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strength in numbers

We tracked marauder ant trails on steep forested slopes, accompanied by the "wish-wash" sounds of hornbills in flight and mournful calls from a green imperial pigeon. As nightfall approached, we made our way back to the village of Toro, in a valley of brilliant green paddy fields at the edge of the forest. My guide, Pak Alisi, invited me into his home for tea. "You know," he said, "here we call the ant you study 'onti koko.' That means you always find many together."

Yes, I agreed. With the marauder ant, the group is everything.

FIELD NOTES, SULAWESI, INDONESIA, 1984

"We have three kinds of ants here," declared Mr. Beeramoidin, the forestry officer at the village of Sullia in India. "A black one, a big red one, and a small red one that bites."

I was twenty-four, a graduate student on a quest for the ant I had reason to believe had one of the most complexly organized societies in existence. A column of dust-speckled sunlight emblazoned a rectangle on the floor too bright to look at directly—a reminder of the intense dry heat outside. It was late November, and I was worried my choice of season wasn't giving me the best weather for ant hunting.

As Mr. Beeramoidin spoke, his round, bespectacled head rocked from side to side. I had learned that this meant his attention was friendly and focused on me, and though I had only been in India a month, I had already adopted the same habit. I also found myself chewing betel nut, wearing a Gandhi-style *lungi* around my waist and flip-flops known locally as *chapels* on my feet, and using words like *lakh,* meaning a hundred thousand, to describe the number of workers in an ant colony.

Rocking my head in turn, I told Mr. Beeramoidin it was likely that scores of distinctive ants lived within a stone's throw of his office, though even an experienced person would need a strong magnifier to tell many of them apart. I sought just one of them, *Pheidologeton diversus,* a species to which I later gave the name "marauder ant."

In 1903, Charles Thomas Bingham, an Irish military officer stationed in Burma, provided detailed and theatrical descriptions of this ant. In one memorable passage, he wrote that "one large nest . . . was formed under my house in Moulmein. From this our rooms were periodically

Previous page: Marauder ant major workers serve as heavy-duty road equipment. This one in Singapore is gnawing at a twig, which she later dragged off the trunk trail.

invaded by swarms, and every scrap of food they could find, and every living or dead insect of other kinds, was cleared out." The locals found the swarms overpowering. "When these ants take up their abode in any numbers near a village in the jungles, they become a terrible nuisance. . . . I knew of a Karen village that had absolutely to shift because of the ants. No one could enter any of the houses day or night, or even pass through the village, without being attacked by them."[1] In spite of the vividness of Captain Bingham's report, the group remained a biological mystery.

I had arrived in India in the fall of 1981, primed to explore the social lives of the minor, media, and major workers of *Pheidologeton diversus*. My first stop had been Bangalore, more specifically its prestigious university, the Indian Institute of Science. My host was Raghavendra Gadagkar, a professor whose subject was the social behavior of wasps. He believed in learning from experience and smiled at my naïveté and youthful enthusiasm. Rather than teaching me how to eat rice without utensils, in the local fashion, for instance (the nuances of handling hot food bare-handed are many), he dropped me at the door of a local restaurant, recommended I order the "plate meal," and came back for me an hour later. During that first lunch I spilled more than I ate.

Bangalore was going through a dry spell, and I had trouble finding any *Pheidologeton*. Raghavendra recommended I try the Western Ghats, a chain of low mountains famous for its forests and wildlife, just inland of the western coastline of India. On the road from Bangalore to the coast was a village named Sullia. I was told it had a forestry office where I would find both accommodations and advice.

The next day, I learned a basic fact about Indian bus drivers: they were trained to accelerate around blind curves as if suicide were a career expectation. After a stomach-churning ride, I was dropped at the drowsy center of Sullia. I hoofed it to the forestry office, where I was delivered into the presence of Mr. Beeramoidin, who listened attentively to my explanation of ant diversity and then told me the guesthouse was full. Afterward, out under the roasting sun, my nerves jangling at the thought of the harrowing six-hour ride back to Bangalore, I kicked a tree in frustration—and got my first taste of *Pheidologeton diversus*. Hundreds of the tiny minor workers stormed from the earth, the major worker among them looking like an elephant among pygmies. Even Mr. Beeramoidin gave an impressed whistle, conceding with an enthusiastic rocking of his head that Sullia may be more of an ant haven than he thought.

Struck by my preternatural ant-locating skills, Mr. Beeramoidin promised to find me a place to stay. An old man with a limp appeared. The two men conducted a rapid-fire conversation in the local Kanaka language, then the old man guided me down the road to a tiny room next to a mosque. Except for a thin sleeping mat, it was bare: no toilet, water, electricity. That night, I lay for hours watching geckos in the moonlight. Awakened at dawn by the call to prayer, I hobbled to my feet, rubbing my fingers across the areas where the mat's reed latticework had impressed a design like a city map into my flesh.

Finding ants in the dry forests around Sullia proved as arduous as it had been in Bangalore. That first morning, the ants in front of the forestry office had vanished, as had Mr. Beeramoidin, whom I never saw again. I decided to comb the forests, but they were desiccated. It wasn't until the fourth day of looking that a diversionary hike at the edge of town through a watered

Minor workers of the marauder ant riding on an especially large major (a "giant").

plantation of stately oil palms brought me luck—a batch of *Pheidologeton diversus* crossing my path. I fell to my knees, thrilled to finally find some of Captain Bingham's fabled swarming ants, and began inspecting the *diversus* column.

First, a marvelous sight: a major worker was careening along carrying a dozen minors, much like the elephant whose *mahout,* or trainer, had given me a wave from the back of his pachyderm soon after my arrival in Sullia. Except the ant passengers didn't appear to be giving instructions to their beast of burden. Why were they there? I could see no evidence that the minors were cleaning or protecting their mount. I decided they were probably hitching a ride for a simple and practical reason: it takes less energy to ride than it does to walk. The smaller the individual, the more energy walking takes. Being bused by large ants saves the colony energy.[2]

While I was in the entomologist's "compromising position," my nose practically brushing the frenzied ant workers that scurried beneath me, a young man of about my age walked up. Oblivious to my rapture over the ants, he started a conversation by saying his name was Rajaram Dengodi, which he explained meant "King God of All Mankind," and inviting me for lunch. It turned out he was the son of the plantation owners and lived with his parents at the edge of the palm grove. When I arrived at their low whitewashed house, he proclaimed that I'd be sharing his room for the month.

Despite the grandeur of his name, Raja was a low-key fellow with no apparent ambition other than to strum his guitar. But he proved an admirable companion and was eager to learn about ants. During that first week, I mapped the plantation and decided where to concentrate

my search. Then Raja and I set about following the activities of the local *Pheidologeton diversus*. It quickly became evident that the colonies were huge. We saw several migrations with dense legions of ants moving their larvae and pupae to new nest sites, which suggested the workers numbered in the hundreds of thousands.

We also witnessed the hunting and harvesting of meals on a massive scale. The workers carrying food moved along well-demarcated roads that remained active day after day. In time, I would learn that these tracks had as many functions as human road systems. Ant specialists call such persistent routes trunk trails. The marauder ant's trunk trails are substantial structures, with a smooth surface an inch wide. Along them, the ants craft soil walls or even a complete roof of soil. The trails frequently lead belowground, especially where they cross dry or exposed stretches of earth.

Hundreds of ants, and sometimes more, crossed back and forth on those trails every minute. In one extreme case I recorded eight thousand workers per minute climbing a cacao tree to flow into and out of a rotten pod over the course of a full day. Marauder ants excel at plundering large foods, such as fruit or carcasses, that take them a while to devour. But these expeditions represent only a small portion of their efforts. At any time, day or night, I could see them traveling from the trunk trails in ever-changing, reticulating networks, or, as Captain Bingham described them in Burma, in swarms. These extended into vegetation and leaf litter, where the ants' activities were hard to document.

I confirmed the observations of early naturalists that marauder ants can harvest seeds in bulk. More impressive, the ants returning to the nest labored by the dozen to cart centipedes, worms, and other creatures that, if viewed through ant eyes, would appear bigger than dinosaurs

Marauder ants subduing a frog in southern India.

to us. A few dozen minor workers, each about 3 millimeters long, easily hefted the head of one of the doves the Dengodis had tried to induce me to eat after they found out Americans eat meat. Later, Raja and I saw a seething mass of workers rip up a live, 2-centimeter-long frog, pulling its twitching body taut to the ground and then flaying the meat. Raja and I studied the action with both horror and a newfound respect. That was the day I named them marauder ants.

Though Sullia was in no danger from the ant swarms, it was easy to believe Bingham's report from Burma that droves of this species could overwhelm a village. Raja enthusiastically told me how the ants would sometimes pour into the family pantry and make off with supplies of rice and dried condiments.

At dinner we reported to Raja's parents about the marauders' feats of predation, which I described as astonishing, particularly because the workers have no stinger, the weapon with which many predatory ants—especially those species in which the workers carry on alone or in small groups—disable victims. Mr. and Mrs. Dengodi, who took everything I said with great seriousness, no matter how eccentric the subject, listened as I explained that the marauders' success with gargantuan prey seemed to rely on a coordinated group attack in which workers, individually inept, pile on high and deep, biting and pulling in such numbers that the victim doesn't have a chance.

I could attest personally to the effectiveness of that approach. While watching the frog, I'd made the mistake of standing in a throng of marauders. The sheer volume of the minor workers' bites was enough to drive me away, with one major lacerating a fold of skin between my fingers.

This scale of operations brought to my mind the most infamous raiders of all: the army ants.[3] As a teenager in America's heartland, far from any jungles, I had devoured popular descriptions of army ant swarms killing everything in their path. The stories often relied on florid writing, most famously in an unforgettable story by Carl Stephenson, first published in a 1938 issue of *Esquire,* "Leiningen versus the Ants": "Then all at once he saw, starkly clear and huge, and, right before his eyes, furred with ants, towering and swaying in its death agony, the pampas stag. In six minutes—gnawed to the bones. God, he couldn't die like that!" Although this is hyperbole, army ants do have an appetite for flesh and a coordinated battle plan that depends on sheer force of numbers.

Like many army ants, marauders have no stingers. Rather than incapacitating prey with stings, they mob it. This gang-style predatory attack is just one element of both ants' complex routine. How much deeper did the resemblance go? I knew that currently there are as many species of ant as there are of bird—perhaps 10,000 to 12,000—and that the marauder and the army ant are no more closely related than the hawk and the dove.

Convergence is the process by which living things independently evolve to become alike, as a result of like responses to similar conditions or challenges. The wings of bats, birds, and bugs are convergent because they are limbs that have been independently modified to function in flight; the jaws of humans and the mandibles of insects are convergent because both can be used to hold objects and chew food. If the marauder ant and army ants proved to be alike in how they hunt and capture prey, it would be a similarly marvelous example of evolutionary convergence. That day in Sullia as I watched the ants dispatch that unfortunate frog, I made a decision

that would affect the first years of my budding professional life: I would study the kill strategy of the marauder ant. I would make that my quest.

FEEDING THE SUPERORGANISM

Standing in a Sullia field on a tepid afternoon, with Raja's guitar providing an incongruous musical accompaniment to the massacre at my feet, I felt like a general observing his troops from a hilltop and trying to make sense of the skirmishes below. My brain was whirling: one moment, trying to picture what it's like inside one of those tiny, chitinous heads; the next, envisioning all the ants at once, forming a kind of arm flung over the ground with fingers that were rummaging through the soil and low plants.

The nineteenth-century philosopher Herbert Spencer was the first to treat in detail the simultaneous existence of these two levels, individual and society, and in 1911 the ant expert William Morton Wheeler came up with the term *superorganism* to describe ant societies specifically. Both men saw an ant colony not merely as an individual entity, as one might think of a bank or a school, but more specifically as the exact equivalent of an organism.[4] They could readily make this point because others had already described the human body as a society of cells.[5] The superorganism concept took on real meaning for me as I watched marauder ants. Before coming to India I had read an essay by the physician and ant enthusiast Lewis Thomas, who took Wheeler's writings to heart:

> A solitary ant, afield, cannot be considered to have much of anything on his mind; indeed, with only a few neurons strung together by fibers, he can't be imagined to have a mind at all, much less a thought. He is more like a ganglion on legs. Four ants together, or ten, encircling a dead moth on a path, begin to look more like an idea. They fumble and shove, gradually moving the food toward the Hill, but as though by blind chance. It is only when you watch the dense mass of thousands of ants, crowded together around the Hill, blackening the ground, that you begin to see the whole beast, and now you observe it thinking, planning, calculating.[6]

Like a more traditional organism, a superorganism is most successful when its activities are carried out with maximum productivity at the group level. Consider the cells of a human body, an assembly of trillions. Although these cells may be doing rather little as individuals, collectively they can yield results as intricate and choreographed as a dancer's in a corps de ballet. I developed a feeling for a marauder colony as an organism. I watched as the ants worked together like the organs in a body to keep the ensemble healthy and stable, with their trails serving as a nervous system used by the whole to gather knowledge and calculate its choices. With mindless brilliance, this colony-being established itself, procured meals and grew fat on the excess, engineered its environment to suit its needs, and fought—and on occasion reproduced—with its neighbors. I imagined that, given enough time, I could watch each superorganism mature, spin off successors that bred true through the generations, and die.

How do the members of an ant superorganism supply food for the whole? Unlike the body of an ordinary organism, a colony can send off pieces of itself—the workers—to find a meal. Regardless of species, once an ant detects food, her searching behavior stops and is replaced by a series of very different harvesting activities: tracking, killing, dissecting, carrying, and defending. In the majority of species, an ant can mobilize others to assist her. This communication practice is known as recruitment and usually involves chemical signals called pheromones. Often, a wayfaring ant releases a scent from one of a battery of glands on her body, a mixture that serves to stimulate or guide her nestmates. The mobbing of marauders at prey reflects the speed and effectiveness of their recruitment.

I'd known about recruitment, without having a name for it, since I was a child. At family picnics, I would drop a crumb in front of a lone worker. Within minutes, a hundred ants would be pouring along a column to the bread. Had I been able to inspect the successful hunter who first found the crumb, I would have seen her glide the tip of her abdomen on the ground on her return to the nest, depositing a pheromone that diffused in the air—a common, though not universal, ant practice. When ants form a line or travel in a column, they are tracking such a plume with their sensitive antennae, which they sweep left and right before them, in many cases while running faster for their size than any baying foxhound.

Each ant adds pheromone to a trail offering a good payoff, so the scent builds over time. Then, when the food supply runs low and the ants begin returning unrewarded, the pheromone is no longer replenished and the scent dissipates, attracting fewer ants. (Pharaoh ants have an even more efficient way to flag a route that has ceased to be profitable, signaling "don't bother" by depositing a different pheromone at the start of the trail.)[7] The chemicals required to convey a message can be minuscule. With one species of leafcutter ant, a thousandth of a gram of recruitment pheromone—a minute fraction of one droplet—would be enough to lead a column of workers around the world sixty times.[8]

Since traffic depends on pheromone strength, it is modulated by the ants' overall assessment of a trail's offerings—what we call mass communication. This technique can lead to what appear to be deliberate choices by the colony, despite the ignorance of the individual ants of such matters as the size of the food item they are visiting and the number of workers needed to harvest it. For instance, a colony will more quickly exploit a nearby food source than one farther away, simply because it takes less time for the ants to walk the shorter distance. This results in the quicker accumulation of the trail pheromone, which in turn attracts more ants to the meal.[9]

Among the Sullia oil palms, however, such subtleties of individual reaction and mass response were hidden to me. Instead I recorded seemingly spontaneous eruptions of ant multitudes followed by sudden mass retreats, like an arm that was extended, pulled back, and then extended somewhere else. What was going on?

I thought back to a similar eruption involving army ants that I had seen as an undergraduate studying butterflies in Costa Rica. I was awakened one morning to a rustling sound in the room of the hacienda where I was a guest. *Eciton burchellii* army ants were everywhere, moving in

waves over the floor, flowing through cracks in the wall, falling from furniture while clinging to the backs of beetles and silverfish. I heard a plopping sound as an inch-long body landed on the carpet next to my bed: a scorpion cloaked in ants had dropped from the ceiling. The only reason no ants had swarmed my body was that each leg of the bed had been set in a dish of oil by the owner's wife. Thank heavens—I doubt Señora Perez would have appreciated my dashing naked, draped only in ants, into her parlor. I put on my robe and ran to the ant-free hallway, then waited out the ant raid over toast and scrambled eggs.

What had those ants been doing? In a word, they were foraging.[10] For all ant colonies, this search for food is carried out by multiple workers at once. But while the foragers of most ant species operate independently of each other, army ants forage together, much like a pack of wolves looking for elk.[11] Unlike a wolf pack, however, army ant hunting groups do not have a circumscribed membership. Thousands may be present in a raid, but different workers come and go en route to the nest, a search strategy called group foraging or (my preference, because there is no set "group") mass foraging.[12]

Many fierce predators dispatch difficult prey without searching for it in a group. In certain ant species, workers acting alone can both find and kill small vertebrates. Workers of one Brazilian ant dispatch tadpoles larger than themselves.[13] But most predatory ants cannot overpower such prey without help. Most commonly, a successful forager—called a scout when a few scattered individuals are doing the reconnaissance—recruits a raiding party, often guiding it for many meters to the specific site where she discovered the prey.[14]

Elsewhere in the Western Ghats of India, I saw this system used by *Leptogenys*. The tight pack of slim, glossy ants was moving through the dry litter at the reckless speed of an Indian bus driver. I followed and watched as they entered the mud galleries of a termite colony. The ants soon emerged, each with a stack of termites in her jaws. This regimented form of group predation was a joy to observe, as long as I stayed back far enough to avoid the needlelike stingers that *Leptogenys* use to immobilize their prey in one-on-one combat. Later I determined that this species employs scouts. These individuals then return by themselves to the nest and recruit a few dozen nestmates who together do the potentially dangerous work of mining and transporting the unwieldy termites.

Army ants employ a completely different foraging technique. Rather than proceeding with guidance to food already found, the workers sweep ahead blindly in a mass, the absence of a single target turning the whole raiding business into a gamble.

Some army ants regularly invade homes, and in the underdeveloped world their arrival is welcome (even though they force everyone out for an hour or two), for they clear out vermin such as roaches and mice. Marauder ants perform a similar service—though they also make a nuisance of themselves by absconding with grain and other human foods, as Captain Bingham recorded.

Indeed, it was impressive to watch marauder ant mobs take on centipedes and frogs in India. From those clashes I saw that, like army ants, marauders recruit members explosively as each prey item is found, then kill and cart off the bodies together. But to understand marauder ant foraging behavior, I needed to learn how they located their prey in the first place.

After a time, Raja tired of the ant bites and stayed home to practice his guitar. By then I had been in Sullia three weeks, surviving on sticky rice splashed with a red curry so spicy that it often left me panting. This diet kept me ravenous, and to sustain my energy I purchased caramels at a roadside stand. (The shop had more ambition than inventory, with the former evidenced by its name, Friendly Mega Supermarket Store, which was crudely painted on a board.) I surreptitiously devoured the candy at night, fearful of hurting my host family's feelings, and disposed of the paper wrappers down rodent burrows on the plantation.

One cool evening as I watched marauders rushing in the tree litter, as greedy for high-calorie food as I was, a vision of the ants as a superorganismic being crystallized in my mind. I began to think about the army ant stratagem of foraging in a "group." Within the superorganism, what does membership in such a group entail for an ant? Is it proximity? Among humans, techniques as old as jungle drums and as new as Twitter allow people to form groups without physical closeness. Conversely, being close to others does not automatically confer membership in a group in a meaningful way. Often enough I have joined a crush of people on a city street—quite a crowd, but not much of a group.

I had seen many ant species in which nearby workers show no semblance of joint action. Is proximity even less meaningful to ants than to people? In many ways, yes. The workers of most ant species cannot detect another ant's presence until they are virtually on top of each other. Army ants, legally blind by human standards, sense a nestmate only during fleeting moments of contact. In such times, the ants distinguish friend from foe, but what they learn is unlikely to play a role in the organization of their armies. Rather than responding directly to others, ants tend to react to information left by nestmates who may be long gone—to the webwork of social signals, such as pheromones, spread throughout the environment in an ant version of the Internet.

Think of household ants following an odor trail to a cookie left on a kitchen counter. What happens if I pluck out all but one ant? Her actions won't change an iota as long as she can track the scent. She continues to participate in a group effort to harvest food whether the trail is thick with ants or not. Could we define an ant as being part of a group when her actions are constrained or guided by the varied signals and cues arising from the actions of her nestmates, and as solitary when she acts on her own?[15]

As it turns out, army ants conform to this view of a group. The workers have negligible freedom to wander far from nestmates and any fresh chemical communiqués those nestmates have left behind; the superorganism never sends out lone pieces of itself, but droves of workers operate as an almost tangible appendage that stays attached, through a continuous flow of ants, to the main body. Some scientists point to other aspects of army ant life, such as their ability to catch or retrieve prey in groups, but it is this aspect of their behavior—how they forage, and not what they do after they find food—that sets army ants apart from other ants.

My goal became to determine whether the marauder ant uses the army ant group approach to hunting. In India, I documented the movements of teeming battalions, with the workers numbering in the tens of thousands. But such details as whether the raids relied on scouts were difficult to assess during the bone-dry weather I experienced there, which forced the ants to be

cryptic and subterranean. I would continue my marauder ant studies in Southeast Asia, where the species was common.

Rajaram Dengodi, smiling dreamily as he strummed his guitar, saw me off on the bus to Bangalore. As I climbed the steps, the proprietor of the booth where I had been buying caramels ran over and gave my hand an enthusiastic shake. He had gone upscale, with fresh paint and a fancy poster of the Indian deity Ganesha. I wondered how much of my patronage had gone into subsidizing his new, neatly lettered, laminated sign: FRIENDLY MEGA SUPRMRKET STORE.

HOW TO HUNT LIKE AN ARMY ANT

A year later, in Irian Jaya, Indonesia, the dryness of southern India was long forgotten. The rain was so thick and the air so muggy in the Cyclops Mountains that I felt like I was walking in a bowl of hot soup. My kinky-haired guide, Asab, had to scream his customary question over the roar of water battering leaves: "Sudah cukup?" ("Had enough?"). In the heavy rain I could barely see the ancient Russian machine gun slung over his shoulder—protection, he had told me, from guerillas.

For two days the downpour was nonstop. I slept in wet clothes. My camera, though sealed in a plastic bag, somehow got waterlogged. I was often up to my waist in mud, making it difficult, at best, to locate ants. The few specimens I did manage to collect were washed away in the middle of the night, along with the majority of my toiletries. Fortunately, my other experiences in most of Southeast Asia were far more pleasant and productive.

I had embarked for Irian Jaya from Singapore, where I would be based for two years. In India, on my diet of rice and caramels, the weight of my six-foot frame had dropped to 138 pounds; since then I had gained back twenty pounds, largely from my time in Singapore. It was hard to resist a country so immaculate and orderly that bubble gum is illegal and so attuned to style that when the *Straits Times* announced that Paris fashions had shifted from red and white to black, all the girls were wearing black within the week. For anyone on a student budget, moreover, Singapore was a dream come true: *roti parata,* fried *kway tiao,* Hainanese chicken rice, Hokkien noodles, and ice *kachang* are just some of the foods from the hawker stalls near Orchard Road that I frequented. Of more academic consequence was the University of Singapore; I often found myself nursing Tiger beer with ruddy expat professors, feeling like a character in an Anthony Burgess novel.

I rented a tiny room in a high-rise from a Chinese family whose composition kept changing. Each evening, I would return from ant-watching to find their apartment in darkness and would tiptoe past a dozen or more people sleeping in rolled blankets on the floor. At sunrise, I would be awakened by soft Cantonese voices and an aroma of tea. We had no idea what to make of each other, they with their elegant apartment managed like an ant heap, and me, the muddiest human in Singapore, leaving a trail of ants wherever I walked.

Sir Thomas Stamford Raffles, the early-nineteenth-century British colonial agent who founded Singapore, was a keen naturalist. His love of nature is manifest today in a Singaporean

fondness for parks and gardens. This meant that there were plenty of places to observe marauders, since they do well in deteriorated natural habitats and on human-altered terrain. Lawns and gardens and the weeds that colonize human clearings almost always contain abundant supplies of high-energy food. Plants in open spaces allocate more resources to rapid growth and dispersal and less to defenses against herbivores or competitors. That means they can support more plant feeders, and thus more of the predators that eat them, including insatiable omnivores like the marauder ants.

The Singapore Botanic Gardens, founded by Raffles in 1822 to display some of his own exquisite plants, offer plenty of marauders in a manicured setting where they are easily watched. I was introduced to the gardens as an ant haven by D.H. "Paddy" Murphy, a senior lecturer at the University of Singapore. A native of Ireland, Paddy is an autodidact, an entomological genius of a kind that normally falls through the academic cracks. Because he lacked a Ph.D., his prestige-minded colleagues didn't know what to make of the fact that when any entomologist visited Singapore, he or she called on Paddy. No matter what the researcher's area of expertise—whether some obscure group of crickets, plant lice, or marauding ants—Paddy would pull out the specimens in his collection and begin gently instructing about the local species. The visitor would leave enlightened, while Paddy seemed to soak up everything his interlocutor knew.

In addition to showing me the Botanic Gardens, Paddy took me in his battered white Nissan on expeditions to Singapore's watershed, the Bukit Timah Nature Reserve. After several hours rooting in the mud and stuffing specimens into vials, we would finish our day with a stop for a drink. Oblivious to our jungle-rat appearance, he'd drive to one of Orchard Road's fancy hotels and, shuffling into its gleaming five-story foyer, demand two Tiger beers from the bar, all the while holding his insect net like a national flag. Libation consumed, we would then retreat to his flat, where his wife, a chemistry professor of Indian descent, kept a motley herd of little dogs. Sitting at the kitchen table, Paddy would scrutinize the day's catch, never raising his eyes from the magnifying glass. Meanwhile the dogs, announced by a rumble of paws on the tile floor, ran in formation like a migration of African wildebeests, circuiting the house every minute or two.

After another round of beers from his fridge, Paddy would drop me off at what came to be my favorite part of the Botanic Gardens, a seldom-visited back section where I began to understand how deep were the convergences between marauder and army ants. The foraging behavior of both displays a specific set of characteristics that, in scientific fashion, form a sequence in my head. In brief, (1) the workers are tightly constrained by one another's activities, such that while individuals constantly enter and leave the raid on a trail to the nest, (2) those in the raid nevertheless avoid spreading apart, so that the raid retains its existence as a cohesive whole; in fact, (3) adjacent ants stay close enough together that communication between them can be virtually instantaneous. (4) This unit moves along a path that (5) is not controlled by any steadfast leader or leaders within it, (6) nor by scouts arriving from outside. Indeed, (7) their movement does not target a specific source of food, (8) nor is progress dependent on finding food en route, because the ants are drawn forward not just to meals but also to the land ahead; further, (9) the advance can continue across "virgin ground," because advance doesn't require cues left by prior raids. Finally, (10) all foraging is collective. No ant sneaks out to grab lunch on her own.