

TABLE OF CONTENTS

Prologue	xv
Introduction	1
The Mycelial Way: A Quick Guide	11

Part One—Of Ants and Apes

1. Supersaurus Wrecks	17
2. Ask a Local	20
3. The Meek Shall Inherit the Earth.	27
4. The Sacred Desert Monkey.	40
5. All for One and One for All	48
6. Our Magic Friendship Number	54
7. The Tao of Superchimp	59
8. The Maker Instinct	64

Part Two—Design Your Own Superorganism (Collective Intelligence)

9. Build from the Bottom Up	71
10. The Power of Self-Organization.	75
11. Scattered, Squandered Scraps	89
12. Confucius Says Think for Your Own Damn Self	103
13. Feel Like Making Stigmergy?	110
14. Simple Rules and Tipping Points	121

Part Three—The Urge to Pro-Create (Swarm Creativity)

15. Fairy Rings.	131
16. Shared Purpose	135
17. Toss it Up and See What Sticks	145
18. It's Sexy Time!	152
19. The Inbreeding Valley of Death	157
20. Going Viral	162
21. Brewtopia	170

Part Four—The Sweet Spot Between Order and Chaos

(Distributed Leadership)

22. We Meet in the Middle	183
23. Surfing the Edge	187
24. Are you a Grizzly or an Aardvark?	191
25. Lead Like a Superorganism	194

Part Five—The Two Percent Difference

(Reciprocity and Sharing)

26. Please Don't Eat Me	211
27. The Ant-Like Ape	221
28. Now We're Cooking Soup	225
29. Freaks, Geeks, and Folks Like Me.	229
30. Might Versus Right	234
31. You Say You Want a Revolution?	239
32. A Rat in our Midst.	246
33. Fuhgeddaboutit	251
34. Our Lips are Sealed	256
35. Expanding our Superorganism	263

Part Six—The Superorganism Value Proposition

(Regenerative Value)

36. Reincarbonation.	271
37. The Tail Grows Back, You Know	281
38. Ecosystem Engineers	285
39. The Snuggle for Survival	289

Notes	295
References.	309
Acknowledgements.	316
About the Author.	320

PROLOGUE

[The ants] have been dominant elements of most of the land habitats for at least 50 million years . . . It gives great pleasure to think that they stung or sprayed formic acid on many a dinosaur that carelessly trampled their nests.

—E. O. WILSON¹

Did you ever see that old black and white nature documentary, where hundreds of lemmings jumped from the Norwegian cliffs to their death, all for the good of their species? It made a deep impression on the four-year-old me. Their instinct for self-sacrifice was so moving.

Humans should really do that, I thought.

But we don't. *Why not?* I'm embarrassed to say I devoted way too much time over the next three decades trying to figure out how lemming suicide could possibly evolve. This somber scene was the catalyst for an entire life (and a dissertation) spent trying to understand how behavior drives evolution, and vice versa. It was only a few years ago I discovered the film crew had tossed those lemmings off by hand for a little extra drama. The whole thing was a fake—evolution just doesn't work that way.

This is not a tree-hugging book, though I've hugged my fair share of trees (and actually dated a guy that lived in one for awhile). It's not about giving everything away for free, or moving companies onto communes. I'm not advocating a return to the mythical innocence

of our forgotten nature. But I am an evolutionary biologist, and I study social systems. I know first-hand that predation and parasitism are real, and that every group of collaborators needs to protect their collective wealth against them. Competition *does* drive life's radical innovations, honing wondrous form to function, and life really is survival of the fittest.

I first learned this math of evolution in the tide pools, where I spent a lot of time as a kid. Waves and piercing UV rays blast the rocky shores here twice a day, and a good piece of real estate was—and still is—hard to find. Collaboration doesn't jump out at you here—everyone seeks opportunity at someone else's expense. The nudibranch eats a stinging anemone, borrowing its paralyzing chemistry to make predators think twice. Hermit crabs move into the spiraling safety of shells discarded by the snails that make them. These are one-time transactions, not relationship-builders. *Thanks, and buh-bye.* Reputations aren't built here, and it's every man—or mussel—for himself. For beloved writer John Steinbeck, these pools were a tranquil and lovely and murderous metaphor for human endeavor—creatures scratching desperately for a patch of rock to call their own, holding on for dear life once they found it.³ A barnacle retreats deep into his home, sealing shut to protect his soft, tender body from the harsh realities of life, and if one anemone creeps too close to another, the cranky carnivores shoot tiny harpoons of paralyzing toxin at each other until the rival moves on. It's eat or be eaten on the reef.

Our lives feel like this a lot, and on Wall Street it's that way all the time. Business is premised on tidepool strategies—capturing market share, securing proprietary assets, monopolizing commodities. It's a dog-eat-dog world, and the unsentimental competitor cleans Mr. Nice Guy's clock every time. Right? Well, not exactly. It turns out the game of life isn't played in a vacuum, in business or on the reef, and the next level of growth demands alliance. In our lives and companies, competition and cooperation go hand in hand. They ebb and flow like the tide, driving the magic of evolution together.

As an undergraduate, I studied biology in the coastal redwood

forests of Santa Cruz, California. The fog there drips from spindly needle-like redwood leaves, condensing and harvesting every drop in eerie silence. Mushrooms pop up for an eager sip of moisture, while the tallest creatures on the planet scrap it out for sunlight high above them in the gloom. They carpet the forest floor with their acid needles, poisoning any who dare shadow their seedlings.

But there is more to the story than just a feverish arms race for sun. These plants need other things too—water, fertilizer, and mates—and these can be spread far and wide. If a plant can't get what it needs rooted in place, it has to partner with someone who can.

These trees cook up sugar—lots of it—and trade it with useful and quicker creatures in exchange for their services. Deep in the soil, the redwoods' roots intermingle with a pulsing network of fungi, which deliver a steady stream of water and fertilizer to their door. Other plants do business here too. In the nearby meadows, perfumed and nectar-rich flowers entice busy honeybees to smear their sexual pollen from one flower to another, while candy-colored sugarberries on the forest edge shrubs tempt squirrels and jays to gather and plant them, or splatter them around in moist packets of fertilizer. All of life is entwined in a tight dance of hungry bodies, and the next level of growth demands alliance.

Like most backyard biologists, I spent a lot of time scrabbling around in the dirt as a kid, watching ants. I scratched out their invisible trails with a stick and tried to trick them into following the wrong ones. They spoke in a chemical code—*Food's over here! Hey, who moved our cheese?* Each was a brainless machine cruising in dopey circles, but they always figured it out. You could stop a few, but more were always on the way. And they never ate on the spot. They took it home to share. I'd pour a pool of *Log Cabin* and time them with my swim team stopwatch. They were good at their work. It never took long. They were industrious and easy-going, running in endless, cheerful loops.

One day, my mom took me to visit a friend of hers, ten minutes east on the dry, planned-housing frontier—at the edge of the wild chaparral. I hotfooted it on their ill-conceived black slate patio, looking for

a patch of shade, when a mass of furious red things began teeming in frenzied agony up my leg from a crack between pavers. Like my peaceful little black ants, there was no stopping these hot-pepper red ones either. I shrieked and stamped, and rubbed my legs as my mom whisked me to safety and hosed me down. *Wow!* I was struck with respect for these angry red soldiers, and happy to leave them at her friend's house.

I never saw those red ants again. San Diego's native Southern Fire Ants are gone from these chaparral hills—wiped out by the mellow little black ants. How could that be? It turns out the black ants were descendants of Argentine banana boat stowaways, disembarked decades before. All claimed the same clan—these were super-sisters with the same chemical fingerprint. Today, this vast colony sprawls across California, displacing the natives as they go. The black ants just had more friends than the red ones.

Friendship and collaboration are their keys to success, and Professor Robert Trivers drove this home for me one day in 1989, when the Fates conspired to bring me to his lecture hall.

I was taking a class on neurobiology, planning a career in it. I wanted to know what kind of animals humans are, and it seemed to me the answer lay with our hideously swollen brains. I was eager to find out. Unfortunately, neurobiology involved finding out about a litany of horrifying experiments—each more disturbing than the last. How could the researchers stand it? Spinning mice in centrifuges until their bones grew wrong, keeping kittens in boxes until their eyes didn't work—how could they go home at night and make dinner for their kids? Was this the nature of the human animal? Repulsed, I turned away and stopped attending lectures. I sped through the textbook—but figured I should go the day before the final. But the regular professor wasn't there! Instead, we had a guest lecturer. I had no idea who this Professor Trivers was, but he immediately and irrevocably electrified me, and I've never been the same since.

He told us about something called Sociobiology—the study of social evolution. He spoke of vampire bats taking turns to cough up

blood for a hungry friend who returned the favor another night, and how closely related he'd have to be to make jumping in a river to save someone genetically worthwhile (he said he'd do it anyway—probably). He showed us the simple math of good deeds, in ant colonies and baboon troops, and showed us—mathematically—how a man might invest less in his offspring if he couldn't be sure he was their father; why siblings fought for their parent's attention to the point where an eaglet could push his brother from the nest to his death; and why a male lion taking over a pride could be expected to kill all the cubs.⁴ I was bolt upright in my seat the whole time. This explained everything. But the rest of the hippies in the audience didn't care for it one bit. *What about free will, empathy, fairness, and equality?* Trivers didn't give two figs about any of that. Nature was just math. There was *no should be*, just *what is*. I was tired of sanctimonious hippies anyway—this was good stuff and I was hooked. I've been a sociobiologist ever since—studying the evolution of social systems, and how social systems drive evolution in turn.⁵

Sociobiology has a cold kind of logic—it's society with the skin peeled off, an unflinching vision of our social lives. It's certainly not for everyone. It's like passing a grisly car accident on the freeway. You don't want to see, but it's the raw truth, and that's rare. Part of you is compelled to know. You may be deeply repulsed by what you see, because it's not in our nature to do math when we make social decisions. But the math is baked into us nonetheless—evolution has done it for us. Sociobiology goes beyond what we think *should be* and backs way, way up to *what is*. At the very least, it's a fresh and provocative framework for looking at the familiar social choices we make every day. It makes us think about things we take for granted a little differently.

There's an unexpected wrinkle in this story, by the way. It turns out society doesn't evolve quite the way sociobiologists used to think. Free will, empathy, and fairness are real, and they are baked in our biology as well, as you'll see. That's exciting, because these are the keys to *what could be*. These are what bind us together, allowing us to create far more than we could on our own.

Since that day in Dr. Triver's class, I've applied sociobiology to orca whale pods in the Bering Sea, and to the fishermen I lived with on that boat for too long (a whale of a tale). I've applied it to baboon mating behavior in Ethiopia, and to newly engaged couples at my now ex-husband's photography studio (not too different, really). I've even applied it to my colleagues at the Biotech where I worked as a bench scientist—not nearly as interesting as whales and mating baboons, but better than crazy brides.

Now, I mostly apply this evolutionary lens to help companies evolve. I'm a Biomimicry Consultant, working with a Fortune 500 clientele to help them develop biologically-inspired solutions to their thorniest challenges. The teams I work with search for the deep principles and technologies that make life go, and help corporate R&D translate them into their own workable solutions. The innovations we discover stem from looking deeply at every facet and scale of biology, and apply to everything from material science to automotive design, packaging and cosmetics, to medical devices, business models, and everything in between. Anything you can frame into the question "how would nature do it?" is fair game.

As an entrepreneurial scientist, I see everything through the lenses of sociobiology and evolution. I look for deep patterns, and try to uncover what lasts. Sharks, for instance, are virtually unchanged since they appeared on this Earth 400 million years ago. Their way of life works, even as the world changes. Similarly, ant societies have been around 150 million years, and the fungi still network through the soil as they did half a billion years ago. These ways of life work through dramatic upheaval and radical change.

After all these years of thinking about evolution and sociobiology, there's one thing I've learned about organizations: *we can't keep structuring them the way we do*. We can't expect our hierarchical pyramids to grow without collapsing, or for them to sense and respond effectively to change.

You don't need a sociobiologist to tell you this. Any kid playing with blocks can show you: if you want to build tall, the base must

be wide. Even then, you can only go so high, because there are limits to vertical growth. The dinosaurs grew very big indeed, but required huge bones to support all that weight. The more weight, the more skeleton; the more skeleton, the more weight. Only the smallest, lightest, and most mobile survived: the birds.

Our ponderous global organizations are like those dinosaurs right now—lumbering behemoths, sitting ducks for a cosmic collision. As hierarchies grow, the costs of management rise steeply, along with the risk of error. It's a mathematical fact: if each manager earns three times the amount of a base-level employee, and there is one manager for every ten people, then management will eat a quarter of your payroll. Decisions get bigger as you move up the chain of command, and the number of people making them gets smaller. The most powerful managers are those furthest from the frontlines—and they are overwhelmed with decisions.⁶ Management is the weighty skeleton that struggles to keep enterprise from collapsing under the weight of its own complexity. The beast slows down and begins to sway, and when change comes—and it will—they topple. There are limits to hierarchical growth, and there's not much we can do about it. Vertical just doesn't scale past a certain point.

Extracting growth and profit from a vertical structure has limits, and responding to change gets harder. That's a problem, because a hard rain's gonna fall, make no mistake. And it's no coincidence. As top-heavy structures get more complex, the slightest wind triggers collapse into chaos. The way we design organizations—and global society, for that matter—instability is inevitable. Between exponentially growing technologies and social revolution, climate change and peak everything, our companies inhabit an increasingly unpredictable world of their own design. Multinational corporations span many divisions and fractured market segments, and teams cross cultures, languages, time zones, and political regimes. Supply chains and customer needs shift suddenly, resources grow scarce and prices volatile. Change is sudden, unexpected, and calamitous. The beast will topple and fall.

To be clear though, there's nothing inherently wrong with hierarchies. They have important biological functions, and nature uses them all the time. A hierarchical system of cells stops cancer from proliferating, and the Department of Corrections keeps the inmates from running the prison. Hierarchies separate important signals from noise in our brains, amplifying good signals and suppressing noise while building coherent patterns. They are important—but they aren't the right structures for adapting to change at scale.

As people who inhabit lively social networks, hierarchies drive us nuts. We have ideas and something to say, and hierarchies filter us out. We are noise in the system, and hierarchies are designed to remove that. As organizations struggle beneath burgeoning weight and increasing complexity, individuals disengage. Only one in three workers say they care about the work they do, and more of us hate our jobs than not.⁷ Most of us live for the weekend. We just aren't that motivated to make a billion dollar bonus for a handful of executives and shareholders we've never met, or to do repetitive stuff hawking toxic pieces of plastic crap that will be in the trash in six months and never go away. Pushing faceless numbers around, going to endless meetings—it can be a soul-destroying, tiresome, and unproductive bore. Our daily mottos should be "Grow but don't collapse today!" or "Delay the inevitable!" "Do more with less!" But these aren't compelling reasons to get up in the morning, no matter how high up the chain you are. For most of us, even if we could do something important at work, we lack the decision-making authority to do it.

So, work is just a paycheck, how we feed our families or keep the kids in school. We do the same pointless things in the same stupid ways, though we know we could do things better if we were given free reign to do it. There is turnover, disengagement, and a fair degree of hopelessness. That's bad for business—it's expensive to keep replacing people who hit the revolving door, and a lot of the talent we have gets left on the table. We stop bringing our whole selves to work—our noise is filtered out anyway.

Here we stand on a dwindling planet, staring down the barrel of

a ten billion-human population explosion, on the brink of the sixth wave of extinction. The summers get hotter, the winters weirder, and it seems no one is doing anything about it. The truth is, few of us *can* do anything, because we have no time or energy left after running around in our hamster wheels all day! We're caught between a rock and a hard place at every level. The relentless pressure for growth under scarcity is a vise. Most of us are asleep at the wheel, and why not? *We need more freaking sleep.* The car is going there anyway, right? In our hearts, we know we can't beat our global problems by growing bigger or better bones, so we're inclined to get rid of those bones altogether. *Another election? Throw it to the wolves.*

There is hope, though. The giant dinosaurs are long gone, but tiny, nimble birds and mammals inherited the earth in their place. These ancient and furtive little fur and featherballs diversified into everything from elephant shrews and platypus, blue whales and bats, penguins and eagles, kiwis and ostriches. One of these species is us—and just look! We are everywhere—with a powerful transformative effect on everything we touch.

There are other creatures as well, even better at surviving change. Hard-working teams of termites and ants built wealth alongside the dinosaurs, and they are still doing it today.⁸ A single termite or ant may not survive for long, but together they are wildly successful, to our lasting dismay. They are superorganisms—colonies that act quite literally as one animal. Fourteen of the one hundred most invasive species in the world are superorganisms (including fireants and yellowjackets), and of course we're locked in perennial battle with the termites.⁹ There are at least 14,000 ant species, if not twice as many, and each and every one of them inhabits a superorganism society. All those ants, tied into a sack, would weigh about the same as all humankind. And globally, the termite population weighs twenty-seven times more than ants or humans—there's a cow's worth of them for each one of us. Social insects make up a quarter of the animal biomass in the Amazon Basin, and eighty percent of the total weight of insects in the world.

That's some serious creepy-crawly factor. But there are societies even more successful and ubiquitous than these. Beneath the soil you walk on lies a half-billion year old pulsing nutrient superhighway of fungus—a dense fuzzy network of individuals on the hunt for matter to digest, and minerals and water to absorb. If a meal is out there, they will find it. When they do, those nutrients flow throughout the system, wherever they are needed most—because the fungi are fused into one. Each fungal cell gets more as a member of the network than it ever could on its own.

Now I imagine you thinking, Oh, *I know where she's going with this*—“*It flows through all of them because they're fused into one*” must be a thinly-veiled socialist sentiment! I'm pretty sure this isn't good for business! But bear with me—like I said, this isn't a tree-hugging book. I want to get you thinking about leading, managing, and responding to change in a whole new way—one based on the deep patterns we see in these ancient superorganisms. These creatures have been networking for 500 million years, through all kinds of change. How do they capitalize on opportunity, ride out disturbance, and stay resilient? How do they spark innovation, nurture collaboration, and lead their teams? How do they seed the present for lasting—and growing—returns on investment? And most importantly, can we learn to structure our own global superorganisms the way they do?

This book offers a new and deeply biological way to do business. In fact, it's a new way to organize our entire global society, as we do the hard work of adapting to our finite Earth. This isn't a recipe for despair, scraping by, or doing less harm while delaying the inevitable death spiral. I'm not suggesting we become an army of faceless automaton clone ants, or assimilate into the Borg. For many of us, the ant way of life conjures up images of the *Iliad's* fearsome Myrmidon warriors—ants turned into people by Zeus to repopulate a plague-decimated island, who never hesitate to sacrifice their individual selves for their collective society, or the miserably constrained ants in movies like *Antz* or *A Bug's Life*.¹⁰ But this book isn't like that at all. Quite the contrary—*Teeming* is a recipe for unbounded optimism,

abundance, individuality, and creativity, as we find new ways to live and grow value faster than any species has done before us—and just as sustainably.

The ants aren't choking on smog or stuck in traffic, and the fungi aren't counting carbon credits or worrying about the Pacific Garbage Patch. Termites don't have slums. All have grown and prospered for hundreds of millions of years, through all kinds of radical change—and they have the same biomass we do, or more. So why can't we do it too? We can, and I know we can—because it's been done before. It's just the simple math of evolution. Study nature's fractal ebb-and-flow math of cooperation and competition, and change our perspective on business. If we want organizations to adapt continuously, nimbly, with no fossilized, rigid, slow and costly layer of management, what we need is a living thing.

What we need is a superorganism. And this book will show you how to get one.