The Gloworm

Time flies like an arrow;
fruit flies like a banana. - Groucho Marx

MISSISSIPPI STATE UNIVERSITY
EXTENSION SERVICE

Volume XXI No. 1 January 2014
An Extension Newsletter of the Dept. of Biochemistry, Molecular Biology, Entomology, & Plant Pathology

Alert: Bug and Plant Camp Is Filling Fast!

Campers started registering for the 2014 Bug and Plant Camp before Christmas by sending in their fees by check. This is the earliest camp has started filling! We are almost half filled and it is only January! A number of our returning campers wait until late to register, but since we are developing a science fair research component for you (see below), we would hate for you to miss it. I really do not have any expectations of a fully functional online registration system this year, so please go ahead and reserve your spot with your registration and down payment using a check!

Beekeeping Camp Becomes a Reality!

I am excited to announce a new camp in our outreach programming! Dr. Jeff Harris and I have been discussing a beekeeping camp since we joined the department, and the time has arrived. We are very interested in getting more youth involved in beekeeping. I started as an undergraduate student and kept bees for almost two decades, only quitting when I finished my doctorate and moved to Kentucky to accept a faculty position at Murray State. And yes, that is a picture of me collecting a swarm—that almost got away!

We will operate this as an intergenerational camp and youth campers will be required to be accompanied by a parent or guardian. We will only accept 12 camper teams, or 24 people. Youth need to be 12 years of age to attend, unless they have been participating in our Bug and Plant Camp. The announcement of the camp to Mississippi and Louisiana beekeeper associations has already generated a lot of interest! Camp will be the week of June 8 (the week before Bug and Plant Camp). At the end of camp participants will be ready to setup their own hives. We will take them through the entire process from purchasing bees and equipment to processing honey and wax. They will know what to watch for to insure the health of their bees and produce a crop of honey. We will also find mentors to assist them, as close to where they live as possible, as they get started. As usual, we will respond to campers' emails or calls. A registration form is included in this newsletter as we are not optimistic online registration will be available for this camp, either.

Bug and Plant Camp Adds Science Fair Research Component

For repeat campers who will be at camp this summer, we are exploring the possibility of adding camp research projects to the curriculum. Participating in this track will cut night collecting in half and reduce the number of day presentations those campers would otherwise participate in by 2 or 3. Dr. Natraj Krishnan will lead this component, using *Drosophila melanogaster* (fruit flies) as the research organism. Campers will remember him from the physiology section last year.

Over the next few months, we will provide background information through the Gloworm, and internet references to get you ready. We will lead you to an understanding of why Drosophila are so useful in research and may introduce you to research done by a high school student we have been working with. To get started, Wikipedia has a good introductory article that can be accessed at http://en.wikipedia.org/wiki/Drosophila_melanogaster. As you read and study, start thinking about research projects you may want to undertake. After you have reviewed the first several articles, send Dr. Guyton an email indicating you are interested and we will begin working with you individually. Even if you are not coming to camp, you may enjoy following this process.

Science fair judges are looking for good research project designs that involve control and experimental or treatment groups. Write down all the questions that occur to you. Think about the construction of apparatus needed to apply the treatment to the flies in the treatment group, for example, you may need mazes, wind tunnels, or environmental chambers.

As you think about your science fair project, google it. Has it been done? You will not make it to the International Science and Engineering Fair with a replication of a simplistic experiment. What fruit do fruit flies prefer? Do they prefer a light or dark, moist or dry environment? Been done! Fruit flies follow a circadian rhythm. If you force one group to stay active for a long day and make comparisons with flies on a normal schedule, how is their behavior affected? Better.

FEATURED INSECT: Fruit Flies (Drosophila melanogaster) by Dr. John Guyton

If you have ever waited just a little too long to eat your bananas and they have reached the optimum sweetness for use in banana nut bread, then you have met Drosophila. Those annoying red-eyed gnats, commonly called fruit flies or vinegar flies, that you may first notice in your kitchen sink have proved phenomenally useful in biological research because they are easy to care for, breed quickly, produce a lot of eggs (high fecundity), have a life cycle of about 30 days, exhibit sexual dimorphism (easy to differentiate males and females), are easy to anesthetize (with CO_2 or by chilling), have only four pairs of chromosomes, and their complete genome (genetic information) has been sequenced (determined).

Drosophila melanogaster male (left) and female laying egg (right). Photo by J. Guyton.

The tip of the male's abdomen looks like it was dipped in ink, and the female's abdomen is striped. It will be hard to see without a microscope, but the male flies have sex combs on their front legs used to hold the female during mating. As you learn to sex your flies, watch for the male fruit fly's dance, which is used to attract mates. See if you can describe this dance. All males use a similar sequence of steps.

The female, once fertilized, will lay 30–50 eggs per day, producing around 500 eggs on rotting fruit in her short lifetime. The fly maggots hatch from the eggs and immediately begin eating the fruit. They will be sexually mature in about a week, so you will soon have a very good supply for your experiments!

Drosophila were among the first organisms used in genetic research and are the most widely used today. Since all organisms use a common genetic system, fruit flies are ideal subjects for learning about transcription and translation (the first steps in gene expression) and DNA replication. Life involves cells responding or adapting to changes in their environment, and regulation of

transcription and translation, the two main steps of protein production, is critical to this adaptability.

Learning the Language for Research Projects

by Drs. John Guyton and Natraj Krishnan

We need to introduce a new word. *Taxis* is a translational or orientational movement by a freely motile organism in relation to a stimulus. Such directional movements include chemostaxis (in response to chemical stimulants), geotaxis (in response to gravitational force), and phototaxis (in response to light). Movement toward a stimulus is a positive taxis. Movement away from a stimulus is a negative taxis. Adult fruit flies demonstrate a negative geotaxis, i.e., they climb in their vials, against gravity.

And now, a process we will use in our discussions and that may possibly be involved in your research: *gene expression*. The thousands of genes expressed in a particular cell determine what that cell does. Every cell in multicellular organisms contains the entire genome, however only some of the genes produce messenger RNA (mRNA), and then only in response to a stimulus or at a certain point in the cell's life. Hence, the process of gene expression is regulated depending on the requirements of that particular cell or tissue. Genes are sequences of nucleotide bases in DNA that carry information that is used to make proteins. A section of the DNA spiral separates and this "information" or "pattern" involves the attraction and arrangement of nucleotide bases that are attracted to a strand of DNA. The nucleotide strands then separate as mRNA in a copying process called *transcription*. So, transcription is the process of copying the genetic information encoded for a particular gene from the DNA to RNA (mRNA). Following this, mRNA sequences are “translated” to proteins. Thus, proteins are sequences of amino acids encoded by genes. Proteins in living cells influence an organism’s traits, and in certain cases also influence gene expression. After transcription, a cell performs a specialized role; adapts to an environmental condition; displays a new or altered trait; or stimulates, alters, or maintains a metabolic process as the result of gene expression.

Drosophilas' biological clock efficiently maintains their *circadian rhythm*. Adult insects emerge from pupae between 6:00 a.m. and 9:00 a.m. even if their entire pupal stage occurred in the dark! If reared in darkness from eggs, their circadian rhythm is disrupted and they do not emerge. However, even a single flash of light can establish the rhythm, beginning with the illuminated portion of the 24-hour cycle at that incidence.

BUG CLUB ACTIVITIES: Rearing Fruit Flies

Fruit flies are not native to this hemisphere and they are not found so much in the wild as they are in close association with humans! You might check your compost pile, though this is really the wrong time of year to find them there. You can also check with produce managers at grocery stores to see if they have fruit flies where they dispose of old fruit. They may save a few bananas for you that they have removed because they have ripened too far and have fruit flies. To get enough fruit flies to run experiments, you can sustain them on the bananas in a quart jar or you can rear them on the following artificial diet. Blend a banana with a teaspoon of sugar, then add oatmeal until the mixture is thick. Pour it in a quart jar and sprinkle a few granules of baker’s yeast on the surface. Drop a banana peel in the jar; if it contains eggs, you are on your way!

Now, Let's Experiment. An easy experiment to do with fruit flies is to watch their response to smell. Place some rotting banana peel in an aspirator and blow a gentle, steady stream of air past

the bananas and toward the fruit fly from its side or back, or just blow over a ripe banana peel. The fruit fly will turn toward the banana smell and may even walk toward it.

Fruit flies carry a large supply of glycogen (animal starch) to support flight. If you stick a fruit fly's abdomen to a melted drop of wax on an insect pin you are ready to experiment with its energy reserves. With little puffs of wind or light taps on the pin, the Drosophila can be induced to continue in stationary flight for several hours. When the fly can only lift its wings but no longer beat them, it has exhausted its energy supply. It cannot use its fat for flight, only carbohydrates. If you give it some concentrated sugar water, it will be ready to fly again in a minute or so. However, sugar water is not an efficient energy source and it will not fly very long this time.

Fun Fact. Fruit flies are attracted to oviposition (egg-laying) sites by the smell of fermentation. You can use this to your advantage if your colony gets out of hand or you have escapees. Vinegar, beer, and wine are powerful attractants, so you now have a way to take care of the problem before your parents take care of your experiments! Put out a saucer containing one of the baits and the fruit flies will find it. The next day you will find them—drowned in the bait.

Crickets

Worrying about the lack of fruit flies at this time of year, we decided to add another insect you can find—at pet stores and bait shops. You can do many things with crickets besides eating them in chocolate chip cookies or covered in chocolate!

Crickets are considered good luck in Asia and are kept in cages. They are related to grasshoppers but are are close kin to katydids. We enjoyed a male pink katydid at Bug and Plant Camp some years ago that serenaded us every night. Crickets are hemimetabolous (undergo incomplete metamorphosis) insects with fanfolded hind wings that can be carefully teased out once the forewings are pulled forward. Crickets are omnivores and scavengers and enjoy a variety of foods. They will do fine on a piece of apple, dog food, or vegetables and other fruits you eat.

If you have a chirping male cricket, use your smart phone to record his chirping. Now, isolate the male and place a female on a table where you can carefully watch her and begin playing back the male's chirps. Watch how the female uses her front legs while the recorded chirps are playing. Her "ears" are small holes in the exoskeleton beneath her "knees" and she will position and reposition her two legs while she locates the serenading male. Soon, if she likes his tune, she will begin advancing toward the phone!

Examine the two crickets and note their adaptations for different habitats. One lives in the grass and the other underground. Can you find at least two adaptations. The top one is a female house cricket and the lower a mole cricket. An internet search will reveal even more adaptations not visible in the photos.

Try this next activity later in the year when you can collect crickets outside. Crickets chirp faster as the environment gets warmer. The snowy tree cricket chirps slow enough that you can count their chirps. If you have a male inside and it begins to chirp, immediately check the temperature on the thermostat and count the number of chirps in 15 seconds. Add 40 to this number for the approximate temperature in degrees Fahrenheit. Now, increase the temperature 10 degrees. When the cricket begins chirping again,

count the chirps and estimate the temperature as above. How closely does it agree with the new temperature?

Bug and Plant Camper Becomes Associate Dean

Dr. Scott Willard, who attended Bug and Plant Camp with his son Aiden during his first year as the head of the combined departments of Biochemistry, Molecular Biology, Entomology, and Plant Pathology, has been named Associate Dean of the College of Agriculture and Life Sciences at MSU. He was a very active camper, a fine pinner, and has a good insect collection displayed behind his desk. He also helped procure animals for our necropsy and was instrumental in obtaining funding for the Arthropod Zoo. He loves night collecting so we have probably not seen the last of him!

'Tis Always the Season for Entomology **by Clarissa Balbalian**

As a child growing up in the Blue Ridge mountains of Virginia I was privileged to live in a neighborhood that was borderline suburbia. What I mean is that it had not yet morphed into the well-manicured subdivisions that are so common today. Tracts of the woodland from which my neighborhood was cut still surrounded homes and the roadside was not a strip of neatly clipped grass, but contained fun and interesting plants like sassafras, milkweed, Queen Anne's lace, and blackberries. I was fascinated by the insects that would show up at the same time every year like clockwork. As the landscape changed, I noticed that some of my once dependable friends had disappeared. I thought I would introduce you to a few of my seasonal friends from the past who like to "bug" plants. I'll bet you've met most of them yourselves!

Every spring, some of the first trees to wake from their winter slumber were the black cherry trees. They were easily identifiable from the webbed nests in the crotches of their limbs. The webbing would appear each spring just as the trees had shed their white blossoms and begun to push out their new leaves. The nests quickly grew in size and tiny black eastern tent caterpillars could be seen wriggling inside. The caterpillars were ready to start munching as soon as the tree produced its first leaves. As the caterpillars grew, they would leave the nest and there would be scads of them crawling on lawns and roads throughout the neighborhood. I admired their fuzzy bodies with the pretty blue stripe running down their sides. I also felt sorry for the trees they were defoliating, so I occasionally made a game of seeing how many I could squish as I bicycled down the street to my friend's house. My friend, on the other hand, always had a shoe box full of eastern tent caterpillars that she would dutifully feed, and together we would watch them make their fuzzy yellowish cocoons and wait for them to emerge as moths.

About the time the eastern tent caterpillar cocoons were showing up under the overhang on the warm, south-facing wall by my basement door, I knew it was time to keep an eye out for the daddy-longlegs who also loved to be on that wall, especially above the door. It only took one incident of a daddy-longlegs dropping off the wall in my presence for me to live in fear of being attacked as I put my bicycle away for the night. Also known as harvestmen, these arachnids look like spiders but are not. Unlike spiders, harvestmen only have one pair of eyes and their body segments appear fused into a single body segment. Gangly in appearance and harmless to people, harvestmen do not

produce webs, do not have venom, and scavenge for their food on the ground. I wonder if they feasted on the tent caterpillar cocoons.

Across the street from my house was a narrow drainage gully that was full of milkweed and Queen Anne's lace (wild carrot). My friends and I enjoyed playing with both the sticky white sap of the milkweed and the fat and beautiful white, black, and yellow-striped caterpillars munching on the leaves. These caterpillars would later become monarch butterflies, and we would marvel that such delicate creatures migrated to and from Mexico every year. One day city workers came and put in a concrete culvert and then planted grass over it so that the neighbor's lawn extended all the way to the street. No more milkweed and no more monarch larvae. While many of the adult neighbors were pleased that the weedy gully was gone and replaced by a neat lawn, we kids mourned the loss of our weedy playground and its beautiful inhabitants as we learned a hard lesson about habitat destruction.

In the summer we would spend our days at a nearby lake mostly surrounded by woods. There was a grassy slope leading down to the water's edge. Each year we waited for the green June beetles to come out. About an inch long, these fat, green and gold flying beetles sounded like C-5 Galaxy transport planes, and flew with about as much grace. The beetles emerged from the ground, where as grubs they had been feeding on the roots of grass. The low-flying, clumsy adults would fly around, bouncing off people who wandered into their flight paths while they presumably searched for mates.

In mid-summer more webbed caterpillar nests began appearing in trees; not in the branch crotches like the tightly woven nests of the eastern tent caterpillar, but at the ends of branches. These were the nests of fall webworm. While eastern tent caterpillar prefers trees in the rose family (cherry, peach, nectarine, apple, and crabapple), fall webworm will seemingly eat just about anything with leaves. The larvae of fall webworm feed on the leaves within their webbed nest and pupate in the ground.

In September, shortly after we had started back to school, the leaves on the black locust tree in my front yard would turn brown but they wouldn't fall. Black locusts on the roadsides and mountainsides were easy to spot because their leaves were brown and all the other trees were still green. I assumed that black locusts got their fall coloration earlier than other trees. Years later I learned that the leaves turn brown every year because of the locust leafminer that feeds in the leaf. Locust leafminer is a small black and orange beetle that lays its eggs on the undersides of locust leaves. When the eggs hatch, the larvae burrow into the leaf and feed on its inner layers, creating meandering, brown mines in the leaf. The tree is not harmed and this is a good way to learn to identify black locusts!

Winter insect encounters were fewer. Occasionally we would lose a pine tree in a winter storm and it was always interesting to see what lay beneath the bark. Giant holes in the bark meant that we would probably find fat, white beetle grubs glistening just beneath the bark. Cocoons and spiders were common finds as well.

Keep an eye out for your arthropod companions as you journey through 2014, and never take their presence for granted.

Bugs that Glow—No, Not Just Fireflies by Breanna Lyle

Many species of animals from almost all given groups have the ability to produce light. This is called bioluminescence and is used in communication, hunting for prey, and attracting a mate. Insects are no different. On warm summer nights you can walk outside and be greeted by the glow of fireflies. When thinking of insects that glow, without a doubt they are the first insects to come to mind. Our newsletter's namesake, the glowworm, is the glowing larva of a species of beetle. Many would be surprised to discover that other insects, including flies, roaches, springtails, and even the true bugs in the order Hemiptera, have the ability to produce light.

One of the most interesting examples of bioluminescence in insects is a cockroach that glowed with a specific wavelength in a brilliant display of mimicry. The glow pattern of this roach mimicked the glow of a particularly poisonous click beetle. Predators over time have learned that the effects of eating this beetle aren't worth it! By imitating this glow, the cockroach kept birds or other predators from eating it. Sadly, this species is known from only one specimen collected in the 1930s. The area where this roach was found was recently wiped out by a volcanic eruption and this amazing cockroach is considered to be extinct.

The insect considered by the scientific community to produce the brightest light is a species of click beetle known as the Jamaican click beetle and is found, as its name suggests, in the West Indies. When sailors landed on the islands, they would see these beetles glowing in the forest and, thinking that they were natives of the island with torches, they would turn tail and run! Genes present in individuals of the species determine the color light they produce so the colors vary. In recent times, the color orange has become more common, most likely due to some sort of advantage. The individuals that produce orange light are favored more highly during mating, so those genes are passed on, making the color more common with each successive generation.

Bioluminescence has also been seen in small insect relatives known as springtails. Springtails are small hexapods that live in leaf litter and soil. They spring around on specialized organs called furcula that allow them to travel relatively great distances searching for choice things to eat. There is no known reason for these creatures to produce light, but just the same, go out on a warm night and watch the ground. Who knows, you might just see tiny, hopping lights.

To sum it all up, insects have numerous uses for producing light. Some use light to attract a mate and reproduce. Others use it to ensure their safety by telling predators that they are not an appetizing snack. Clever insects produce their own light to mimic those foul-tasting critters in an attempt to keep from being eaten themselves. A night spent watching these glowing arthropods will surely not be wasted.

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MSU Beekeeping Camp Registration
June 8–12, 2014

Youth Beekeeper Information

Name_____ Age_____ Gender_____ Grade Completed in 2014_____

Have you attended Bug & Plant Camp at MSU? ☐ Yes ☐ No

Allergies_____

T-shirt size (all sizes are adult) S M L XL XXL XXXL (Circle one)

Pant Size_____ Shirt Size_____
This info is needed so we can reserve personal protective equipment for you.

Hometown newspaper_____ Name of school attended_____

Adult Beekeeper Information

Name (Parent/Guardian)_____Gender_____

Address_____ City_____ State_____ Zip_____

Home phone_____ Cell phone_____

Email address_____

Allergies_____

T-shirt size (all sizes are adult) S M L XL XXL XXXL (Circle one)

Pant Size_____ Shirt Size_____
This info is needed so we can reserve personal protective equipment for you.

Payment Options
Down payment for team of two (reserves your place): $400
Full payment for team of two: $750

Amount enclosed _____ Make checks payable to MSU Beekeeping Camp.

Mail registration form and payment to:

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