WHEN IS A STICK NOT A STICK?

When it is a sexual partner for life

Insect copulations often have a certain vulnerable quality Bodies ill designed to embrace appear awkward during mating. Courtship and copulation are sometimes very conspicuous, and almost always engrossing. Common sense suggests that nature would exact a price for awkwardness, as well as for inattention. To be obvious, oblivious, and shackled to each other would seem to be extremely dangerous. Anyone who has witnessed the disorganized flutterings of some mating butterflies can imagine the ease with which an observant blue jay could snatch a meal.

Given our perception of how perilous they are to the performers, we might expect insect pairings to be kept to a minimum, and indeed, for many species, sex is short-lived. In some wasps, the whole affair-from frenetic courtship to rapid ejaculation-spans less than a minute. The male cricket in one species passes his spermatophore (a capsule containing sperm) to his mate in under a second. Yet for a sizable minority of insects, mating is far from fleeting, and for a few, the awkward postures and hobbled captivity of pairing are practically a way of life.

Among those that endure nearly indivisible union are certain species of stick insects. Also known as walking sticks, phasmids, and specters, stick insects often closely resemble parts of plants. This mimicry frequently enables these herbivorous, leaf-eating insects to escape detection by predators.

Many stick insects are little and spindly and look very much like twigs. A few are considerably bigger, more like small branches: at thirteen inches, the female of one species from Borneo is among the longest of all insects. Many species have additional details mimicking their particular environment. Green and thick as a finger, members of the genus Hermarchus have swollen ridges along their bodies that turn them into bamboo shoot lookalikes. Numerous tropical forms bear warty excrescences, leafy flaps, and lichenous crusts on their abdomens and legs, enabling them to disappear into a background of foliage and mossy bark. One ten-inch giant of the Congo River basin carries a splintery, hornlike growth on its head that resembles the snapped-off stump of a smaller twig.

A few stick insects look like leaves. One species from Malaysia, for instance, is peculiarly expanded, flattened to a leafy thinness, and freckled with funguslike blemishes. Even the eggs of stick insects are sometimes not what they seem, often looking something like small seeds. On occasion, eggs closely match the seeds of the plants the insects frequent. One stick insect from the mountains of New Mexico glues its long, pointed eggs to grass stems, where they faithfully reproduce the appearance of the plant's own seeds.

A particularly graphic example of specialized plant mimicry is Diapheromera covilleae, a North American stick insect that lives solely on the creosote bushes of the southwestern deserts. The blotchy green-and-brown juveniles match the thin, fresh growth of their host. Even the bases of

their legs take on the color and shape of the leaf petioles among which the insects graze. As the insect grows, the adult male puts on a light brown dead twig disguise, while the larger female imitates the purplish gray of larger creosote branches.

Stillness is perhaps the essential quality of the stick insect. I once saw a living specimen that was being used as one of the structural supports in a spider's web. Occasionally, a stick insect will sway as if tossed by a breeze, but otherwise it spends its daylight resting time motionless, often contorted in remarkable postures to conceal its "insectness." Legs, for instance, can be dead giveaways. Stick insects eliminate the problem by stretching out, their front legs forward and hind legs rearward, sometimes pressed close to the plant.

The main body, too, no matter how well camouflaged, might still cause a telltale thickening of a branch and so must be projected or suspended at an angle suggestive of a sprouting twig. Males of one species actually grasp plant stems with the genital claspers they use to grip females during mating and, so anchored, stick out stiffly into the air. Even in the grip of a predator, a stick insect sometimes retains its sticklike rigidity. When working with captive Mexican jays, I have often seen birds familiar with stick insects picking at twigs of the insects' host plant, apparently confusing the vegetable for the animal. On occasion, I've noticed the birds drop stiff insects, perhaps making the opposite mistake.

A number of species, several from Micronesia, have added hardened spines and "armor plate" to their body design. The spines not only break up the outline of their cryptically colored bodies but also are sharp enough to pierce the tender paws of insectivorous mammals. The great spines on the legs of one species can draw blood from a careless finger and were used by the indigenous people of Goodenough Island as fishhooks.

As impressive as stick insects' poses and disguises are, they don't always work. Fortunately for the insects, they also have an array of physical and chemical strategies to avoid being eaten. Birds-the insects' chief predators-tend to be nervous, and stick insects have ways of making them jump. Some flightless stick insect species have retained wings that unfurl rapidly, with a startling sound and a flash of bright colors and bold patterns.

Some stick insects' bright colors are bluffs, but others advertise genuine and potent defenses. One blue-green, black, orange, and red species of the North Moluccas has fury behind its flash: from two glands just behind its head, this insect can project foul-smelling vapors up to twenty inches forward and backward. Less dramatic looking, but just as capable a squirter, is a pudgy brown-and-white species from the southeastern United States.

The active ingredient of its spray, anisomorphol, acts as an irritant, deterring birds, mice, ants, and beetles.

Still other species use a shorter-range chemical weapon in the form of distasteful additives mixed with their own blood. One, a native of New Mexico's and grasslands, can force drops of viscous yellow blood through the joints of its legs and the places where the plates of its exoskeleton come together. This blood (actually hemolymph, the circulating fluid in insects) is apparently

repulsive to predacious ants, which, if they touch the fluid with their mouths, will drop their intended prey and rub their jaws in the sand.

Like their distant relatives the grasshoppers, stick insects can spit, or more accurately vomit, when harassed. The fluid from at least one species I know well-Diapheromera veliei-is considered inedible by insect-eating mice, which sometimes carefully pull out the insect's gut before sitting down to their meal.

Living the life they do-nearly motionless for hours, only infrequently and slowly walking from one resting spot to another, their bodies swaying like twigs in the wind--stick insects give an impression of patience, almost forbearance. Their capacity for prolonged sexual coupling is equally impressive. Depending on the species, male and female may remain attached for hours, days, or even weeks. At present, the New World record is five weeks. This effort, however, is surpassed by an Indian species, in which the pair mate for up to seventy-nine days.

A male stick insect certainly doesn't need weeks to ejaculate. In fact, a male riding about on a female and attached to his mate by genital claspers only periodically inserts his penis. Why, then, does he stick so closely to his mate? One possible explanation that I have considered in my work is that stick insects may be seeking security through coupling. Could it be, for example, that members of species with powerful sprays are pooling their chemical weapons in a defensive alliance?

Cooperation to form a living fortress is unlikely to be the sole purpose behind prolonged matings; otherwise, homosexual couples would be a common sight. But the increased safety enjoyed by a mating couple might have driven evolution to take what was initially a brief interlude and stretch it out. In some cases, both partners may benefit. Whatever their particular battery of weapons, the two together can put up a more formidable defense. Also, a mating pair is unwieldy, and the increased number of waving and grasping legs is disconcerting.

In one species at least, one partner fares better than the other. D. veliei is a desert species with days-long matings. It has no potent spray, but it does vomit distasteful fluid and drip noxious blood when attacked, and it has spines on its legs. It is also relatively big (three and a half inches long), the female being larger than the more slender male. For much of the year, both sexes are equally abundant and appear to be preyed on more or less to the same extent. But when local birds, such as western kingbirds and flycatchers, are feeding their fledglings, females become scarce. Perhaps birds hit harder on females because they are meatier.

One refuge open to the female D. veliei may be her mate. Armed with blood, vomit, and spines, he stands upon her back like a shield. Perhaps as important as any of his weapons, when attacks come from above, he is in the way. Unfortunately, in this case the male derives little security from the sexual union. If a bird manages to hang on to a pair of mating D. veliei, it is generally because it has a good grip on the male. The bird may fly with its awkward catch to a feeding perch and dine on the male, while the female, along with discarded male limbs and other bits of unappetizing rubbish, falls away.

Could males have evolved long copulations to protect their mates and not themselves? Under certain circumstances, yes. Females are often less abundant than males and thus great prizes. For a male lucky enough to inseminate one, any sacrifice--even his life-to protect her, and thus his genetic future, may be worth it.

There is, however, another, equally satisfying explanation for protracted copulation. Perhaps it is not the female's life that is being guarded, but rather the male's sperm. The immediate fate of insect sperm after mating is not like that of their human counterparts. Instead of striving to fertilize an egg quickly or dying in the attempt, most insect sperm are held in receptacles that branch off from the female's interior egg-laying tube. Sperm are released to fertilize eggs only when the eggs are being laid. In some insects, sperm may wait years for release.

If a female mates only once, the male can ejaculate and then leave to hunt for more females. His sperm will be left undisturbed to do their work when the time comes. But what if a female remates? Unfortunately for the first male, his sperm are often displaced, replaced, blocked, or removed by the next male to come along. For example, some damselfly males use comblike structures on their intromission organs to rake out any sperm left by predecessors before depositing their own. In other insect species, old sperm may be crammed to the rear of storage organs, unlikely ever to reach an egg.

So a male whose mate may copulate again faces a dilemma: should he use his time and energy to mate with many females, trusting to the odds that at least some of his matings will lead to offspring, or should he concentrate on preventing his present sexual partner from mating again? Often, guarding an already inseminated female turns out to make the most sense.

Guarding can be done in a number of ways. A male honey bee simply detaches his penis and leaves it as a plug inside his mate, a fatal subtraction (for after giving up his penis, the male dies). Similarly, a tiny Canadian fly allows his mate to pierce his head and suck up his body fluids as they mate, until all that remains is his empty shell hanging from her genital tract, effectively blocking access to it. Less drastic are the plugs and glues used by some other males; diving beetles, for instance, smear white "cement" across their mates' rear ends.

Rather than leave behind a body part or substance to do the job, some males stay with their mates and, at least for a time, protect their paternity themselves. Few, however, hang on to their mates as long as stick insects do. Why? Unlike the many insects that lay batches of eggs at a time, female stick insects often drop only a few eggs a day. Depending on the species, adults live for several weeks to several months (female D. veliei, for example, live an average of eighty-three days), and given a chance, females will mate more than once. There is thus no safe time for a guarding male to dismount and move on. And since any new female would produce eggs in the same way anyway, he might as well stay put. Unless, of course, rivals are few. In that case, it may be safe to leave one mated female and go off in search of others. Research with D. veliei suggests that they are flexible: males appear to cut short their couplings when caged alone with multiple females and extend copulations when other males are introduced.

Under normal, natural conditions, however, such sexual freedom is seldom possible. For much of

the year and in most places, competition is fierce because adult female D. veliei are rare, relative to adult males. The ratio may be even more lopsided in other species: one female from the Seychelles was found with six males dangling off various points of her abdomen and a seventh was standing nearby. Competition could be responsible for the stretched-out mating times we now see with stick insects.

A few cases of ferocious combat between males have been observed. Two male D. veliei, for example, may attach themselves to the tip of a female's abdomen with their genital claspers, then hang freely, forcing the female to support their combined weight while each boxes with his front legs and attempts to puncture his opponent with spine-studded middle legs.

Although no one knows for sure yet, the female's role appears to be a passive one. Even during combats, she will continue to feed, her jaws working unfalteringly as she carries about the thrashing and sometimes bleeding combatants. Unlike many other female insects, she does not seem to choose a mate from among her suitors or to discourage any passing male from mounting her. Perhaps, for stick insects, the time and energy required to pick the best and fight off the rest is more profitably spent producing young, or perhaps the protection that any male can provide against bird attacks is most important.

In the end, stick insect behavior retains a certain ambiguity that seems fitting for creatures that survive largely by misdirecting attention through false appearances. We know that the world of stick insects (whose unusual looks and calm demeanor sometimes lead to their being kept as pets in England) is not entirely placid. And we can be pretty sure that their marathon couplings are not the result of mere inertia. But whether predation or sexual rivalry, or some combination of the two, is responsible, we don't know; these insects haven't yet divulged all the secrets of their amorousness.

PHOTO: Neither rain nor fear of predators keeps these North American stick insects from mating for a prolonged period. Stephen P. Parker; Photo Researchers, Inc.

PHOTO: The cryptic posture and color of many stick insects make them nearly impossible to see in their natural environment, such as a stand of grasses in Brazil, left. But if discovered, they are still far from helpless. Some, like this individual from West Australia, below, rapidly unfurl brightly colored wings and swish them about to startle predators. Gunter Ziesler Jan Taylor; Bruce Coleman, Inc.

PHOTO: A male stick insect from Trinidad transfers his sperm capsule to his mate, below. Males of most species are smaller than the females, as in the odd couple at right. Raymond A. Mendez Lynn M. Stone

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