

The Beautiful Katydids

Piotr Naskrecki

The male stops singing and lifts his body high above the surface of the palm leaf on which he stands. His body shifts almost imperceptibly toward a large shape in front of him. A female has finally arrived, attracted by the loud bursts of high-frequency calls that he has broadcast from his perch for the last couple of nights. She is definitely interested in him, but the deal is by no means sealed. All the energy he has expended on calling, and the dangers he has exposed himself to by revealing his location to the entire world, are nothing but a prelude to the true test that will determine whether his genes are passed on to the next generation. In most animals the arrival of the female signifies her willingness to mate, and her wooer is more than happy to oblige. Katydid males, however, are far more

discerning than most, and he is almost as likely to reject her as she is to reject him. In many katydids, the male's investment in offspring is nearly as significant as that of the female, and, not surprisingly, he wants to place it with the best partner possible. Females who are deemed too small or too weak to be good mothers will be unceremoniously spurned.

On the leaf, the female spotted sylvan katydid (*Scopiorinus impressopunctatus*) extends her long antennae toward those of the male, and for a few minutes the pair "smell" each other with their long appendages. Suddenly, still silent, the male forcefully shakes his entire body, sending a series of low-frequency waves through the leaf toward the female. She responds in the same fashion, and for a while the pair continue



The globular white mass at the base of the female katydid's swordlike ovipositor is the spermatophylax, the nutrient-rich gift from the male. Photograph by Piotr Naskrecki.



This southern African species, *Clonia melanoptera*, a predator, uses its large, spiny legs to catch its prey. Photograph by Piotr Naskrecki.

to exchange short, silent vibrations. Satisfied with her strength and size, the male does not retreat. As the female approaches, he lowers his body and slides under her, firmly grabbing the tip of her abdomen with a pair of short processes on his; he then secures her position on top of him by crossing his long hind legs over her back. For the next few hours the pair remain connected, while the male produces a complex gelatinous structure, which he carefully attaches to the base of the female's ovipositor, her egg-laying organ. Then, after the pair finally separate, the female doubles up and begins eating it.

This nuptial gift, known as the spermatophylax, represents a major investment on the part of the male and is the reason why the male katydid is often as coy as the female in selecting a mating partner. The spermatophylax

contains not only his sperm cells, which ensure fertilization of the eggs, but also a large packet of carbohydrates and proteins, which nourish the female. In some cases, the weight of this nuptial gift may exceed 20 percent of the male's body weight and constitutes an enormous contribution to the fitness of the potential progeny. It has been shown that a large nuptial gift significantly increases the body size—and thus the survival potential—of the offspring. Of course, not all katydid males produce huge nuptial meals; in some species, the only function of the spermatophylax is to keep the female busy removing it, with the hope of reducing the chances of her mating with another male.

Katydids, known in Britain and Europe as “bush crickets,” are classified as the superfamily Tettigonioidea of the order Orthoptera. They are related to



Translucence allows this sylvan katydid (*Mustius superbus*) to blend with the leaf. Photograph by Piotr Naskrecki.

crickets and grasshoppers, but differ from them in a number of important characteristics. Nearly all species of katydids produce sound by rubbing the base of the left wing against the right one. Crickets employ a similar technique, but one that involves a different part of the wing, whereas grasshoppers usually sing by rubbing their hind legs against their wings or abdomens. Katydid songs can be extremely loud. In North America, the robust conehead (*Neoconocephalus robustus*) produces a call with the intensity of 116 decibels, a sound louder than a lawnmower or a jackhammer, although a large part of its energy is inaudible to human ears because of its high frequency. Many species produce calls that greatly exceed our hearing capabilities, often reaching frequencies above 100 kilohertz—the upper range for the most sensitive of human ears is about 22 kilohertz—and some entomologists speculate that the main function of such high-pitched calls may be to interfere with the echolocation of bats, the katydids'

principal enemies. In any case, luckily for us, courtship calls of many North American species can be enjoyed even by those whose high-frequency perception is past its prime.

Late-August evenings in rural New England tend to be hot and sticky, and if you close your eyes it is easy to believe that you are in some remote tropical location. Mosquitoes reinforce this feeling, but if you brave that minor unpleasantness you may be rewarded with one of the most beautiful aural landscapes on the North American continent. Among the multitude of bell-like tree crickets and buzzy cone-headed katydids, one sound is sure to stand out and make an unforgettable impression on your senses—the otherworldly, loud, and steady staccato of the true katydid (*Pterophylla camellifolia*). But despite the ubiquity of its acoustic presence, finding the singer is not an easy task. True katydids usually sing from high perches, often twenty to thirty feet above the ground, and their green, cryptic coloration makes spotting a singing male difficult. If you are persistent, though, and lucky, you will be rewarded with the sight of a large, beautiful insect that looks like something that came from the steamy rainforests of South America. And, in fact, it probably did.

The North American true katydid is a member of the lineage known as sylvan katydids (the subfamily Pseudophyllinae), a group of insects that flourishes in the tropics and includes some of the most spectacular examples of plant mimicry in the animal kingdom. One tropical species in particular, the peacock katydid (*Pterochroza ocellata*), takes its resemblance to a dried, damaged leaf

to the extreme. No two individuals are alike in their color or even the shape of the wing, a mechanism adapted to prevent such predators as birds and monkeys from learning to recognize them as a potential meal. This polymorphism fools not only predators, but also some taxonomists. A recent study demonstrated this unequivocally when twelve previously recognized “species” of the genus *Pterochroza* were identified among the offspring of a single female!

For decades, ethologists—scientists who study animal behavior patterns—have used a handful of katydid species as model organisms to study and understand processes that govern mate selection and parental investment, but we know shockingly little about the lives of the vast majority of the more than sixty-seven hundred known species. In addition, there are probably two to four thousand species awaiting discovery and description; virtually every

recent, comprehensive regional study anywhere in the world revealed faunas of katydids of which 30 to 75 percent of species were new to science. Even in the United States, where the katydid fauna is relatively well known, new species are discovered with some regularity. About 280 species have been recorded from the continental United States—Hawaii has its own endemic genus, *Banza*, with eleven species—but new kinds are still being found in the southern regions of the country. In some groups, such as the coneheads (*Neoconocephalus*), studies of their acoustic behavior reveal the presence of “cryptic species,” types that are virtually indistinguishable on morphological grounds but are reproductively isolated and different in their behavior.

Unfortunately, as new species are being discovered, we are losing others. Katydids are one of the few groups of North American invertebrates in which the extinction of species has been un-



Many katydids have remarkably realistic camouflage. The peacock katydid (*Pterochroza ocellata*) resembles dead leaves; other species mimic green foliage. Photograph by Piotr Naskrecki.

ambiguously demonstrated, as exemplified by the now-extinct Antioch Dunes katydid (*Neduba extincta*). As with most invertebrates, habitat loss is the main culprit, but North American katydids may face additional dangers. In many meadows of the northeastern United States you are less likely to encounter any of the native shield-backs (*Atlantiscus*) than you are an invasive Roesel's katydid (*Metrioptera roeselii*). This aggressive, predaceous species came from Central Europe, probably sometime at the beginning of the last century, and has been spreading like wildfire along the East Coast and steadily moving west. Although nobody has yet looked at the actual impact of this species on local katydids, the fact that it hatches and matures earlier in the season than local species do—and then feeds on young nymphs of other species—is bound to have serious implications for the native fauna. Woodlands of the Northeast are also full of another European arrival,

the oak katydid (*Meconema thalassinum*). It is a small, pale-green species, whose males are unusual for their inability to sing, choosing instead to attract females by drumming against tree bark with their hind legs. In some places, including my own garden near Boston, this outsider is now the only species found.

Although the general perception of katydids is that of green, leaflike, and rather dull herbivores, across the globe they have evolved into a multitude of shapes, sizes, and lifestyles. In southern Africa, giant predatory katydids (*Clonia*) spread their muscular, spiny legs to catch cicadas and beetles, while in the forests of Costa Rica rhinoceros katydids (*Copiphora rhinoceros*) prey on snails and lizards. In Australia, pollen-feeding katydids (*Zaprochilus*) extract nectar and pollen from the flowers of trees and bushes; and in Tibet the black *Hyphinomos* ekes a living among patches of ice sixteen thousand feet (forty-nine hundred meters) up in the



The oak katydid (*Meconema thalassinum*) is a European species now well established in North America. Photograph by Piotr Naskrecki.



This katydid (*Hetrodes pupus*) is well protected by the armored plates on its body, but if those fail it sprays the attacker with its own bitter blood. Photograph by Piotr Naskrecki.

Himalayas. The diversity of shapes among species of katydids, such as the sticklike *Phasmodes* and the armored, tanklike *Hetrodes*, is so great that it is hard to believe that these insects are members of the same lineage. But this is what makes them such interesting subjects of research. We know, based on both morphological and genetic data, that they are all closely related to each other, and we can now trace the historical and evolutionary forces that shaped their bodies and behaviors.

Ecologists use katydids to assess the level of habitat disturbance, often applying methods that rely solely on the unique acoustic signatures of each species, and physiologists tap into their nervous systems to understand the nature of hearing. Ethologists continue to disentangle the intricate rules of their courtship in order to explain what lies behind the often mysterious choices of mating partners, and biochemists have

just begun to discover potent chemical defenses present in some species. Katydid are beautiful and fascinating animals that in many ways help us understand the world around us. It would be nice to repay the favor by making sure that we allow them to continue their very existence.

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