The Gloworm

Cicadas are the souls of poets who cannot keep quiet because, when they were alive, they never wrote the poems they wanted to. – Socrates, in Plato's *Phaedrus*

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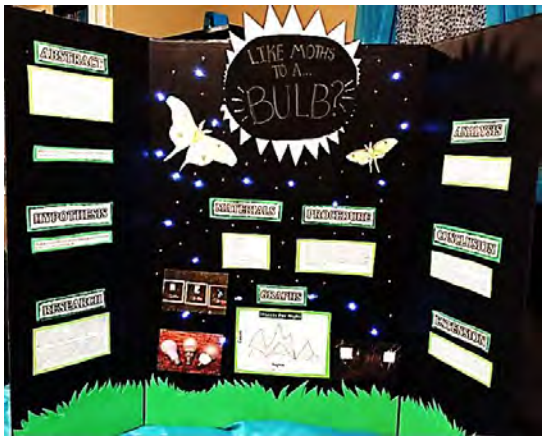
Bug and Plant Camper Riley Sullivan Wins Big at Local and Regional Science Fairs in California by John Guyton



We are excited to announce that Bug and Plant camper Riley Sullivan from Moreno, CA, won first place in a field of 300 at her school's science fair for her camp-inspired project, "Like Moths to a Bulb?" Riley compared incandescent, fluorescent, and LED lamps to determine which attracted the most insects.

Following Riley's initial win, Mrs. Thomas, her Starkville grandmother, emailed, "Riley's science project on Entomology won overall in her age group at Regional Science Fair yesterday. It was held at UC Riverside. She also won the Gold Medal awarded by the Entomology Department."

Riley's mother added, "The University of California Riverside Entomology Department gave her a huge bag of gifts including two shirts, a large bug book, $50 gift certificate to Barnes and Noble, water bottles etc. I guess they liked her project. So on to the next level she goes. Thank you [Bug and Plant Camp staff]!!"

A gold medal from the University of California Riverside Entomology Department, whose programs I greatly admire, is an incredible endorsement of Riley's research skills. Congratulations and continued success, Riley!

Riley at Bug and Plant Camp.

BUG AND PLANT CAMP ALERT

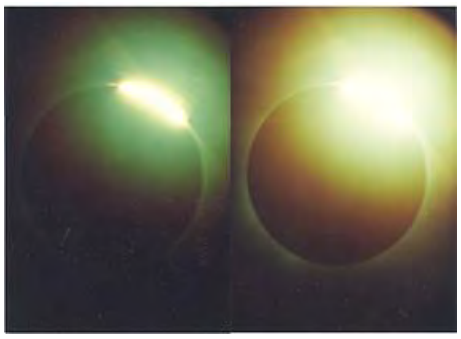
Register Soon to Reserve Your Spot

If you know you want to come to camp this summer, please do not delay registering. Camp registration starts early nowadays and we will cross a point soon when registrations will pour in. The worst part of my job is to tell one of our long-term campers that camp is full, but that has happened for the last two summers. It is a rare event that we have someone drop out of camp at the last minute, allowing us to draw from the waiting list.

As always, there will be some new activities at camp this summer. We are currently working on the schedule and have two new activities planned—so now we are trying to decide what to drop! If there is an activity you wish we would do, now is the time to email us and let us know. We are also working on the necropsy cage and hope to have it functioning properly this year.

Make Time in Your Life for Cicada Emergences and Total Solar Eclipses by John Guyton

Visitors to my office know of my eclectic interests and love of adventures, in space and time. Everyone should take a few scientific pilgrimages to see some of the great natural events: auroras, volcanic eruptions, glaciers, eclipses, whale migrations, and cicada emergences! These are a few of nature's greatest and most spectacular events and when the siren summons, you should make every effort to heed the call.



Rare green flash during a total solar eclipse north of Tuxpan, Mexico, on July 11, 1991. Photos by J. Guyton.

Total solar eclipses are relatively rare and without question worth the time and effort to witness. I saw my first on February 26, 1979, in Winnipeg, Canada, and I knew that afternoon that I would be standing in the moon's shadow again on July 11, 1991, on the west coast of Mexico. Most people have only seen *partial* solar eclipses, which pale in comparison and do not in any way portend the whole-body experience of a total solar eclipse. The eclipse pictures on this page show a very rare green flash just as the sun was emerging from behind the moon and a second later on its way to fourth contact (the end of the eclipse). The experience of watching the moon's shadow race across the ground toward you and the dragon swallowing the sun is awe inspiring. As we were peering into the "Eye of God'" at noon on that July day, we became acutely aware of one of his lowly creations, mosquitoes, who thought it was dusk and came out for a sip of our blood. The next most accessible total solar eclipse will cross the heartland of the United States on August 21, 2017. I hope to complete a trifecta of continental eclipses on that date!

Newly emerged cicada and its cast skin. Photo by J. Guyton.

Before the next eclipse, we have an exciting cicada emergence to witness. Periodical cicada emergences are entomological events worth pausing for or traveling to enjoy. There are annual cicadas that emerge every year, but I am not focusing on them in this article.

Time lapse images of a newly emerged cidada as its wings expand. Photo by J. Guyton.

The first thing we need to establish is that *these insects are not locusts*. Locusts are grasshoppers. Early New England colonists didn't know any better, but they had heard stories of the hordes of locusts in the Old World and figured the unexpected and sudden appearance of swarms of bugs must have been a locust plague. If this many grasshoppers showed up in town, it really would have been a plague. Don't embarrass your minister if he refers to them as locusts, but discretely suggest he google up "17-year locusts," which will take him to a cicada website. Now, on with our story.

After an extended period of 13 or 17 years underground, the root-sucking periodical cicada nymphs emerge from the ground, climb a nearby tree or tall grass stem, and begin the process of shedding their old skin. Their new skin begins to harden and their wings begin to grow as they inflate. That alone is worth taking a series of pictures. Once dressed, the males begin flexing their tymbals and calling the females with a repetitive sound. Females respond with a coordinated wing-flick response. Different species have different calls that can be identified by sonograms.

Within a couple weeks of emergence the females will mate and begin depositing eggs in twigs and branches. They typically do not oviposit in evergreen trees. The female will deposit 400–600 eggs in twigs using a stylus-like ovipositor that leaves a characteristic slit down the twig. Eggs will hatch within six to seven weeks after deposition, when white, antlike nymphs work their way out of the slits and fall to the ground, burrowing into the soil, inserting their piercing-sucking mouthparts into a root, and continuing their 13- or 17-year subterranean cycle.

The song of the cicadas is easy to recognize as the loudest of the evening, and the insect world for that matter. Often the springtime twilight serenade begins with locusts or grasshoppers calling, followed and drowned out by the loud cicadas that can exceed 100 decibles. After dark the softer katydids or crickets take over. The volume of the cicadas' singing over the period of only a few weeks seems loud enough to compensate for their long silent subterranean life. Male cicadas also make an alarm sound, or buzz, when handled that will make you consider dropping them. For recordings of many cicadas that can be used to identify species, visit the Cicada Mania website [http://www.cicadamania.com/audio/].

All 13-year and 17-year cicadas are in the genus *Magicicada*. The 17-year cicadas include three species: *M. septendecim, M. cassini,* and *M. septendecula.* They have the longest life cycle of any insect. The 13-year cicadas are composed of *M. neotredicim*, *M. tredecim*, *M. tredecassini,* and *M. tredecula*.

There are two races of periodical cicadas. The 13-year life cycle is more common in the southeastern U.S. and those with a 17-year life cycle are more common farther north. Several populations of 13- and 17-year cicadas, called broods, emerge at different 13- and 17-year intervals. Fifteen broods have been described and are designated by Roman numerals. The 13-year cicada broods are XIX, XXII, and XXIII, and the 17-year cicada has 12 broods (I–X, XIII and XIV).

The magicicadacada website <www.magicicada.org> reports: "2015 will be a remarkable year for periodical cicadas. 13-year Brood XXIII, the Mississippian Brood, and 17-year Brood IV, the Kansan Brood, will both emerge." Brood IV cicadas will emerge in IA, KS, MO, NE, OK, and TX. Brood XXIII cicadas will emerge in AR, IL, IN, KY, LA, MO, MS, and TN. Of interest is that most cicada emergence maps and data are based on C. L. Marlatt's nearly 100-year-old references.

Female cicada depositing eggs. Note the black ovipositor just behind the hind legs. Photo by Dan Kennell, camp staff.

The Cicada Central Magicicada Database (http://hydrodictyon.eeb.uconn.edu/projects/cicada/databases/magicicada/magi_search.php) is a Magicicada database query page worth checking to see if cicadas have been reported from your area. The cicada photos on pp. 2 and 3 were taken in Mayhew, MS. Mayhew is not included in the Lowndes County records; cicadas emerging around Starkville and Oktibbeha County at that time are not listed either. This suggests there is an urgent need for a lot more people to report the locations of periodical cicada emergences. If you do report sightings, you will also need a few vouchers or samples for more precise species identification.

In 1920, entomologist H. A. Allard, in Eastern Virginia, described what it was like when the cicadas left: "I felt a positive sadness when I realized that the great visitation was over, and there was silence in the world again, and all were dead that had so recently lived and filled the world with noise and movement. It was almost a painful silence, and I could not but feel that I had lived to witness one of the great events of existence, comparable to the occurrence of a notable eclipse or the invasion of a great comet." One final thought: possibly the greatest thing about cicada emergences is that they come to the same locations, periodically, while total solar eclipses will not reoccur in the same locations during our lifetimes.

Reference: Marlatt, C. L. 1898. *The Periodical Cicada*, USDA Division of Entomology Bulletin No. 14.

Source Materials and Digital Libraries by John Guyton

If you are not already accumulating a digital library, now is a good time to start. I have several files where I save books on my hard drive, though it is hard to accept the fact that digital books may replace paper. One of the early seminal reports on the periodical cicada was USDA Bureau of Entomology Bulletin No. 71 *The Periodical Cicada*, published in 1907. When I started the cicada article above, I needed to borrow the paper copy of the bulletin from Dr. Richard Brown, who had first loaned it to me some years ago. As I carefully opened the fragile book to refamiliarize myself with its contents, I wondered, might this be on the internet now? Much to my delight, it was! I immediately downloaded the PDF file and quickly reviewed the cicadas' life history and other details. I also realized two earlier versions were also on the internet, so I downloaded them as well and was able to cite an earlier reference for the following transformation story. I even snipped two of the pictures (now in the public domain) from the PDFs to use in this article.

The richly detailed description of cicadas' transformation in bulletin No. 14, excerpted below, is pictured to the right. This 117-year-old account aptly illustrates the timelessness of the natural world, as well as the dedication to detail of early entomologists.

> The pupae (frontispiece, figs. 1 and 2) begin to rise as soon as the sun is hidden behind the horizon, and they continue until by 9 o'clock the bulk of them have risen. A few stragglers continue until midnight. They instinctively crawl along the horizontal branches after they have ascended the trunk and fasten themselves in any position, but preferably in a horizontal position on the leaves and twigs of the lowermost branches. In about an hour after rising and settling the skin splits down the middle of the thorax from the base of the clypeus to the base of the metanoturn (frontispiece, fig. 3), and the forming Cicada begins to issue. The colors of the forming Cicada are a creamy white, with the exception of the reddish eyes, the two strongly contrasting black patches on the prothorax, a black dash on each of the coxae and sometimes on the front femora, and an orange tinge at the base of wings.
>
> There are five marked positions or phases in this act of evolving from the pupa shell, viz, the straight or extended, the hanging or head downward, the clinging or head upward, the flat winged, and, finally, the roof winged. In about three minutes after the shell splits the forming imago extends from the rent almost on the same lane with the pupa, with all its members straight and still hold by their tips within the exuvium (frontispiece, fig. 4). The imago then gradually bends backward and the members are looseued and separated. With the tip of the abdomen held within the exuvium, the rest of the body hangs extended at right angles from it, and remains in this position from ten to thirty seconds or more, the wing pads separating, and the front pair stretching at right angles from the body and obliquely crossing the hind pair (frontispiece, figs, 5 and 6). They then gradually swell, and during all this time the legs are becoming firmer and assuming the ultimate positions.
>
> Suddenly the imago bends upward with a good deal of effort, and, clinging with its legs to the first object reached, whether leaf, twig, or its own shell, with-draws entirely from the exuvium and hangs for the first time with its head up (frontispiece, figs. 7 and 8). Now the wings perceptibly swell

(frontispiece, fig. 8) and expand until they are fully stretched and hang flatly over the back, perfectly transparent, with beautiful white veining (frontispiece, fig. 9). As they dry they assume the roofed position (frontispiece, fig. 10), and during the night the natural colors of the species are gradually assumed (frontispiece, fig. 11).

The time required in the transformation varies, and, though for the splitting of the skin and the full stretching of the wings in the flat position the time is usually about twenty minutes, it may be, under precisely similar conditions, five or six times as long. But there are few more beautiful sights than to see this fresh forming Cicada in all the different positions, clinging and clustering in great numbers to the outside lower leaves and branches of a large tree. In the moonlight such a tree looks for all the world as though it were full of beautiful white blossoms in various stages of expansion. [pp.70–71]

Reference: Marlatt, C. L. 1898. *The Periodical Cicada*, USDA Division of Entomology Bulletin No. 14.

Bug Club Activity

Monitoring Climate Change Using Periodical Cicadas by John Guyton

Cicadas are coldblooded, emerging when the soil temperature is consistently 64°F (18°C). Science teachers or 4-H agents with bug clubs can involve their young scientists in canvasing the community for adults who can show them where cicadas have emerged in past years and noting these on a map. They can then begin monitoring soil temperature with a soil temperature probe and recording the results for each location. It might be enjoyable to keep a county map in the county Extension office to identify the location of cicada emergences along with a chart to record soil temperature and cicada emergence data, similar to the chart on p. 6. The density of the cicada holes or cicadas or their shed exoskeletons on stems or trees per square meter or yard would be another important variable to measure. A few vouchers from each location should be carefully collected, killed, and saved until the species can be identified.

A soil temperature probe. Photo by John Guyton.

Of course it will be years before the next survey so it will be necessary to store this year's data where it can be found in 13 or 17 years. Online in one of the cicada databases such as the Cicada Central Magicicada Database is a very good choice, but another might be your county Extension office with a note in the file to not discard it and a description of the monitoring activity. 4-Hers in 13 or 17 years may enjoy adding to the county data.

Phenologists have established that spring moves north at about 16 miles per day or 100 miles per week. If two schools are located in a N-S line 100 miles apart, a plant should bloom about a week later at the northern location. Cicadas are known to emerge later at more northerly locations.

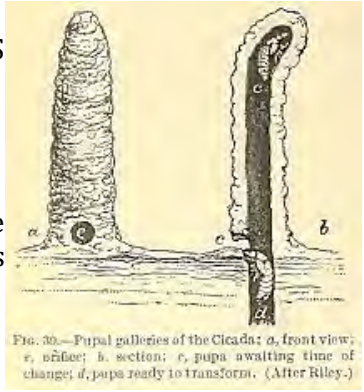


FIG. 30.—Pupal galleries of the Cicada: *a*, front view; *c*, orifice; *b*, section; *c*, pupa awaiting time of change; *d*, pupa ready to transform. (After Riley.)

Pupal galleries, from: Riley, C.V. 1885. *The Periodical Cicada*. USDA Division of Entomology Bulletin No. 8.

Another interesting observation would be the trees and shrubs used by the female as an oviposition (egg-laying) site. A record of these plants would be another useful list to keep. You may find 60 to 80 trees being used. As climate changes over the decades, we can anticipate there may be changes in the composition of forests, with a possible consequence in the available host plants. Quantify your reports, such as how many females were seen depositing eggs in each kind of tree or shrub within 6 feet of the ground. Pictures of the surroundings would also be helpful.

What I am hoping to photograph this spring are the pupal galleries or cones if the weather is suitable (heavy rains before emergence), and the female cicadas ovipositing on twigs.

Cicada Emergence Density and Ground Temperature Data for _____County

Location	Date/soil temperature	Date/soil temperature	Date/soil temperature	Date/soil temperature	Date/soil temperature	Date adult cicadas emerge	Average number of cicadas/sq. meter

Start a Periodical Cicada Edible Insect Banquet Tradition! by John Guyton

Entomophagy, the practice of eating insects, could become a significant component of our global food security strategy. Insects are easy to raise, cheap, abundant, and environmentally sustainable. They could also become part of an economic and nutritional disaster relief plan, especially in third world nations.

Some Native Americans believed that the large cicada emergence had evil significance, but people of the Onondaga Nation's oral tradition described their rescue from famine by periodical cicadas. The Iroquois considered them to be a delicacy. Cicadas are a gluten-free, low-fat, low-carbohydrate, high-protein food! The insects spend most of their life underground sucking sap from tree roots. This practice reminds me of maple syrup and the sugar pine sap I melt from pinecones and eat off the baking sheet. Some think cicadas taste a little like asparagus. Crispy cicadas have a nutty, almond-like flavor. **If you are allergic to shellfish, you should not eat cicadas.**

A wealth of cicada recipes appear on the internet so I will only offer preparation tips and menu suggestions. The females are preferred because of the large hollow space in the males behind their tymbal. You will want to collect them as soon as the adults emerge in the evening and immediately freeze them—before their wings have time to develop. [Note: This is almost as soon as they eclose.] The cicadas can later be stirfried or skewered and barbecued on a grill. You will have 13 or 17 years to brag about your traditional periodical cicada dinners. Your more interesting friends will expect an invition to your next cicada dinner!

Entomological Collections Contain Clues to the Past by John Guyton

When I am asked what one thing young entomologists should take away from their interest in insects, I suggest it be to select a common order (not something like Mantophasmatodea or the ice crawlers that live on glaciers) and learn as much as they can about it: the families in the order, where they live, ways to collect them, their host plants, their life cycle, when they are active, how and where they overwinter, their parasitoids, and their prey. Make a collection of these insects and learn and record the plants on which they are collected. Where do they deposit their eggs? Rear a few. What are the beneficial insects and the pests in the order? This information will serve them well for the rest of their lives and give them the opportunity to personally monitor the health of the environment by observations of their order. We know most youth that explore entomology will not become professional entomologists, but wherever they go and whatever they do, they will be the entomologist in their group of friends. They can make contributions to the field just by their observations and sharing with others around them what they have learned. Important discoveries have been made by professionals in many fields who enjoy studying insects as a hobby or avocation.

My first insect was a bumble bee and I guess that is where my interest in bees, wasps, and ants started. I was with my grandmother in her flower garden and pinched an althea bloom closed around a bumble bee as I twisted the flower off the plant. My delight was short lived when it stung me on the thumb through the flower petals and regained its freedom! I could return to the very spot today where I received that painful sting and learned that valuable lesson! Since preschool I have known bumble bees and carpenter bees.

A few years ago I was scanning campers' collections and was alarmed that not a single bumble bee had been collected. The following year there was only one in a camper's collection. By then I

realized I had not collected or even seen one in the past year. My concern reached the point that I asked Dr. Richard Brown, Director of the Mississippi Entomological Museum, if he had noticed a decline in bumble bee populations and he said he had not, but indicated he had not been watching them. He studies Lepidoptera, so when there is a fluctuation in their populations in areas where he collects, he knows it. I have continued to watch for bumble bees and I am definitely not seeing as many.

In November, Carl Zimmer's enjoyable blog *Friday's Elk* directed my attention to his column in the *New York Times* with the lead: "Sometimes it can seem like all the thousands of specimens stored in museums are just a waste of space. But a new study shows the unexpected secrets that museums can reveal. I look at how museum specimens of bees show how they declined over the past century as they lost their preferred plants."[1] What follows is a synopsis of his article "Clues to Bees' History, Tucked Away in Drawers."

Bees are in trouble, and it is not just the European honey bee (*Apis mellifera*). The 20,000 native bees, and about a third of bumble bee species in the U.S. are declining with their host plants. Jeroen Scheper, a graduate student at Wageningen University in the Netherlands and colleagues are examining the records, including insects, in museums collected over the past 140 years. Scheper's study in the Netherlands revealed more than half of their 357 species of native bees are endangered because of the loss of plants they pollinate and depend on for their sustenance. Bees and their companion plants have been adapting together since the beginning of time, and as one goes, so goes the other.

Scheper and other scientists were able to study the insect-plant interactions by examining the pollen still adhering to the legs of bee specimens in insect museums and identifying the plants on which they depended. The intensity of agricultural practices, including land clearing and the use of toxic herbicides and fertilizers in the 1950s, had a devastating impact on native plant communities. As native plants declined, so did the pollinators that depended on them. Scheper also found a relationship relative to bee size. Larger bees are at greater risk because they require more food than the smaller bees.

Ignasi Bartomeus and colleagues at Rutgers University reconstructed the history of 30,000 wild bees in the Northeast using bee collections at the American Museum of Natural History, the New York State Museum, and a number of other universities. Their study lends support of Scheper's realization of a more devastating impact on larger bees. They discovered the overall bee diversity has declined by more than 15% and bumble bees by 30% between 1872 and 2011.

Studies like those above were likely initiated by observations such as mine about the local bumble bees. The large amounts of data examined are in museums and other large collections, but amateur entomologists can, and do, play a part in tracking the presence, health, and population trends of insects over time and asking critical questions based on their observations.

References

[1] http://www.nytimes.com/2014/11/25/science/clues-to-bees-history-tucked-away-in-drawers.html?ref=topics&_r=0

WHAT'S NEW AT THE ZOO?

Missing Millipede Found Unharmed after Four Months by Lois Connington

It's nice to be able to report on a story with a happy ending for a change. When we moved the zoo into the beautiful new cabinets in early October, 2014, we soon learned that millipedes could and would climb the walls to bask on the screens below the lights (they were unable to climb the glass and plastic sides in their previous habitats). In fact, one of the two millipedes from Texas has taken up nearly permanent residence at the top of the cage. The ca. 8-inch-long desert millipede in the same cabinet, a donation from Dr. Richard Brown after one of his collecting trips to the

Southwest, enjoyed life on the sandy bottom for a short time, developing a great love for carrots once its cactus pad rotted off—then disappeared entirely.

We have spent the last few months scratching our heads. Where on earth could it be? We noticed a hole at the back of the hide we fashioned from a broken saucer, but had no idea where it led. The blue death feigning beetle (a dung beetle by trade) we put in the cage to clean up the considerable waste from the large millipede was seldom seen, but there did not seem to be much need for its services. We finally resolved to tear the habitat apart to see if we could solve the mystery.

We found and preserved our desert millipede's secret cavern. Photo by J. Guyton.

Last Friday Dr. Guyton rolled up his sleeves, shoveled the sand from the cabinet, and discovered the burrow the millipede had excavated from the hide to the side of a plant pot, where it was happily hanging out in a relative torpor. It perked up a little when we misted it with water, but it just lounged on the sand in the redesigned habitat. When we returned from the weekend, the millipede had disappeared, this time, apparently, into a hole in the sand's surface near the same potted plant.

Does the desert millipede come out at night to visit the water dish or is it in some kind of resting phase? To track its movements (if any), we plan to set up a camera under infrared lights. Stay tuned for the results of our nighttime surveillance of the millipede cage.

Note the entrance to the desert millipede's new cavern in the cactus' shadow. Photo by J. Guyton.

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Visit *The Gloworm* archives at http://msucares.com/newsletters/pests/gloworm/index.html.

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