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STUNG

Children are born naturalists.

Children are born naturalists whose play is exploration of the environment surrounding them. Throughout most of human history, that surrounding environment was nature itself, a nature filled with sights, sounds, and smells of plants, animals, and the landscape. To the child, the ant walking in the play area or nipping at a food scrap was an object of interest. Equally interesting was the nearby flower with its intriguing bee, busy collecting nectar and pollen, and the lurking crab spider on the flower's edge. To the growing brain, these experiences were exciting and valuable. At this youngest stage of life, fear is muted. Fear is mostly learned by play experiences and from nearby parents and adults. For their part, the adults in the community realize that play and learning are crucial for the developing young mind and encourage or allow mostly unrestricted play for the first five years. Play transforms the young human into an aware, observant, analytical, and adaptable individual prepared to face the world as an experienced, functional adult. But ever watchful adults are vigilant in making the environment secure for children to explore and learn in safety.

Should a snake appear on the scene, quick action is taken to protect the children and to reinforce a preexisting fear of snakes. Over thousands of generations, as studies by Lynn Isbell and others have shown, humans developed a strong genetic fear and aversion to snakes and an instinct to avoid them. This instinct is biologically rooted.[1] Those

individuals who lacked a fear of snakes, or who failed at avoiding snakes, frequently were bitten, with dire consequences, and sometimes died. Genes governing detection and fear of snakes were positively adaptive for individuals possessing the genes. Those with genes that did not confer strong detection and avoidance abilities were slowly eliminated from the gene pool.

As natural scientists, children learn to appreciate and value many elements in nature and to avoid others. By observing, formulating hypotheses, testing these hypotheses, noting the results of the tests, and repeating the process, they are engaging in science. This process comes naturally to children. No teachers are needed to instruct them in the method. Sadly, teachers later are needed to reinstill the scientific method after children grow older and have had this natural talent driven out of them. A paradox? Yes and no. Modern parents inherently sense that children love and need nature. That is why baby clothes are frequently adorned with fuzzy motifs of bumble bees or honey bees, and children's beds abound with stuffed animals, such as bears, tigers, and even sharks. Parents know these animals can all be dangerous in real life, so why encourage them as intimate parts of their children's lives? Could it be that parents know these mascots of nature encourage children's excitement, learning, and comfort?

My own early childhood in Appalachian Pennsylvania was not much different from that of many children around the world. My parents, unbeknownst to me, allowed and encouraged my exploration under their watchful eye. Frogs would be placed in pockets, mud pies made, and lightning bugs put in jars. I suspect these activities were not enjoyed by my mother, though they were tolerated, perhaps with the hope that I would outgrow them. At about five years of age, my well-being was sometimes entrusted to the care of my seven-year-old brother, my ten-year-old sister, and groups of older kids. I, as the youngest, needed to prove my worth to the group. One pleasant spring day the gang happened to notice a large mound of thatching ants from the genus *Formica*. These ants have no sting but produce copious quantities of formic acid, the most corrosive and acidic of

the aliphatic organic acids, which they spray from the tips of their abdomens. They also bite. The combination of a solid bite breaking the skin and formic acid sprayed into the wound yields a sting-like pain. Some of the older boys dared me to sit on the ant mound, a challenge and an opportunity to prove myself that could not be missed. The ants swarmed over and under my britches and started biting my posterior. Up from the mound, down with the pants, and frantic brushing to get rid of them. No long-term damage was done, but I had learned an important lesson: insects can fight back. I continued with the group on to other adventures, a bit wiser and more experienced. Thus, my beginnings as an entomologist.

As children grow, their play turns to honing skills that may be needed in later life. For our ancestors, some of these skills were hunting and solving mysteries of nature. To master hunting skills, physical strength and coordination need sharpening, and nature must be observed, explored, and tested, and its mysteries probed. Today, in economically developed societies, hunting skills are less important, but the urge is still strong, especially in boys. The time-honored rural Pennsylvania tradition of declaring the first day of deer hunting season a school holiday exemplifies the modern continuation of old instincts. Old fields, fencerows, small woodlands, and streams abounded in the area of my childhood—perfect places for refining skills. Other than the dusty ball field, not much entertainment was available. Our small neighborhood group of six to eight boys, ranging four years in age span, was always on the alert for new adventures, whether we were climbing a challenging tree or discovering a bumble bee or hornet nest. I, perpetually the youngest, became a skilled tree climber, and, as the lightest, soon became the best tree climber in the group. In terms of running speed and throwing ability, I was at the bottom. One June day, as we were walking along a fencerow, an older boy discovered a baldfaced hornet nest deep inside the branches of a long-neglected apple tree struggling to produce green apples. What an opportunity.

What a challenge. If we threw rocks at the nest, would they attack? If they attacked, would we escape? If they stung, would it hurt? Mysteries. To solve these mysteries and to test predictions that we could escape unscathed, the oldest boy grabbed a rock and, with the rest of us watching warily behind him, hurled it toward the nest. Poor shot. Nothing happened. We all ran a short distance. A pecking order of bravery then emerged with each boy sequentially grabbing a rock, approaching closer, throwing it toward the hidden nest, and all of us running. The rocks all missed, resulting in only a few hornets flying out to investigate, and nobody got stung. Finally, it was my turn. I found the perfect rock, approached closer than anybody had dared, and gave my mightiest throw toward the nest. A direct hit. Half the nest fell to the ground. The gang, clustered about 15 feet behind me, had a head start, and I learned how the term "mad as hornets" originated. This time the hornets meant business, and I was the closest and the slowest runner. About all I remember beyond this point was that one hornet managed to sting the back of my neck several times. The exact number of stings eludes memory but was at least three or four. It felt like someone had repeatedly struck the back of my neck with a hot branding iron. This was my first experience with what would several decades later become a 2 on the insect-sting pain scale.

About this time, I changed my approach to stinging insects from the recipient of the experiments to the designer. I was a small, skinny kid with tiny fingers and sharp eyes for close-up objects, traits that later became perfect adaptations for my training as an entomologist. I wasn't proficient at baseball or football, and marbles, our favorite game, had been recently banned from school. I had little else to do during recess other than observe plants and tiny animals on the playground. One day I saw a honey bee on a dandelion. I had been told that they could sting, so I decided to see for myself. This time, rather than be the recipient of the test results, I decided to test the hypothesis on my teacher, who was watching over the playground. I picked up the bee and put it on my teacher's forearm. I learned that honey bees can sting, and my teacher learned that honey bees can be picked up by hand. My innocent

test was without malice, though it did become the topic of discussion between my parents and the teacher whenever they met, even decades later. Lessons learned from stings are remembered a long time.

Prominent in most insect guidebooks, the "cow killer"—sometimes called the mule killer—is a frequent summer visitor to yards and parks throughout the southern United States and much of the Midwest. Nearly an inch long, covered with a soft, inviting red and black fur, the cow killer superficially resembles an oversized ant. The common name "velvet ants" for cow killers and other members of this worldwide and immensely successful family of more than 8,000 species is derived from its ant-like appearance. In reality, velvet ants are wingless female wasps. Male velvet ants are winged and look much like other wasps, albeit fuzzier and furrier. Female velvet ants easily vie for entry into the Guinness World Records for the greatest number of defenses known for any insect. First is their stinger, the longest stinger relative to body length of any of the true stinging insects. This is the group called the Aculeata and includes the stinging wasps, ants, and bees but not the parasitic wasps. The parasitic wasps differ from true stinging insects in that their stingers serve primarily to lay eggs and only secondarily to inject venom. Enhancing the effectiveness of the cow killer's stinger, which can be half the total insect length, is the insect's ability to aim it widely, so that it can sting a person or predator grasping any part of its body, whether it's the head, thorax, or abdomen. The pain is instantaneous and searing, much like sticking a red-hot glowing needle into your thumb. The thumb recoils, but not the pain, which continues unabated for 5–10 minutes before gradually easing. This is in addition to a rashy-nettly pain reminiscent of a nasty brush with stinging nettle plants alongside a path near a stream. A natural urge to rub the rashy sting area increases the pain and the itch, a combination just shy of torture.

During my graduate studies at the University of Georgia in Athens, I was called to a golf course whose operators were in a panic over a large

aggregation of cicada killer wasps that had taken a fancy to some of the sand bunkers. Male cicada killers were busily flying around looking for females and challenging anything moving in their territory, including golfers. Meanwhile, numbers of beautiful, colorful cow killers, *Dasymutilla occidentalis*, were entering cicada killer burrows and looking for the wasps' young as food for the cow killers' young. I captured several of the cow killers and took them to the lab where I was analyzing their defenses. A young undergraduate student who was helping care for them decided one Friday evening to give them some honey and water. I received an urgent call about 11:30 p.m. from the campus infirmary concerning what to do for my panicked student who was stung while handling a cow killer and was frightened that he would not survive the night. About all I could do was advise that the bark was far worse than the bite and that while the sting was among the most painful known, the venom was among the least toxic known. He had no chance of dying, and after a little antihistamine and some tender loving care, the student was back in the lab the next day.

I am aware of few reports of young children being stung by a cow killer. Why would a child seeing a beautiful red velvety cow killer running across the backyard not simply pick it up? Perhaps some do and the screaming child cannot describe the source of the sting to the parent. But surely the parent would look for the source and should easily spot the culprit. The more likely reason cow killer stings to young children are so infrequently reported is that they rarely occur. Just as we instinctually notice and avoid snakes and spiders,[2,3] we instinctually notice bees, wasps, and other potentially dangerous stinging insects, including cow killers. The bright red and black coloration both attracts notice and signals pause and caution: look before you leap; watch before you touch. Contrasting patterns of red and black are classic aposematic warnings that signal would-be predators to "back off, leave me alone . . . if you do not, you will regret the consequences." Aposematic, derived from the Greek words *apo* = away, and *sematic* = signal, perfectly describes the cow killer. Its nasty sting backs up the warning, and in the case of the cow killer, additional warnings also

come in the form of sound, a squeak of broad frequency range that resembles a miniature rattle of a Lilliputian rattlesnake, and an odorous chemical warning signal. The cow killer releases these warning chemicals from glands at the base of the mandibles (the insect's jaws), a blend of volatile ketone molecules that smells like fingernail polish remover. For nocturnal predators, or those with poor vision, one or both of the sound or smell warnings are memorably received.

Cow killer defenses do not stop here. In case of an actual attack, two powerful backup defenses come into play. The first is the immensely hard integument, or shell, of the cow killer, rather like a biological tank with a hard, impenetrable body armor. Cow killers are so hard that stainless steel insect pins sometimes bend without penetrating the body. Equally impressive and more biologically relevant, adult tarantula spiders are unable to penetrate cow killers with their impressive fangs, and, on feeling the vibratory squeaking, a feeling akin to a mini jackhammer against one's teeth, quickly release the cow killer. Immense leg strength is a final defense. The cow killer's box-shaped thorax, the middle of the three insect body parts, houses not powerful muscles for flight, as in most insects, but instead enormous muscles that power the legs. These powerful legs combined with the rounded, slippery body enable the insect to wrest itself free from a predatory grip and then rapidly run away and escape. Does a child or adult consciously know of these defenses? Not likely. But the signals are clear: be cautious and avoid me or you'll be sorry. The sting message is conveyed; truth is communicated.