SPOTLIGHT ON A SPECIES

Bats and Mosquitoes, A Reality Check

By Lynn S. Kimsey

There is a growing public awareness of the need to protect bats because of progressive habitat loss and bat specific diseases, like white nose syndrome. I know you’re wondering at this point why I’m writing about bats, but there is a new twist to this bat protection movement. Over the past several weeks I’ve gotten a number of calls and emails from folks about the need to protect mosquitoes because they are such an important food for bats. This raises a number of questions and the need for a reality check.

This is potentially a huge topic as there are a lot of bat species, so I’m going to focus on California. Twenty-four species of bats are found in California. Some of these are residents, others seasonally migrate into the state. All of the California bats are insectivores, which is kind of boring, since in other regions bat species could be predators of fish, each other, fruit eaters, and even blood feeders, such as vampire bats.

There are 74 species of mosquitoes in California. Most of them are native to the state. However, we now have established populations of three, and perhaps a fourth exotic species, including the yellow fever mosquito, *Aedes aegypti* and the Asian tiger mosquito, *Aedes albopictus*. The behavior of native mosquito species varies from small populations breeding in tree holes to large, very large populations associated with salt marshes and potentially rice. Each species of mosquito has a preferred host range. Some species prefer large bodied animals like cattle and deer, others specialize on birds. The exotic species tend to be strongly anthropophilic and peridomestic, meaning that they like to bite humans, and live in and around human habitations.

Mosquitoes have three basic behaviors that dictate where and when they fly, mating behavior, method of host searching and oviposition site choice. Males aggregate in large mating swarms, which may extend as far as 4m above the ground. This is the only time males aggregate. Females that feed primarily on mammals search for blood sources fairly close to the ground or at least within 10 feet of the ground. Those that feed on birds fly higher to reach birds roosting in tree canopies. Oviposition sites vary from group to group. Some species lay their eggs in treeholes or water filled rock crevices, which could be 30 to 60 feet above the ground, others use large bodies of water, like ponds and

Continued on page 4.
The end of the academic year has come and gone and some of our student employees have graduated or will be by the end of summer session. In spring quarter we had ten students working in the museum on various projects, including Emma Club, Angel of Love “Lovey” Corniel, Brennen Dyer, Abram Estrada, Lohit Garikipati, Minsu Kang, Eliza Litsey, Karissa Merritt, Danny Nguyen and Ivana Satre. Brennen and Minsu graduated this spring.

Brennen will continue to work in the museum on a grant from the California Department of Food and Agriculture. This grant is a detailed follow-up on biocontrol agents of exotic weeds to determine if any of them have switched over onto closely related native plants.

We’ve also had several young, budding entomologists interns working in the museum this past year, including Jasmine Duenas-Ibarra, Noah Crockett, James Kjer and Parras McGrath. Noah will be attending Cornell University starting this August. James and Parras will be going to community college to get their prerequisites out of the way before going to university. Jasmine is still in high school.

We’re now at the end of the NSF tardigrade grant. The collection is in great shape, and all of the specimens are organized and housed in new slide cabinets.

We were hoping to perfect a process to remount disappearing specimens into a different mounting medium.

Unfortunately, the tiny specimens didn’t cooperate and curled when removed from the original mounting medium, so we’re going to try some new imaging techniques to see if the specimens can still be “seen”.

Brennen Dyer is creating a website that highlights entomological techniques, procedures and materials. A sort of how-to website for the insect collector:

http://resourcefulentomology.com

Among other things he’s posting is information from Jeff Smith on how Jeff makes the glass-topped specimen drawers we use to store specimens, and Lohit Garikipati is providing detailed mantis rearing techniques. Brennen has also included specific recommendations for specimen labels and labeling procedures. The graphics are being prepared by Karissa Merritt.

For the past 20 years I’ve been teaching introductory entomology to juniors and seniors here at UCD. Students taking the class have to write a 5-page term paper. To maintain my sanity I started collecting silly sentences from their term papers. Some are so good that I hired Karissa Merritt to illustrate them. The Illustrations are awesome. Here’s an example of her work below:
The Bohart Museum has one of the largest collections of insects from Mexico ever assembled, and here’s the story why. Photos are courtesy of Ron—LSK

In 1966 Steve Buckett had applied to and received a grant from the American Philosophical Society (APS) to explore the entomological fauna of Veracruz. Mike [my brother] was kind of a protégé of Steve’s and was invited to participate. Much to my surprise, Mike recommended me as a third and Steve agreed, so in the summer between high school and starting at UCD I was included. I was over the top about it. How cool.

In mid-June, the three of us headed out in a university-provided GMC Travelall stacked to the ceiling with gear. We collected our way through the Southwest desert before crossing into Mexico at Laredo, TX. We traveled south over the next day or two until setting up in a small rented house in the town of Cordoba, west of the city of Chihuahua. The geography was hilly and had thick jungle forests, torrential summer rains, and impressive rivers. We collected all through the region, from the jungle lowlands to the slopes of Mt. Orizaba, an 18,000 ft volcano. We stayed through early September, as I recall, and returned to Davis via Mexico’s west coast, collecting here and there as we went.

The next year, based on the success of our 1966 trip, Steve was able to get a second grant from the APS, this time to collect the Central Mexican Plateau in and around the state of Chihuahua. This time, neither Steve nor my brother could go, so Steve put me in charge since I’d been part of the 1966 trip. It was pretty bold. I was 19 years old and had only the one experience to go on. I teamed up with two other Entomology students, Chip Kovacic and Ken Lorenzen.

Veracruz. The area was hilly and had thick jungle forests, torrential summer rains, and impressive rivers. We collected all through the region, from the jungle lowlands to the slopes of Mt. Orizaba, an 18,000 ft volcano. We stayed through early September, as I recall, and returned to Davis via Mexico’s west coast, collecting here and there as we went.

We also were provided a university Travelall, which promptly broke down in Albuquerque! But a couple days later we continued on and crossed into Mexico at El Paso/Ciudad Juarez. From there, we headed south to Chihuahua, then west into the undeveloped desert highlands. We found a little town with a motel-like set of rooms and settled in. We ranged in all quadrants around Chihuahua. The geography was incredibly varied, ranging from right around 4,000 feet to well over 10,000 feet in the mountains. To the west, we could visit mountain ecosystems and cool climates. To the north and south there were flat prairie-like zones with few trees but lush ground vegetation. To the east it became increasingly arid, almost but not quite a desert due to the elevation. As before, during the day we would jump in the Travelall and ranged out an hour or two to potential areas of productive collecting. Most nights, we would set up a light trap, sometimes right at the motel, and find ourselves the subject of lots of curious speculation.

In 1968 I was a roommate with another Entomology student, Terry Sears. Terry and I were toying with a trip into one of the then-wildest places in Mexico, the Barranca del Cobre. It was so remote we were fairly certain few if any other entomologists had ever collected there before. Without roads, the only way in and out of the area was by train, which made only a few stops between Los Mochis on the coast and Chihuahua on the central plateau. The area was rugged, primitive, undeveloped, lush, and remote. The canyons were deeper than the Grand Canyon, with temperate forests on the upper reaches, and thick rich, jungle-like conditions on the canyon bottoms.

To get around, we decided dirt bikes, hauled up on the train, were going to be our method for exploring the canyons and canyon rims. We wrote up a proposal and submitted it to a number of scientific/research organizations…and were quickly and politely rejected in every case. We figured we had the best chance with, again, APS since they had supported the two previous trips and with Steve’s endorsement we might

-continued on page 5
Bats forage on average between 20 and 40 feet above the ground. The smallest California bat, the California myotis hunts near the ground, whereas the largest, the California mastiff bat, tends to fly between 100 and 200 feet above the ground. Mastiff bats primarily eat moths and beetles. The California myotis eat moths, beetles and flies.

Whether bats are likely to encounter and feed on mosquitoes depends on the bat’s size (weight), foraging height, and the diversity and number of mosquitoes present in the habitat. Mosquitoes are most vulnerable to bat predation in mating swarms and when ovipositing in open water sources, first, because they are easier to find, and second because large numbers can be eaten without having to expend a lot of energy.

Bats are expensive animals to operate. They have high metabolic rates and flying is energetically expensive. If you compare the energy requirements of a 0.6 lb. bat to a 125 lb. human, the bat needs twice as many Calories per pound as the human needs (these figures are based on nectar-feeding lesser long-nosed bats, which are not found in California. California bats feed on insects, which are much lower in high energy carbohydrates than nectar. Flying is energetically very costly.

Measurements of the number of Calories in a single mosquito show some impressively small numbers. The average mosquito weighs 2.5 mg, which yields roughly 0.01 calories. The smallest California bat, the California myotis, weighs 4 grams. It is known to feed on mosquitoes. If this bat relied exclusively on mosquitoes, but if this bat relied exclusively on mosquitoes it would have to eat over 1,000 mosquitoes every night. This sounds like a great thing, so much mosquito control in one bat. However, so much energy would be required to capture and eat that many mosquitoes that the bat might starve to death before it finished feeding.

An Australian study found that the little forest bat, Vespadelus vulturnus, which weights 0.3 grams, if fed on mosquitoes would have to eat more than 600 mosquitoes per night or 170 similar sized moths for their metabolic needs. Thus, even though bats will eat mosquitoes, mosquitoes are probably not the best food for them. Mosquitoes are mostly legs, wings and exoskeleton. Moths on the other hand are mostly body and wings, and if female, are full of eggs.

The other side of this equation is the importance of mosquitoes as vectors of disease-causing pathogens. Many mosquito species are effective vectors of a wide range of viruses and Protozoa, like the ones that cause malaria. Bats are known to harbor more than 80 virus species and 20 of these are known to be vectored by blood feeding insects. Bats may also be part of the transmission cycle of Zika virus. In any case bats may eat mosquitoes but mosquitoes, particularly the day biters, like Aedes aegypti will also feed on bats and this could lead to pathogen transmission.

Even though some bats will feed on mosquitoes, this is probably largely opportunistic. There will certainly never be a lack of chironomid midges in abundance near water, and moths, many of which are agricultural pests, and may be very abundant, particularly around suburbs and agroecosystems. Here in the Central Valley there are also large clouds of corixid water bugs flying at night from one water source to another.

Because of the potential health risks posed by mosquitoes, reducing control of mosquito populations to preserve them as bat food should be viewed as an unacceptable risk for humans and other animals, including ironically, bats.
Bohart Museum Society Newsletter Summer 2018

MORE MUSEUM NEWS

**Crocker Museum Event**

Moms and kids enjoying locusts and Bohart Museum traveling exhibits at the Crocker Art Museum. Photos courtesy of Readle Alburn.

In June the Crocker Art Museum (https://www.crockerart.org/) in Sacramento, had an event called *Bugs, Bugs, Bugs!* They borrowed a number of our traveling exhibits for the event. The event was focused on kids and families. Kids got to make bugs, sketch bugs, watch an artist paint a bug, and play with plastic bugs frozen in ice. In addition, the Sacramento Theatre Company performed *James and the Giant Peach*, and visitors got to meet a giant dragonfly named Odo.

**Summer Weekend Programs**

Don’t miss our monthly weekend events. We have three more scheduled for this summer and they should be a lot of fun.

- **Moth Nights**—July 21, Saturday, 8-11 pm
- **Fire & Ice: Extreme California Insects**—August 19, Sunday, 1-4 pm
- **Crafty Insects**—September 22, Saturday, 1-4 pm

**Visiting Scientist**

Barry O’Connor, professor and curator at the University of Michigan, Ann Arbor, visited the museum to work on our mite collection. He was here for the week of June 18-22 identifying specimens and looking for host beetles. Dr. O’Connor studies parasitic and commensal mites that feed and live on birds, mammals and insects. We hope he’ll come back next year.

**Calling all scientists!**

The Hitachi desktop scanning electron microscope is returning. It will be available for use from July 30 through August 19 in the museum.

Continued from page 3.

have a shot. Our re-application/rebuttal was that we acknowledge that our youth and inexperience seemed a risk, but that was exactly what it was going to take for the trip to work. They responded positively, saying something about believing in the power of enthusiasm and we got our $1500. We used a vehicle borrowed from Terry’s parents, recruited a friend of his named Charles Glaser (also a UCD student) to join us, gathered our gear, and completed our plans. The university gave us a small stipend to offset any summer job income we might have been sacrificing, and off we went. We traveled down the west coast of Mexico to Los Mochis. From there, we turned east and headed up toward the Sierra Madre mountains, where we set up kind of a “base camp” operation in a “hotel” in Choix, Sinaloa. The hotel consisted of a single room with a ceiling light bulb dangling on a bare wire, barred windows without glass, kerosene lamps for when the electricity went out, and a single toilet serving the dozen or so rooms. It was pretty “rustic.” We collected through June in Choix, then headed into the mountains via the train, jumping off at various places like Temoris, Santo Nino, Cuiteco, and Creel. These towns provided climatic and geographic variety, from jungle lowlands to pine mountain forests. We returned every week or two to Choix to work on our catches and get restored. In the mountains, we stayed in very rustic places, including in one case a cave.

Despite, or perhaps because of their adventures these young entomologists went on successful careers. Can you imagine the university allowing and funding such expeditions today! -LSK

**Biodiversity Day Video!**

We hired a very talented undergraduate student, Alex Fisher-Wagner, to produce a video highlighting Biodiversity Day last February. Take a look—https://youtube.com/watch?v=zy09D2qKxog
**“Insect” Outbreaks**

**Beetle Mania**

Several nights in May large swarms of the carabid beetle, *Dicheirus dilatatus dilatatus*, were observed aggregating beneath a street light on a bike path alongside a large weedy field on the west side of UC Davis by undergraduate student Emma Cluff.

The beetle was identified by Kipling Will at UC Berkeley. This species feeds on seeds, particularly of grasses and weedy herbs. Evidently these beetles form large mating swarms and the swarms often include two other carabid species, though in smaller numbers.

**Tick Grossness**

*by Mike Niemela*

In June, 2018, the Tehama Co. Mosquito Abatement District contacted the California Department of Public Health (CDPH) to help them identify a “large bug” that emerged nightly to feed on a homeowner’s chickens. Upon receipt of pictures, CDPH found that the blood feeding parasites were soft ticks. Associate Public Health Biologist Greg Hacker collected specimens and identified the ticks as *Argas sanchezi* (Argasidae), a relatively common parasite of chickens and other birds. The homeowner sprayed an acaricide to eliminate the ticks.

The following week, Greg Hacker and Senior Public Health Biologist Michael Niemela returned to Red Bluff to check the progress of the homeowner’s control efforts. They found that a considerable number of ticks had survived the treatment, most likely due to the design of the coop. The chickens were housed in a wooden chicken coop with metal siding, which afforded the ticks a sheltered space away from the pesticide. The CDPH biologists found the ticks mostly between the outer wooden wall and metal siding. As the homeowner removed the metal siding, the exposed ticks were easy to see as they scurried about to escape the sun.

Soft ticks differ from hard ticks in both their body form and biology. Hard ticks, the ticks most commonly encountered by people, possess a scutum while soft ticks do not. The scutum is a hard shield-like structure that covers all or most of the dorsal side of the unfed tick. Hard ticks quest on grass and brush as they search for their next blood meal. Upon encountering an acceptable host, hard ticks will attach themselves to the host for many days and, on average, have a total lifespan of approximately two years. Instead of questing, soft ticks live in rodent nests, in deer beds or otherwise in close proximity to their hosts. When the host is sleeping, the soft tick can emerge from shelter and take a blood meal. *Argas sanchezi* nymphs and adults will feed on the host for just a few minutes while larvae will feed up to seven days. Like hard ticks, soft ticks vector pathogens to their hosts. *Argas sanchezi* is capable of vectoring *Borrelia anserina*, which can cause diarrhea and anemia in affected birds. Soft ticks can live for at least 10 years without feeding.

**More Beetles**

Professor Art Shapiro reported a large outbreak of the cottonwood leaf beetle, *Chrysomela scripta*, on willows along Putah Creek west of Davis. These brightly colored beetles are found across North America. They are specialized leaf feeders on members of the plant family Salicaceae, which includes cottonwoods and willows.
Tick Eggs?!

This is where ticks meet molds?! An image has been circulating around the Internet purporting to be a photograph of tick eggs. However, the claim was debunked by Snopes.com. After further investigation it turns out that it is in fact yet another kind of slime mold—Lindbladia tabulina.

Slime molds are very odd organisms. They used to be treated as fungi but in reality they are more animal than anything else. Normally they are found as single-celled organisms living in damp organic debris, but occasionally they will clump together to form complex reproductive structures. These structures are what we actually see.

Several different kinds have been reported by folks to the museum and by society members, including the ones below.

Walking Stick Dispersal

Just when you thought you’d heard it all, how about bird dispersal of walking stick eggs.

Walking stick eggs are remarkably hard shelled and sometimes elaborately sculptured. They have an external layer of calcium oxalate, which makes them very tough to digest. This characteristic is apparently unique in the Insecta.

The authors of a report published in Ecology: The Scientific Naturalist this year decided to find out if walking stick eggs could survive a bird’s digestive tract.

They fed the eggs of three species of Japanese walking sticks to brown-eared bulbuls to see if the eggs would survive the birds digestive tract. The walking sticks were all capable of producing viable eggs without mating. They found that between 10 and 15% of the eggs made it through the bird intact, although none hatched afterwards.

Blowing Bubbles

Richard Zack at Washington State University recently published an article titled “Bubble-Pooping, High Jumping “Superhero” Bug in a Yard Near You”. How could you not read something with a title like this!

Apparently they’ve seen a large number of spittlebugs this year in Washington state. We haven’t seen so many here, probably because its been too dry.

Spittlebug nymphs produce a white foamy ball by mixing plant sap with air in their rectum creating whitish bubbles like soap suds. They hide in this foamy mass, which not only insulates them from high temperatures and drying, but also hides them from predators.

One species, Philaenus spumarius, not only makes these nymphal “poo” bubble palaces, but the adults show some pretty spectacular jumping behavior. In a study published in the journal Nature the authors found that the adult of this spittlebug uses a unique rachet mechanism in its hindlegs to jump. Using this mechanism this quarter inch long insect is able to leap more than 2 feet into the air.