Bohart Museum Society

Spring 2024 **Newsletter** No. 98

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Spring is always a time of change and that's true in the museum as well. We're seeing a number of changes coming, including a plan to rearrange the public side of the museum and how we handle tour groups. We will probably be seeing new students and visitors working in the museum.

For the time being I am remaining as executive director of the Bohart museum Society, and will continue the newsletters for the foreseeable future.

This year we're also changing things a bit on Picnic Day. Rather than opening the physical museum we're planning to use a tent and set up outside of Briggs Hall, with the Entomology Department. There we will have experts, displays and the petting zoo, and be much more accessible to visitors.

-Lynn Kimsey

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SPOTLIGHT ON A SPECIES

All You Never Wanted to Know About Cicadas...

by Lynn Kimsey

Megapomponia imperatoria (Westwood). Thailand. Photo courtesy of iNaturalist, creator: aomjanw.

Tettigracta tomentosa. Photo courtesy of Field Guide to the Insects of Tasmania.

The superfamily Cicadoidea contains two families, Cicadidae and Tettigarctidae. The superfamily is thought to have originated in the Jurassic Period, some 160 million years ago. Tettigarctids, otherwise known as hairy cicadas, are a primitive group of mostly extinct insects. Today there are only two extant species in the family, both in the genus Tettigarcta found in southern Australia and Tasmania. Cicadas on the other hand are found on nearly every continent. By the mid-Cretaceous some cicadid fossils have been found to have well-developed tymbals and the internal cavity and other structures associated with actual singing. By contrast, tettigarctids never evolved sound generating tymbals but instead use vibrations to communicate.

Cicadas are some of the largest bodied insects in the order Hemiptera, but not the heaviest. The heaviest would be the giant waterbugs in the genus *Lethocerus* (Belostomatidae). Cicadas look massive, but their bodies are largely filled with air. The empress cicada from Southeast Asia is the largest , reaching nearly 3 inches in length and a wingspan of nearly 8 inches.

Although we see cicada skins on tree trunks and the sides of buildings, cicadas spend most of their lives in the ground. Female cicadas have sword-like ovipositors that they use to insert the eggs into plant tissue. The eggs take 10 to 100 days to hatch. When the eggs hatch the nymphs drop to the ground where they then burrow into the soil. They can drop from considerable heights without damage because they are so small gravity has no effect. The nymphs use their enlarged front legs to dig down to roots. They probably first feed on grass and herb roots, followed by tree roots, where they feed on the xylem sap for anywhere from 2 to 17 years depending on the species! Some tropical species feed on the roots of "giant" grasses like sugarcane. Because xylem fluid is low in nutrients, cicadas have bacterial endosymbionts in their guts that help produce the nutrients they need. The fully developed nymphs dig out of the soil and climb up vertical surfaces. Once out of the soil they molt to the adult stage, with fully developed wings.

In years with large emergences the shed skins can be seen on nearly every vertical surface. In regions with large cicada emergences, we only

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MUSEUM NEWS

Jason Bond—The New Museum Director

Jason Bond in his office. Photo by Kathy Keatley Garvey.

Jason Bond joined the faculty at UC Davis in 2018 as a Professor and the Evert and Marion Schlinger Endowed Chair in the Department of Entomology and Nematology. He earned his PhD in evolutionary systematics and genetics at Virginia Tech before continuing on as a postdoctoral researcher at the Field Museum of Natural History in Chicago.

Jason's research program focuses on questions related to evolutionary diversification in terrestrial arthropods, specifically spiders, millipedes, and tenebrionid beetles. Major areas of study include questions related to broad scale evolutionary patterns in primitive spiders (tarantulas and trapdoor spiders), the evolution of silk use and prey capture, sexual selection, arthropod taxonomy, and speciation pattern and process. Much of his current work now focuses on the landscape scale genomics of California species, with an emphasis on understanding the impact of global change on biodiversity. Over the course of his career he has described >60 new species of trapdoor spiders and tarantulas (most from California), several new genera, and is attributed authorship of 14 spider families.

Prior to joining the Davis faculty, Jason was director of the Auburn University Museum of Natural History from 2011 to 2015, where he played a major role in the design and construction of a new state of the art collections facility to house the insect, invertebrate, mammal, reptile and amphibian, fish, bird, and fossil collections. During that time period he also directed the activities of the Alabama Natural Heritage Program which guided the conservation of endangered and threatened species in the Southeast and was member of the Alabama Land Trust board of directors. He is currently an associate editor for the journals Systematic Biology, PeerJ, and Zootaxa and was recently named co-editor and chief of the ESA journal Insect Systematics and Diversity. He is also President of the American Arachnological Society.

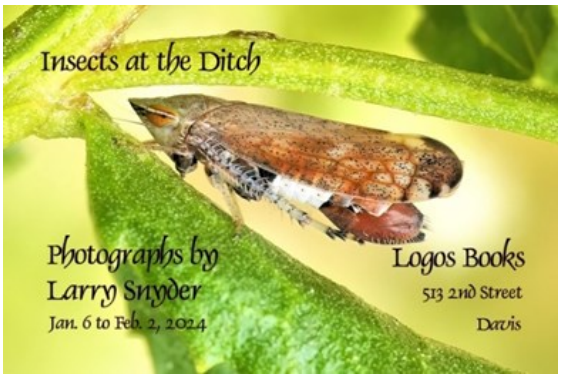
Larry Snyder Exhibit

Larry Snyder with Sammy. Photo by Kathy Keatley Garvey.

Over the past decade Larry Snyder has been watching and photographing insects visiting the "Ditch" in Davis, California. The Ditch is a stormwater drainage canal in north Davis that became an open space sanctuary in town and the site of a monarch-milkweed research project headed by Prof. Louie Yang.

Larry is a retired piano technician, harpsichord maker and music teacher. He graduated from UC Davis in 1968 with a degree in English literature. He founded and directed the Mosswood Spring Opera for young singers. He recently had an exhibition of his photos at Logos Books in Davis.

Larry has donated several dozen matted and framed prints of his fabulous insect photos to the Bohart Museum. We have many of these on display for visitors to the museum.



Polistes nectar-feeding (left), invitation leaf hopper (above). Photos by Larry Snyder.

MUSEUM EVENTS

Biodiversity Museum Day

Biodiversity Museum Day was February 10 this year, and the Bohart was open from 10am to 2pm. We had a great team of students and staff answering questions and showing off the petting zoo. It was a terrific success. Several thousand visitors came to campus for the event and nearly 1,000 came to the Bohart Museum alone. It was a really nice mix of families, retirees and students.

Jason Bond, the new museum director, and Nazzy Pakpour, author of the children's book *Please Don't Bite Me,* at the Bohart entrance. Photo by Kathy Garvey.

Museum day visitors being show the moth and butterfly collection by Jeff Smith and Greg Kareofelas. Photo by Kathy Garvey.

Picnic Day

Picnic Day is coming soon - April 20, and there will be many family friendly events and exhibits. Unlike previous years, the Bohart Museum will be closed during the day. Instead we will join the Entomology Department and have a pop-up tent outside of Briggs Hall, with displays, petting zoo and expertise. For more information on the event go to *https://picnicday.ucdavis.edu*. Don't miss the fun!

More Open Houses

Sol Wantz (center) and her parents, Patti Leggett-Wantz and Adam Wantz, and Nate Walker at the open house. Photo by KE Garvey

Kids playing with the magnet display funded by the Bess Spiva Foundation. Photo by KE Garvey.

March 3 the Bohart Museum held an open house focused on grasshoppers, crickets and katydids. We had over 100 visitors. Undergraduate student, Sol Wantz gave a presentation on these insects and assisted with the open house. She's also been sorting and identifying our grasshoppers and katydids, which have been disorganized for years, with many new additions from field collecting overseas as well as locally.

Our next weekend openings include Picnic Day, and Sunday May 19. Picnic Day is an all campus open house. The May open house theme will be on *Bees: Both Wild and Managed*, from 1-4pm.

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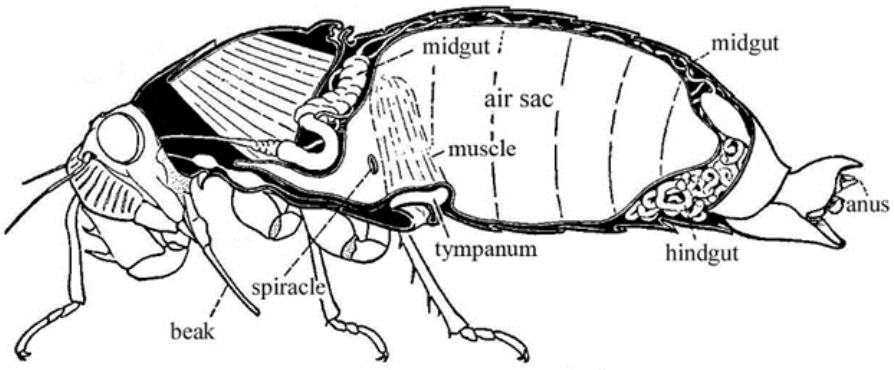


Diagram of male cicada anatomy. Modified from Principles of Insect Morphology, by RE Snodgrass.

focus on cicadas above ground, but imagine the impact they have in the soil with these large numbers feeding on roots for years.

Once adult cicadas have emerged from their juvenile skin, they need to find a mate quickly. Adults generally don't feed and only live a few days to a few weeks. The males group together in aggregations and sing to attract females. Males can produce four different acoustic signals, songs, calls, low-amplitude songs, and disturbance sounds. Each cicada species has its own "song", which helps males attract the right mates.

Cicadas generate sound from a pair of ribbed membranes or tymbals located in the base of the abdomen. Tymbals are like drumheads and there is a large air sac in the abdomen underneath them, again like drums. They generate sound by contracting a muscle attached to the underside of each tymbal, which causes ridges on the tymbal membrane to "click". The sounds they can generate can be incredibly loud in some species. The African species, *Brevisana brevis* and the Australian species, *Cyclochila australasiae*, are among the loudest insects known. Their singing can exceed 100 decibels. For comparison, chainsaws typically generate 95-100 decibels and a 22-caliber rifle shot around 140 decibels! Needless to say, cicadas are noisy beasts.

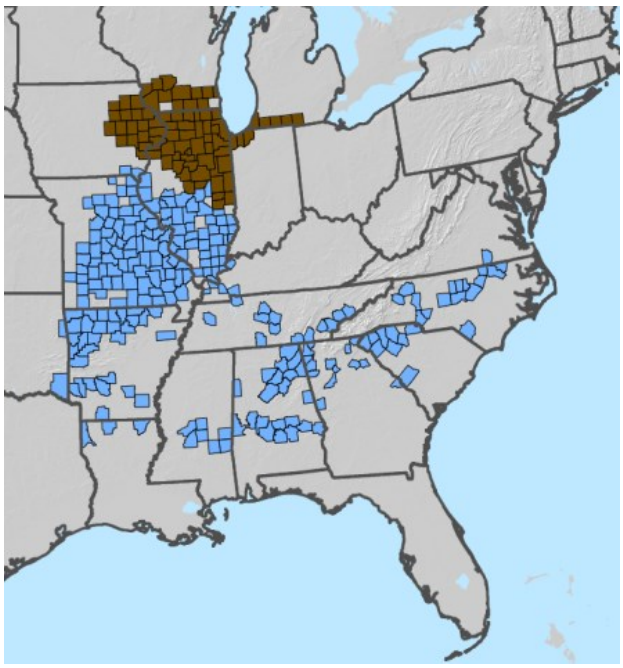
Both males and females have these tympana in their abdomens. However, only the males use them to generate sound. This is due in part to what lies behind the tympana. In males the abdomen is largely filled by a huge air sac that acts as a hollow resonating chamber. In females the abdomen is generally filled with eggs and other reproductive materials. However, both sexes use their tympana to hear. Females respond to male courting songs by flicking their wings making a cracking or popping sound known as crepitation.

Cicadas have two very different biologies depending on the species, periodic and annual. In most parts of the world cicadas, including species found in western North America, emerge annually. However, the species that get the most attention are the periodic cicadas, which are only found east of the Rocky Mountains in North America, along with one species in northeastern India and one in Fiji. In North America periodic cicadas in the genus *Magicicada* have broods that emerge in huge numbers every 13 or 17 years. Biologists have proposed that emerging in odd number periods enables the cicadas to minimize or outrun predators and parasites. Ironically, the two Old World species appear to have periodic emergences every four and eight years respectively, which runs counter to the idea that it is harder for predators to track population emergences that occur in prime number periods.

Historically, periodicity appears to have evolved in response to periods of climatic cooling. Long periods spent in the juvenile stage coupled with cold temperatures would lead to very low densities of adults. Low adult densities would lead to declining populations. Development of synchronized emergences would have strong survival value. Why this would only have evolved in eastern North America, with two possible exceptions elsewhere, is still unclear.

Periodic cicadas are getting a lot of press in 2024 because of a very unusual occurrence. For the first time in more than two centuries, adults from the North American 13 and 17-year broods will be emerging simultaneously this spring. Its going to be a very noisy spring in parts of the eastern half of the U.S.

Newly emerged cicada nymph. Photo by the Bohart Museum staff.



Brood XIII (brown) and brood XIX (blue) emergence areas based on the past. Map courtesy of Cicada Safari.

Asian Honeybee Surprise

Apis cerana queen with red dot and workers from a hive near Chiang Mai, Thailand. Photo by Martin Ziegler, Wikipedia.

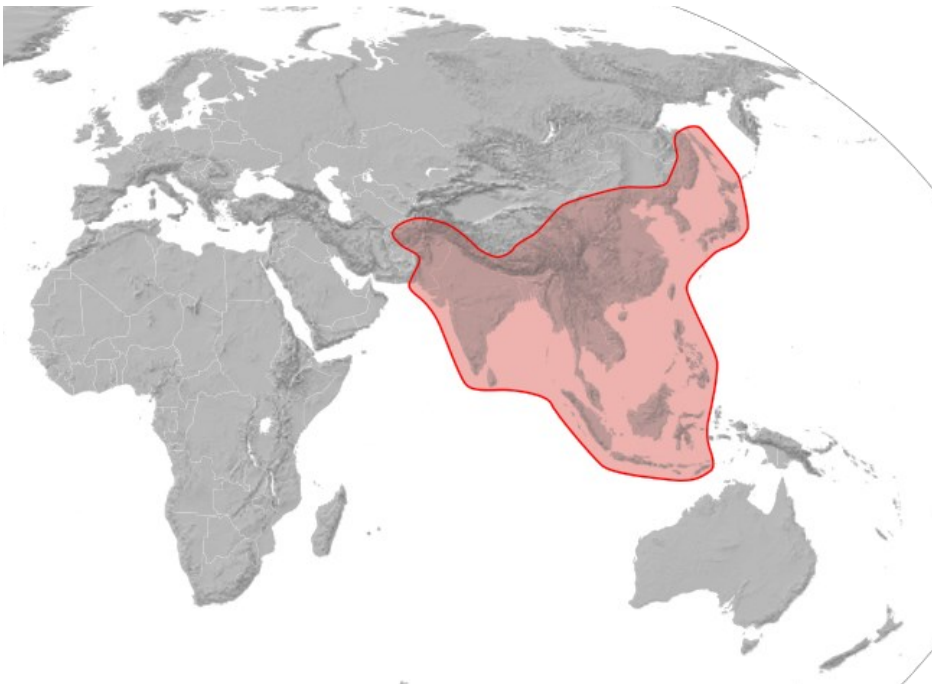
The Asian honeybee, *Apis cerana*, closely resembles the European honeybee, *Apis mellifera.* At one time it was thought to be a distinct race of the European honeybee, but the two species cannot hybridize, and Asian honeybee colonies are smaller than the European ones. Asian honeybee colonies average about 6,000 workers whereas European honeybee colonies have 50,000 or more workers. Their colonies tend to have multiple combs in cavities with small openings.

If you look at published distribution maps for the Asian honeybee they all show the bees occurring throughout Southeast Asia from Afghanistan to Japan, but not in Australia. However, they did make it to Australia.

In a paper published early in 2024 in Current Biology* the authors described an unusual invasion that took place in Australia sometime in 2007. An invasion of Australia by this species apparently resulted from a single queen and her colony being introduced in a port in northern Queensland. Although that should have resulted in an extreme genetic bottleneck, it didn't. One decade later they found that not only was there no problem with inbreeding, but the bees were flourishing and genetically adapting to the new habitat establishing new colonies across Queensland. Apparently, one queen carried enough genetic diversity to create a new viable population in Australia.

The authors found not only where the bees first arrived in Australia but also what genetic changes were occurring that allowed them to adapt to Australian environments. These changes involved genes associated with foraging behavior, reproduction and even their social structure. They found 481 gene alterations that had spread throughout the population. 471 of these gene variants traced back to the New Guinea population, which suggests that these variants were carried by the first colony to establish in Australia. Even though the closest populations of Asian honeybees are in Timor, Indonesia, the bees that made it to Australia were found to be most closely related to the Asian honeybees in New Guinea. These honeybees were not found in New Guinea until they were brought there by humans in the 1970's for honey production and agricultural needs. The authors traced changes in the bees' populations and genetics over a period of ten years, from 2008 to 2018. During this period the bees' population went from 10,000 to 50,000 colonies.

*Popular Science. Feb. 29, 2024. How a single honey bee colony led to a species invasion, by Lauren Leffer.



Apis cerana distribution map from Wikipedia.

WHAT DOES BIG MEAN?

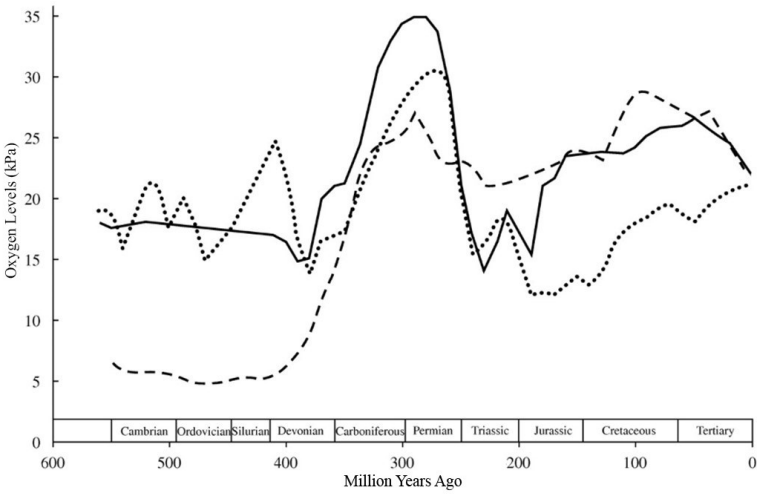
Meganeuropsis permiana fossil. Photo: Geologyin.

Entomologists are often asked what is the largest insect in the world? This is a difficult question to answer because there are so many ways to measure "size". In insects it would be the longest bodied, widest wingspan, heaviest body and so on. Each insect order also has its own "winners" in these categories.

In insects body size is strongly limited by their structure and physiology. Having an exoskeleton limits size in two ways. First, the larger the insect the more massive the exoskeleton must be to support its internal organs against gravity.

Perhaps a more important limitation is the way insects breathe. This also severely limits their size. Insects breathe through a tracheal system, which consists of a system of tubes that resembles our vascular system. These tubes become smaller and smaller, with the tiniest reaching individual cells.

This is not a very efficient system, which may explain why we don't have any insects the size of the Carboniferous ancestral dragonfly. Geological and paleontological studies suggest that oxygen levels were much higher during the Carboniferous Period than earlier Periods or today.



Graph of predicted atmospheric oxygen levels through the geological periods.*

Some of the largest insects that ever existed lived existed in the Carboniferous. *Meganeura monyi,* an ancestral dragonfly had the largest wingspan recorded, measured at 28 in.

There are a number of contenders for the heaviest insect. We might assume that the heaviest are all beetles, but that would be incorrect. Ironically, the heaviest adult insect isn't a beetle but an orthopteroid, the giant weta, *Deinacrida heteracantha*, which weighs as much as 2.5 oz. The largest insect larva belongs to the goliath beetle, *Goliathus goliatus*, which reaches up to 4.1 oz and 4.5 in long.

Adult beetles can be both long and massive. The heaviest species belong to the scarab genera *Chalcosoma*, *Goliathus* and *Megasoma*, and the cerambycid genera *Macrodontia, Titanus* and *Xixuthrus*. The longest one is *Batocera wallacei* from New Guinea. It can reach over 10 inches in length including the legs.

The record holders for longest insects are all walking sticks. *Phobaeticus serratipes* can be more than 20 in long! An undescribed species of *Phryganistria* from China is apparently even longer. The Australian species *Ctenomorpha gargantua* have been measured at up to 22.2 in long including the extended legs.

Finally, the extant insect with the greatest wingspan is either the white witch, *Thysania agrippina*, Alexandra's birdwing, *Ornithoptera alexandrae*, or the Atlas moth, *Attacus atlas*, at 11 to 12 inches across.

*Harrison et al. 2010. Atmospheric oxygen level an the evolution of insect body size. Proc. R. Soc. B 277:1937-1946.

Giant weta. Photo from https://onebugaday.blogspot.com/2015/01/giant-weta.html.

White witch moth, *Thysania agrippina.* Photo from iNaturalist - https://www.inaturalist.org/taxa/194632-Thysania-agrippina.

Giant walking stick. Photo from https://selangorstatepark.blogspot.com/2011/10/phobaeticus-serratipes-thats-one-big.html .

ASK THE BUG DOCTOR

If you have an insect question, need advice, want an identification of something you've found, or would like to see an article in the newsletter on a particular topic let us know. Email us at bmuseum@ucdavis.edu.

Adopt a Wasp Program

Polistes dominula nest. Photo by KE Garvey.

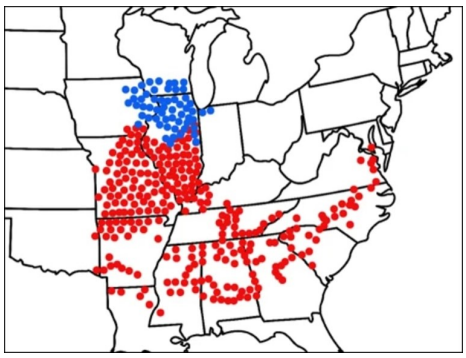
The Washington State Department of Agriculture has announced an Adopt a Wasp Program for homeowners and others to monitor paper wasp nests on their property and report wasp and hornet activity. This was instituted as a way to monitor for the presence of exotic hornets, like *Vespa mandarinia*.

New State Insect?

Spring azure butterfly, *Celastrina ladon*. Photo by Walter Siegmund, Wikipedia.

The European praying mantis has been the state insect of Connecticut since 1977, when a group of school children in Hartford proposed it to lawmakers. However, this year two groups of school children proposed to replace the mantis with a native insect, either the autumn meadowhawk dragonfly or the spring azure butterfly.

Pending Cicada Boom



Map of brood XIII (blue) and brood XIX (red) past emergences. Cicadasafari.org.

This spring two *Magicicada* broods, XIX and XIII will emerge simultaneously in the eastern U.S. The last time this happened Thomas Jefferson was president. Not only is it going to be really noisy but the ground will ultimately be covered with dead and dying cicadas.

Swarming the Navy

Entomologists and Naval officers holding a honey bee swarm collected on a naval ship.

It turns out that US Navy vessels are sometimes landing spots for honeybee swarms. Pest control on naval vessels usually involves insects like cockroaches and bedbugs but in San Diego, CA, honey bee swarms can also be a problem. The Navy Environmental and Preventive Medicine Unit has responded to honey bee swarms on at least eight naval vessels since 2019, and the numbers seem to be increasing over time. The presence of Africanized honeybees may be partly responsible.

California Dengue

A single case of dengue fever transmission occurred this past October in Pasadena, California. This virus is transmitted primarily by infected *Aedes aegypti* mosquitoes. What's unusual about this case is that the patient never traveled outside of the U.S.

Dengue is endemic in more than 100 countries globally. Most of these are in tropical and subtropical regions. In the U.S. local transmission of dengue has also occurred in Florida, Hawaii, Texas and Arizona.

Yellow-legged Hornet

Vespa crabro (left) compared with *Vespa velutina* (right). Photo by USDA APHIS.

Last summer the Asian yellow-legged hornet, *Vespa velutina,* was discovered by a bee keeper in Georgia. Employees of the Savannah Bee Company reported seen these hornets in their gardens for about a week.

Beetle Naming

Euhylaeogena byattae Hespenheide.

In an obituary of the author, A. S. Byatt, published in the London Times last year, a species of buprestid beetle named after Byatt, *Euhylaeogena byattae,* was mentioned. It was named in her honor by Henry Hespenheide in his paper published in 2014 in the Coleopterists Bulletin. He named the beetle for her novella *Morpho Eugenia*, published in *Angels and Insects*, based on the life of Alfred Russell Wallace, one of his heroes as an evolutionary biologist/entomologist.

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Picnic Day

ASUCD

Don't miss it!