THE WINE MENU FROM HELL:

THE SCHMIDT INSECT STING PAIN INDEX

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Coyote Peterson holds a tarantula hawk wasp, the second most painful insect known to man. Clasped between the two pincers of an entomology forceps, the enormous wasp writhes and wriggles. It's two inches long, with luminous orange wings and a beautiful, blue abdomen that culminates in a sharp stinger. The abdomen churns and bends, desperately searching for something to sting. Peterson plans on giving it something—his bare forearm.

Peterson is the host of *Brave Wilderness*, a Discovery Channel and YouTube show about the world's most interesting and dangerous creatures. He's taken stings and bites from harvester ants, blood-sucking leeches, scorpions, a ferocious ant known as the cow killer, and even a crocodile. "This is the most nervous I've ever been," he says about the tarantula hawk. "I'm ready, I'm ready," he repeats, as if trying to convince himself. His hands are visibly shaking. "I'm Coyote Peterson, and I'm about to enter the sting zone with the tarantula hawk," he says. He counts down, taking a deep breath between each number: "One… Two… Three…" He presses the wasp against his forearm.

The tarantula hawk plunges its stinger into Peterson's arm. He screams and collapses to the ground. He holds his stung left arm in front of him. His fist is clenched, and he howls through gritted teeth.

"You alright?" the cameraman asks. Peterson just screams in response. "I can't move my arm!" he finally shouts. "That's the most intense pain I've ever felt," he manages between gasped breaths. "Don't think I can talk." His other hand claws at the ground, like an animal trying to escape a cage. Peterson squirms. His teeth are gritted, his eyes clenched shut, his face screwed up. "I think I'm going to cry," he gasps. His arm is red and swollen like a water balloon.

Finally, after about five minutes of writhing agony, Peterson manages to get up. He's still bent over from pain as he walks. He returns to the tarantula hawk, which is trapped in a glass container now. The insect buzzes angrily against the clear walls. "You little bugger," Peterson says to the wasp, a hint of angry reverence in his voice. "I am lightheaded," he says. "The sting from the tarantula hawk is serious. I can see why it's ranked #2 on the insect pain index."

The Schmidt Sting Pain Index rates insect stings. It was developed by Justin Schmidt, an entomologist who has spent his career exposing himself to stings. He has experienced the stings of 83 species of hymenoptera—the order of insects that includes wasps, bees, and ants. By ranking these relative to one another, Schmidt and other entomologists are able to test hypotheses about the relation of sting pain, toxicity, and hymenoptera evolution.

Schmidt developed his passion for insects, particularly stinging ones, early in life. He grew up in rural Pennsylvania, where he spent his childhood exploring fields, forests, and brooks. In his recent book, *The Sting of the Wild*, he recalls that he "found tiny insects fascinating, perhaps because they were small like me." He studied chemistry in college and entomology in graduate school. One day, while studying the chemistry of harvester ant venom for his dissertation, he was stung by one of the ants. He recounts the experience in his book with the kind of clarity reserved only for truly harrowing experiences: "The pain, delayed at first, became piercing and

excruciating. Then, it progressed into waves of deep throbbing visceral pain." His colleague, who was also stung, described it as "deep ripping and tearing pain, as if someone were reaching below the skin and ripping muscles and tendons; except the ripping continued with each crescendo of pain."

At the same time, as Schmidt and his colleague endured hour after hour of agony, their bodies began exhibiting strange, involuntary symptoms. Their hairs near the sting site stood on end, "much like the bristling shoulder hairs on a frightened dog," and the site became moist with sweat. Following this serendipitous event, Schmidt was hooked. He modified his dissertation to figure out what caused these involuntary reactions. He began collecting harvester ants from all over the United States. And, over the next few decades of his career, he would seek out and study the world's most painful insect stings.

Stings have two primary characteristics: pain and toxicity. In his book, Schmidt calls pain "an advertisement that damage has occurred, is occurring, or is about to occur." Toxicity, on the other hand, is "the truth because it is real damage or death." Toxicity can be straightforwardly measured by analyzing toxins and how they affect tissues in a lab. But pain—the other important component of a sting—cannot be measured as easily and precisely. In fact, the only way to quantify sting pains would be to compare them to one another, effectively developing a kind of hierarchy of stings. Thus the Sting Pain Index was born.

The Index runs from 1 to 4 with a trivial 0 rating for insects that cannot penetrate human skin. The scale only uses four digits—though it sometimes resorts to half-steps as well—to ensure consistency between individuals. After all, the subjective experience of pain is not exactly a precise science. The honey bee, rated 2, anchors the scale because honey bees exist nearly everywhere in the world and nearly everyone has experienced their sting. When surveying a new sting, entomologists can compare the pain to the familiar throb of the honey bee (and other stings) to place it on the scale.

In addition to its numerical values, the Index also includes pithy and poetic descriptions of the stings. The sweat bee's sting, a tame 1, is described as "Light and ephemeral, almost fruity. A tiny spark has singed a single hair on your arm." The western honey bee's sting, a 2, is: "Burning, corrosive, but you can handle it. A flaming match head lands on your arm and is quenched first with lye and then sulfuric acid." The most visceral and alarming descriptions are saved for the 4s, like the tarantula hawk's sting, which is "Blinding, fierce, shockingly electric. A running hair dryer has just been dropped into your bubble bath."

Though measuring pain is necessarily a practice fraught with imprecision, the Index has received universal praise for its accuracy. Christopher Starr, for example, an entomologist at the University of the West Indies, developed his own 4-point sting scale before Schmidt's was widely circulated. Starr's scale matches Schmidt's almost exactly. Coyote Peterson, who has now subjected himself to many of the Index's worst stings, also has unmitigated praise for the Index and its developer. "As far as I'm concerned, I'd say it's fairly accurate," he says. "What a brave guy for putting himself in the strike zone with these creatures."

The Schmidt Sting Pain Index has also helped entomologists draw important conclusions about hymenoptera evolution. Most notably, Schmidt used the Index to demonstrate the relation between painful stings and the evolution of sociality for insects.

Being part of a colony has tremendous advantages. Insects can divide the labor of life—some reproduce, some obtain food, some protect the home. An individual queen ant doesn't have to do everything at once. Instead, she can delegate foraging and defense to specialized workers who, being equipped for one particular purpose, can handle these tasks more efficiently. This frees the queen to spend almost all of her time reproducing, ensuring the survival and growth of the colony. In evolutionary terms, this is a recipe for success. But sociality also has downsides. Predators that were previously uninterested in solitary insects were now intrigued in the feast an entire colony presented. To ward off these newly interested predators, the social insects had to evolve ever more powerful and painful stings. And thus began a kind of arms race between predators and prey—an arms race that continues today.

To illustrate this evolution, consider a particularly tasty berry. If the lone berry is surrounded by a hedge of thorns, it is unlikely you will risk the pain of being pricked for such a meager meal. But if it's a whole bushel of berries behind the thorns, then you might risk it. A small amount of pain is surely worth winning such a large and delicious meal. So to avoid being eaten, the bushel of berries has to arm itself with even more thorns and perhaps even venomous, toxic thorns. The same goes for insects. When they live alone, they require only basic defenses. But when they live together in large colonies, they require painful, poisonous defenses.

Of course, evolution is a complex process, and not every insect follows this simple pattern. Some insects don't have to fend off quite as many predators, so they never developed painful stings. Others live in dangerous habitats that require even the loneliest insects to evolve defenses to survive. But as a general evolutionary rule, greater sociality leads to more potent stings.

This is borne out by the Schmidt Sting Pain Index, which allows entomologists to draw general conclusions about sociality and sting pain by comparing the stings of different insects. For example, they can compare the Indian jumping ant, which forms tiny colonies that have little specialization, to the western harvester ant, which has highly specialized colonies with up to 20,000 workers. The Indian jumping ant rates at a 1 on the pain scale, and its sting is likened to that "wonderful wake-up feeling, like coffee but oh so bitter." In contrast, the western harvester ant rates at a 3, and its sting is "Bold and unrelenting. Somebody is using a power drill to excavate your ingrown toenail." Before the Index, entomologists could only make educated guesses about the relation between stings and sociality. Now they can actually compare insect colonies and stings and make compelling evolutionary claims. As Schmidt sums up his findings: "As the mass of yummy dinner starts getting bigger, you start seeing the pain go up."

The star of the Index is the bullet ant, the world's most painful stinging insect. Bullet ants are giant and ferocious. They're an inch or more in length, jet black, and equipped with enormous pincers. The Index gives them its maximal rating of 4, and describes their sting as: "Pure, intense, brilliant pain. Like walking over flaming charcoal with a 3-inch nail embedded in your heel."

Consistent with Schmidt's hypotheses about sociality and sting pain, bullet ants live in large colonies of up to 2,500 members. These colonies are spread throughout the rainforests of Central and South America, from Nicaragua to Brazil. The nests are usually built at the bases of trees, though the ants forage in the canopies far above them. They eat tree sap, fruits, and sugary vegetation in the canopies. But to meet protein needs, they also hunt other insects, spiders, and invertebrates. To subdue these tiny preys and defend against larger predators, bullet ants evolved a formidable sting, one that stands alone in the insect world in terms of both pain and toxicity.

The active ingredient in these stings is poneratoxin, a peptide unique to bullet ants. It has a remarkably high lethality and is produced in large quantities by the ants. This alarming combination "yields a projected capacity for one sting to kill a mammal of 180 grams," Schmidt writes in his book. That means a single sting from one of these ants can kill an animal the size of a sewer rat.

Like all evolutionary developments, this fearsome sting evolved by random mutation, aided by natural selection, over the course of millions of years. The bullet ant lineage separated from other ants a hundred million years ago, which explains why poneratoxin is only present in bullet ants. Furthermore, bullet ants differ from other ants and wasps in their foraging practices. They seek food in the canopy, where large predators like birds, monkeys, lizards, and frogs are active. Confronted with one of these hungry predators, the small ants cannot escape. They have to fight back, and this they do in an alarmingly effective fashion.

Their excruciating sting was first reported by Richard Spruce, an English explorer who spent fifteen years surveying the Amazon in the mid-nineteenth century. Spruce had the misfortune of encountering a colony of bullet ants, and he chronicled the traumatic experience in a lengthy journal entry in 1853: "I was in agonies, and had much to do to keep from throwing myself on the ground and rolling about as I had seen the Indians do when suffering from the stings of this ant… I can only liken the pain to that of a hundred thousand nettle stings. My feet and sometimes my hands trembled as though I had palsy, and for some time the perspiration ran down my face from the pain. With difficulty I repressed some inclination to vomit… Many times have I been stung by ants and wasps, but never so badly."

Since then, the bullet ant's sting has inspired fearful reverence from people all across the world. Schmidt and other entomologists rank it the most painful insect in the world, and he devotes an entire chapter of his book to the frightening little critter. Some Amazonian tribes incorporate it into their warrior initiation rites, requiring initiates to put their hands into mitts filled with the ants and withstand the agonizing pain. Other tribes use its venom in their poison arrows. And even wilderness adventurer Coyote Peterson recognizes the ant's fearsome reputation. "The bullet ant is the pinnacle of the most painful sting you can get," he says. Having worked his way up the Schmidt Sting Pain Index, he plans on subjecting himself to the bullet ant on one of his upcoming episodes.

One sting story Schmidt remembers particularly vividly happened in the early 1980s, when he was still a young and impulsive student. He had just moved to Arizona and was trying to find a paper wasp nest. Paper wasps build their comb-like nests in sheltered areas, often in tree branches or the eaves of a building. This particular nest was built into a fan palm, tucked away behind a grass skirt of drooping fronds. To get at the nest, a predator would have to crawl up the

tree and force themselves through the mass of fronds and overcome the sharp stings of the wasps—a nearly impossible task.

Schmidt knew there was a nest in the tree, but he was having trouble finding it. Getting impatient, he finally thought to himself, "By darned, I'll get them to fly out so at least I'll know where their nest is." So he grabbed one of the drooping fronds and snapped it sharply. But just as he shook the frond, he spied two or three large paper wasp nests. "My eyes weren't fast enough to stop my brain to hand coordination," he says with a chuckle. The wasps exploded off the frond and stung Schmidt eight times. "It was just like bullets hitting my forehead," he recalls. He remembers fleeing blindly from the nests, "my glasses flying every which way. I just sat down, and I don't think I screamed. I just agonized."

Now, many years later, Schmidt is able to draw lessons from this painful experience, and from his countless other sting escapades too. "Stinging insects are a real window into human psychology and beauty and nature," he says. For him, they're something to be cherished, not blindly feared. If you have knowledge about these fearsome critters, Schmidt says, "then you're not going to be dumb and snap palm fronds. You'll enjoy the beauty of them."

And it's undeniable that these fearsome critters are beautiful. Their bright colors, their sophisticated colonies, their excruciating stings—they simultaneously inspire fear and fascination. For most of us, we want to experience this reverence from a safe and respectful distance. But others, perhaps the bravest or craziest among us, may want to get close, hold these awesome insects in their hands, and sample their stings.