3, 121
walruses, 107
wasp, emerald jewel (Ampulex compressa): about, 150; antimicrobial compounds of grub, 174; attack strategy, 154–55, 159–60; blood meal, 161–62; containment of, 149–
Index

50; defense strategies of cockroach, 166–70, 167f, 169f; egg-laying, 162, 172–73, 173f; escape strategy of cockroach, 157; grub, cocoon, and larvae development, 172–75; horror movie of cockroach and, 163–66, 165f; introduced to Hawaii by Williams, 150–55; as nonnative species, 156; odds of survival for cockroach, 155, 170, 171–72; size of offspring and of cockroach, 170; tomb-building, 161; venom and zombification, 157–59, 162–63; victory of cockroach over, 155

wasp, parasitic (Larra luzonensis), 152

water shrew. See shrew, water

weasel, short-tailed, 15, 16f, 17

whiskers: mouse whiskers and somatosensory neocortex mapping, 32–35, 34f; seals, sea lions, and walruses, 107; water motion detection with, 59, 107; water shrew, 107

White Zombie (movie), 158

The Wilderness Hunter (Roosevelt), 104

Williams, Francis, 150–56, 166, 170

Williams, Louisa Lewis Clark, 153–56

worm grunting (Diplocardia mississippiensis earthworms, Apalachicola National Forest): common mole as prime suspect, 80–84, 84f; controlled experiments, 92–94; Darwin and, 79, 93; description and profession, 76–78; field observations, 87–91, 88f; lessons with experts, 84–86, 88–89; mole foraging strategy and stereo olfaction, 94–99, 97f; rain hypothesis, 91–92; seagull and wood turtle behavior and, 93–94; Worm Gruntin’ Festival (Sopchoppy, FL), 80, 95f

zombification. See wasp, emerald jewel

“zoo within a zoo,” 21. See also National Zoo