



Photos 1 and 2

SPECIES SPOTLIGHT: *by Jeffery T. Wilcox¹ Photos courtesy of the author*

Jerusalem Cricket (*Stenopelmatus* spp.)

Jerusalem! I see linkages: The community value of a misunderstood insect

As I was growing up in the San Francisco Bay Area in the '60s and '70s, new tracts of homes quickly filled vacant fields as erstwhile orchards and rangelands were sold off ahead of the rising land values that augured a burgeoning population. When we weren't in school, those vacant fields were our playgrounds, places we escaped to after being pent up indoors, after weekend chores—and especially, once spring arrived. On those first warm, sunny days of the year we bounded through the new grass, saltating from rock to rock, or between old boards, flipping each in hopes of finding a mouse, a toad, or the first snake or salamander of the season. Invariably, a cry would rise from the grasses: “Oh, gross, a potato bug!” followed by “Kill it, they bite!” Unfortunately, fear being the root of that disgust, the potato bug often got squished.

We said “potato bug,” but a more widely accepted name for members of the genus *Stenopelmatus* is “Jerusalem cricket.” Four genera comprise the family Stenopelmatidae, which ranges from British Columbia to Costa Rica and inhabits grasslands, forests, and sandy habitats from beaches to deserts (Sánchez-Xolalpa et al. 2017; Weissman 2005). *Stenopelmatus* are large, flightless members of the insect order Orthoptera (from the Greek, “straight wings”). More familiar members of this large order include grasshoppers, locusts, katydids, camel crickets, and true crickets. Like most members of Orthoptera, *Stenopelmatus* feed primarily on plant material, although they're also known to eat other insects (Weissman 2001). They are often found under rocks, logs, boards, or in underground burrows of their own making, where they use large, powerful jaws to feed on roots and decaying plant matter.

Those jaws are reputed to deliver a painful bite, but when handled gently in an open hand, none has ever offered to bite this author (Photo 1).

But what's with the name? Across its extensive range, this insect goes by many names—potato bug and Jerusalem cricket, as mentioned, but also stone cricket, sand cricket, and skull insect (Riley 1888; Weissman 2005), each rooted in a behavioral or physiognomic anecdote. Although not a significant pest of the “propitious esculent” (as John Reader subtitled his 2011 book, *Potato*), *Stenopelmatus* species are indeed opportunistically fond of potatoes (“potato bug”). The insects are often found under rocks (“stone cricket”), and many Stenopelmatidae species are sand-dune or desert-sand specialists (“sand cricket”) (Sánchez-Xolalpa et al. 2017; Weissman 2005; CNDDDB 2018). The Hopi call it Sósööpa, meaning “skull insect”—which makes perfect sense when you examine the insect closely: The prominent, smooth, flesh-toned head and thorax, especially when contrasted with the striped, bulbous abdomen, indisputably resemble a human head (Photo 2). In parts of Mexico to which the species is native, these features evoke a child's face (*insecto cara de niño*) because the eyes look more like those of a doll than an insect (Sánchez-Xolalpa et al. 2017), or *niño de la tierra* (child of the earth) because the bald head looks like that of a newborn child (Weissman 2005).

Still, the most common name for *Stenopelmatus* is Jerusalem cricket. Weissman (2005) investigated the origins of this name quite extensively. He wasn't convinced by the explanation that (at rest) *Stenopelmatus* looks like a Jerusalem cross. And the genus doesn't exist in Israel, so the city of Jerusalem is not its namesake.

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Jerusalem cricket *continued*

Its habit of feeding on roots lends to the idea that it may have been named for eating Jerusalem artichokes, but the two do not overlap in their natural ranges. Or perhaps Franciscan priests heard Navajos call the cricket “skull head” and associated this with Skull Hill, the ostensible burial place of Jesus (Stoffolano, Jr. and Wright 2005). Entomologist Richard L. Doutt provided my favorite proposed origin of the name when he reminded Weissman (2005) that young men of the late 19th century used “Jerusalem!” and “crickets!” as expletives. Doutt imagined a young boy rolling over a log and saying, “Jerusalem! What a cricket!” (In 20th century parlance: “Oh gross, a potato bug!”).

Despite their considerable size (30–50 mm), these powerfully built insects fall prey to countless (particularly nocturnal) predators. (This is also because of their size; what a hefty store of protein they are!) I have found *Stenopelmatus* remains in the digestive pellets of several owl species, including great horned (*Bubo virginianus*), barn (*Tyto alba*), short-eared (*Asio flammeus*), burrowing (*Athene cunicularia*), and saw-whet (*Aegolius acadicus*). American bullfrogs (*Lithobates catesbeianus*) eat a lot of them, and they are known to be preyed on by adult California tiger salamanders (*Ambystoma californiense*) (Wilcox, unpubl. data). One winter day, while walking the wind-swept grasslands on the west end of Santa Cruz Island off the coast of California, I came across a pile of boards that had once been a makeshift research shelter. Half a dozen Channel Islands spotted skunks (*Spilogale gracilis amphiala*) had taken shelter under the rubbish pile and bounded away when I lifted a couple of boards, leaving behind a treasure trove of information for an ecologist like me. I grabbed a handful of fresh scats and bagged them, and on later analysis was startled to learn that the scats indicated a diet of nothing but earwigs (Dermaptera)...and Jerusalem crickets!

As an ecologist, my interests lie in what functional role an organism plays in the environment it inhabits. In the case of Jerusalem crickets, it starts with their equipment. They are superb excavators, using powerful legs, equipped with long spines at the terminus of each tibia, to tunnel underground to feed on living and dead plant roots. Dead and decaying roots can be vectors for plant diseases, so it may benefit vegetation for the senescing structures to be excised in this way (Menkis et al. 2006). Jerusalem crickets consume and then defecate digested plant materials, which provide a supply chain of food for soil microbes. In turn, those microbes release nutrients and minerals back into the soil where growing plants can take them up. Tunneling by Jerusalem crickets may also bring atmospheric oxygen to roots and to soil microbes. Recent research indicates that small invertebrates are important contributors to the “detrital food web” and more important drivers of ecosystem processes than their relative numbers would indicate (Yang and Gratton 2014).

Classic food webs are graphical models depicting “who eats whom” in a given ecosystem. Plants are autotrophs (organisms that can synthesize their own food from inorganic substances), and as such are primary producers in a food chain. Plants convert sunlight (solar energy) and carbon dioxide + water (chemical energy) into plant tissue, which in turn is taken up by heterotrophs (organisms that derive their nutrition from complex organic substances); that is, eaten either aboveground by grazing herbivores, or underground by rootivores such as Jerusalem crickets. This converts the plant energy to another nutritional (trophic) level (Elton 1927). In a further link of the food chain, carnivores may eat the herbivores, and then die naturally or be eaten by other carnivorous predators or by scavengers. Eventually the animals (herbivore or carnivore) decompose, returning energy to the soil. Each predation event

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Jerusalem cricket *continued*

transfers energy from one trophic level to the next (Lindeman 1942), with energy being lost in each interaction. These energy transfers are also known as linkages, and linkage strength is measured by how efficiently this energy transfer happens (Paine 1980).¹

As root predators and plant-matter scavengers, Jerusalem crickets function as important contributors to the larger food web. Many animals prey on Jerusalem crickets when they leave their burrows at night. By day, the insects have been feeding on roots and decaying plant material underground, converting plant tissue to usable energy not available to traditional grazers feeding aboveground. The energy derived from underground plant matter normally goes to fungi and bacteria and is released back to the soil, where plants take it up again; little of it gets to top predators such as owls or ground-hunting pallid bats (*Antrozous pallidus*), for example. But imagine a juicy, calorie-rich Jerusalem cricket, belly full of root and underground plant matter, venturing out at night into the open where an owl, skunk, fox, or bat can pounce on it. (Bonus: Jerusalem crickets are easier to catch than a fast mouse!) This particular transfer of trophic energy (plant subsurface–rootivore–carnivore, bypassing surface herbivory) supplants traditional linkages (plant surface–herbivore–carnivore), and delivers the energy to top predators without the participation of aboveground herbivores in the food chain. How's that for playing a key role in the food web?

I wouldn't be surprised if future research reveals many other beneficial community functions of Jerusalem crickets. Perhaps they carry beneficial hitchhiking bacteria or fungal spores to new root zones? We just don't know yet. Genetic research is revealing new *Stenopelmatus* species (Vandergast et al. 2017), some of which, like the Coachella Valley Jerusalem cricket (*S. calhuilaensis*), are already rare. Whatever their community value, and notwithstanding the fear or revulsion they may elicit in humans, I've learned to appreciate this odd, majestic insect species.



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¹It should be said that omnivory also plays a significant role in food web linkages: see Hunter, M. D. 2009. Trophic promiscuity, intraguild predation and the problem of omnivores. *Agricultural and Forest Entomology* 11:125–131.



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