The Gloworm

A termite can do nothing to a stone but lick it. - Sudanese proverb

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The Termites Are Coming! by Dr. John Guyton

The return of the sun to the northern hemisphere portends the return of spring and all of its revelers, including termites. In the past, Isoptera represented an easy order to collect, but today they fall within Blattodea, with cockroaches and mantids. Isoptera, now an "infraorder," is a descriptive name from the Latin for "equal" and "wings" in reference to the equal lengths of the reproductive castes' fore and hind wings. For homeowners, the collection of white-winged insects in windows is a sign they may have termites munching away in their houses. Worldwide this damage amounts to over $40 billion/year.[1] In the U.S. the damage is 2–3 billion dollars annually. Termites have an earned reputation for damaging wood, but they are also among the great builders in the animal kingdom, contructing the most sophisticated and largest nests, though they are blind!

In nature, termites perform the important service of recycling wood, leaf litter, dung, and bones to nutrients. Some joke that termites ate the dinosaurs since their traces have been found on dinosaur bones from the Jurassic in China.[2] Termites exhibit a preference for soft spring growth wood and avoid hardwood and chemically treated wood, as well as redwood, cypress, and juniper. Their order of preference is loose cellulose fibers, paper, cardboard, softwood, and hardwood. They break off and swallow pieces of wood that are then broken down and digested by protozoans, bacteria, and enzymes in their hindguts.[3] One termite farms fungi, eating the fungi and sustaining the garden by depositing fecal pellets that contain viable fungal spores.

During the first day of the Entomological Society of America's Southeastern Branch meeting in Biloxi in March, I celebrated Termite Awareness Week by wearing my clear vinyl *termite tie*. The mockup to the right contains actual pictures of the various arthropods that were in the termite colony we raided in order to populate my tie (arthropods enlarged, of course). My tie contained the most common termite in Mississippi and the eastern U.S., the eastern subterranean termite (*Reticulitermes flavipes*).

A telltale sign of eastern subterranean termites' presence is the mud tubes from the ground up the foundation of a house that provide the termites protection from predators while maintaining the high humidity they need. Damage can be devastating from nests containing over a million termites. Another destructive termite in Mississippi is the non-native Formosan termite (*Coptotermes formosanus*) that was accidentally introduced into New Orleans and other southeastern ports after World War II. They have now spread to Mississippi's southern counties and become a serious threat. Formosans, interestingly, swarm at night. Both species have similar enough biology that the same poisons work against them.

Termites were the *first* social insects and may have had their start at least 300 million years ago in the Kansas Permian deposits as a possible descendant of the genus *Cryptocercus*, the wood roach, hence their placement in Blattodea.[3] The oldest described fossilized (130 million years) termite species, *Meiatermes bertrani*, was found in limestone in Spain.[4] Termites have a second claim to fame in that they are the oldest example of mutualism, a type of symbiotic relationship where two organisms depend on each other for their survival. In this case, termites are dependent on protozoans' enzymes to digest the wood they live on, and protozoans cannot live outside the termite. The evidence for this ancient relationship was termites preserved in a 100-million-year-old piece of amber. An interesting level of development differentiates termites. Those with symbiotic intestinal flagellates are considered "lower" termites. "Higher" termites have lost the flagellate protozoa and now depend on bacteria to digest wood. Around ¾ of all described species are higher termites. Lower termites are most common in Australia. When workers feed young termites they acquire their load of microorganisms. Now just to stretch your mind, some tropical termites cultivate fungi to predigest food instead of using microorganisms![4,5]

Over 2,600 termite species exist worldwide, with most living in tropical and subtropical areas. Less than 185 species are considered pests.[6] Others live in temperate regions, with at least 41 species that live in the U. S., most in the southwest. Most termites can be divided into four distinct groups: dampwood (live and feed in very moist wood such as stumps and downed trees); drywood (common on most continents); subterranean (numerous in many parts of the world; live and breed in soil sometimes very deep, or in trees or other locations above ground); and arboreal/mound builders. Arboreal termites build basketball- and larger-sized nests in trees with mud tunnels connecting to the ground. Mound builders make mounds that can be 25 feet high and are highly efficient in their ventilation, heating, and moisture maintenance. Mound termites are not found in North America.[2]

The three termite castes include the reproductives, soldiers, and workers. The reproductives are called alates or swarmers during their mating and colonizing flight. After mating, the queen and her king shed their wings and go to work producing eggs, a process they may continue for 20 to 50 years! They usually begin their colony outside in the soil feeding on things like pine needles, leaf litter, and smaller wood debris, expanding the colony. In a mature colony, secondary reproductives (actually semi-adult worker nymphs) that have developed inside the colony supplement the egg-laying of the primary queen, thus helping the colony spread. These secondary reproductive are a key part of a termite colony. Eventually they will inhabit a damaged tree, poorly protected home, or other site. The queen continues to grow throughout her life, developing a greatly distended abdomen to sustain her intensive egg-laying program, which may include laying millions of eggs every year. The male is available for fertilization when needed. The queen controls the nest using pheromones. If she dies, all reproductive activity ceases unless there is a new queen. The alates pass through a nymph stage where they molt several times and develop compound eyes, wings, reproductive organs, and tan to brown sclerotized cuticles. Their dark cuticle is one reason they are mistaken for ants. Individual termite colonies have been known to exist for 100 years or more.

Living in a dark world, the male and female workers are blind, white, and sterile. Their work includes nest or gallery building and repairing, foraging, feeding and grooming other members of the colony. It is the worker termites, which only live a couple of years, that are responsible for the destruction of wooden structures.

The male and female soldiers that protect the nest are sterile, blind, wingless, and sexually immature. Some species use large, scissor-like mandibles to decapitate predators, including ants. Others spray a white, sticky, toxic repellent from an opening on their heads. Soldiers cannot feed themselves, requiring assistance from workers that feed them regurgitated food. Soldiers are easily identifies by their enlarged, long dark mandibles and yellow-brown heads. A few species do not have soldiers and the nymphs and workers are responsible for colony defense. Soldiers are useful in identifying the termite species. Interestingly there are similar numbers of male and female workers and soldiers.

Nests are dynamic and, depending on the species, can contain from hundreds to millions of termites. All castes move around the hives. Termite galleries facilitate the almost complete saturation of air, preventing termites' water loss. Temperature is another critical variable and foraging may be reduced if temperatures are too high.[2] Arboreal termites as near as Jamaica and Mexico build nests in trees that may be safer from predators or cooler from the shade and evaporative cooling of the trees. The compass mounds in Australia should be a living wonder of the world, with their narrow east-west dimension and wide north-south. The reason for this shape hasn't been determined, however during the coolest part of the day, the sun shines on a wide surface, bringing the temperature up. During the time when the sun is closest to overhead, the least amount of nest is exposed. The hot afternoon sun falls on the western, greatest expanse, no doubt with considerable heating. Perhaps the narrowness of the nest makes it easy for the termites to spend the afternoons on the cooler eastern side. During my next trip to Australia I would like to take core samples in a mound mid morning and mid afternoon to see where the termites are.

Resources

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BUG CLUB ACTIVITIES

Termite Demonstrations and Activities

1. The ink of certain pens, including Skillcraft, Papermate, and others, contains a compound that mimics the trail pheromones that termites lay down and follow. Using one of these pens, draw a circle on a piece of paper and drop a few termites in its center. They will line up on the circle and walk along the line. Certain groups may follow the circle in both clockwise and counterclockwise directions.
2. Leave a piece of plywood in the yard for a few months then examine it for invasion by termites.
3. Look under rotting logs or under their bark for termites.
4. Drive as many different kinds of wooden stakes as you can find into the ground in the woods and check every couple months for termite damage. Use a permanent marker to label the different pieces of wood. Rate the woods for their resistance to termite damage.
5. On a microscope slide, pull two needles (one on the front end of the termite and the other on the abdomen) in opposite directions, exposing the alimentary canal and revealing the milky-colored gut

fluid, which contains a wealth of microbes. Use a coverslip to preserve the anoxic (without oxygen) conditions while you examine it under a magnifying glass or microscope at 10X and 40X. Sketch what you see.
6. Next, using forceps to hold the front end of a termite, use a second pair to milk the hindgut, collecting a drop of fluid on a slide. Use another coverslip to maintain the anoxic environment. View under10X, 40X, and 100X to observe the protozoal flagella and bacterial endosymbionts. Sketch what you observe.

Is It an Ant or a Termite?

A lot of people confuse ants and termites, but there are several surefire ways to tell the difference. Ants have elbowed antennae and termites have beaded antennae. Termite and ant reproductives are winged at times (both have 4 wings). Isoptera means equal wings, so the fore- and hind wings of termites are of equal length. The hind wings of ants are shorter than their forewings. Ants' waists are very well defined, and if you were to sketch an ant, you would likely have a clearly defined head, thorax, and abdomen. Termites do not have waists and their thoraxes blend into their waists.

Fun Fact: Termites, and other social insects for that matter, have never developed resistance to any type of pesticide.

Collecting and Rearing Termites for Food, Demonstrations, or Experimentation by Dr. John Guyton

A collection chamber for termites can be built from an 18-in.- long piece of 4-in. diameter PVC drain or leach tubing that has numerous holes drilled along its length. Roll up a piece of corrugated cardboard and slip it inside the pipe. Place caps on the top and bottom but do not glue—instead secure with duct tape. Insert this below ground level in a post hole and shovel soil around the pipe but do not pack it. Check the trap every 2 to 3 weeks by removing it and unrolling the cardboard. Termites can be transferred to glass or plastic aquariums lined with dampened cardboard.

Termites live in dark, cooler conditions but are comfortable over a suitable range (45–80°F). They can drown, so do not leave standing water in their rearing chamber. Too much water will also result in mold formation, which is unhealthy for termites.

Termites can be reared in the wood in which you find them by keeping them in a dark plastic box or, for a short time, in a black plastic bag. Make sure the box or bag is well sealed. Periodically you will need to mist the wood or log a little. Termites will not use much oxygen, but you should provide some ventilation. A piece of window screen secured over a 2-in. piece of PVC will work.

You can also keep a sample of termites alive in a petri dish on pieces of moist filter paper for days or months. Watch for the first signs of mold and remove it immediately.

Termites Make an Easy and Historic Entomophagous Snack by Dr. John Guyton

Termites can be eaten raw, but I strongly encourage you to cook them. You can experiment with frying, drying, smoking, or steaming. It is also critical that they be collected where pesticides have not been used, e.g., in woods and prairies. Queens are considered a delicacy in some cultures.

In the "monkey see, monkey do" tradition we may have evidence for an entomophagous element in our early diet! Insightful YouTube videos by the Jane Goodall Institute and National Geographic Society show chimpanzees using tools to eat termites and ants (View the Jane Goodall Institute's at: https://www.youtube.com/watch?v=inFkERO30oM&safe=active). And yes, I have eaten termites off a stick thrust into a termite colony. Remember, 80% of the world's population eats insects, and 5,842,425,656 people cannot be wrong!

Easy Termite Salsa Dip

- (1) 8-oz package of cream cheese, room temperature
- ½ cup of roasted termites
- 1 jar of your favorite salsa
- (1) 8-oz bag of a shredded Mexican cheese blend

Spread the cream cheese evenly in the bottom of a small casserole dish. Next spread the salsa evenly over the cream cheese. Top the mixture with shredded cheese and roasted termites. Bake at 350 degrees for 20 minutes or until dish is heated through.

Source: Florida Pest Control. Available online at http://www.flapest.com/Recipes.aspx

Florida Pest Control may be onto something. They have many more "pest" recipes on their website. The more pests we eat, the fewer pests there are. Bug Appétit!

Termite Nutrition Facts

Serving Size 100 grams
Calories 613
Fat Cal. N/A
*Percent Daily Value
Based on 2000 calorie diet.

Amount Serving	%	DV*
Total Fat	n/a g	
Sat Fat	n/a g	
Cholesterol	n/a mg	
Sodium	n/a mg	
Potassium	n/a mg	
Total Carb.	0g	
Fiber	n/a g	
Sugars	n/a g	
Protein	14.2g	28%
Vitamin A	0%	
Vitamin C	0%	
Calcium	5%	
Iron n/a	0% (35.5mg)	

Courtesy of Bay Area Bug Eating Society (B.A.B.E.S.)

Nearing the End of the 'Butterwalk' Era? by Lois Connington

The saga of the sedentary painted lady butterflies (*Vanessa cardui*) in the zoo continues. In an incredible twist of fate, reliable witnesses can now confirm that these creatures, whom Dr. Howard Chambers has dubbed "butterwalks," CAN and DO fly. Indeed, the adults lounging on the floor of the display cabinet have an active daily flight period—just not when people are normally in the lobby.

I already knew they could fly. At the "bewitching hour," ca. 4:30 pm in the dead of winter, I thought twice about opening the cage door to perform needed maintenance. As I leaned into the cage I would hear the whisper of wings by my ear, looking up to see a butterfly (or two) making a low beeline for the front windows and the approaching dusk. They were not hard to recapture, and when I returned them to the cabinet they joined the others on the floor, feeding placidly or mating.

As much as I tried to entice the painted ladies to the upper reaches of the cabinet, putting in heat lamps, lights with varied spectra, and slices of fresh oranges and bananas, only a few would venture to the top of the cage to bask or feed. Each time I hung pupae in the cage I crossed my fingers, hoping these would yield the adults that would emerge high up on the wall, discover the near-perfect conditions we had provided, and stay there. But they did not, and the skeptics around us continued to question our choice of butterflies to display in the zoo.

The gravity-defying discovery was made shortly after 30 painted lady adults nearly knocked themselves senseless by flying against the ceiling of a cubic-foot rearing cage as I carried them into the sunshine and slight breeze to release them in the pollinator garden. They were a cohort I used to maintain the colony, the fifteenth generation raised in a rearing room with ideal light cycle, temperature, and humidity conditions on artificial diet developed for corn earworm. At the last minute I carried them to the lobby to release them in the display cabinet, knowing that a number of tours were on the docket before the next pupae would provide a fresh crop of adults.

We rolled the cabinet next to the front windows to capture the short stretch of natural sunlight that shines in each morning, temporarily turning the cabinet to catch the rays directly. While the adults lined up and turned their backs to bask in the sun, they did not take flight, even when the fan in the cabinet was turned on. I was stymied and, quite frankly, just a little bit frustrated. What would it take to get the painted ladies to fly in the display case?

Well, apparently nothing more than we had already provided. As I left the building just after 7 pm, I could not help noticing the butterflies spiraling through the air in groups of two, three, four, and even five! What? I returned for the next several nights, pulled up a chair, and settled in for the show. From as early as 6:20 pm to 9:00 pm (and maybe later—I got hungry and headed home), they flew in their corkscrew patterns, drifting up and circling down, settling on a branch momentarily only to fly back down to the floor, replaced by a different butterfly headed for the ceiling. During peak activity they resemble popping kernels of corn. As the night wore on, more and more butterflies headed for the Gatorade feeder to satisfy their energy needs.

I took videos and pictures and, bewildered, relayed what I had seen. Dr. Frank Davis, head of the International Insect Rearing Workshop, stopped by one evening and confirmed my findings: these painted ladies fly just before dusk and into the night, not during the day as most butterflies do.

In researching painted ladies, so common worldwide they are sometimes called cosmopolitans, I learned that the males perch on plants or the ground in the afternoon and wait for interested females to pass by. Small groups of butterflies circle briefly around each other in a corkscrew flight pattern, landing within 15 ft of where they started.

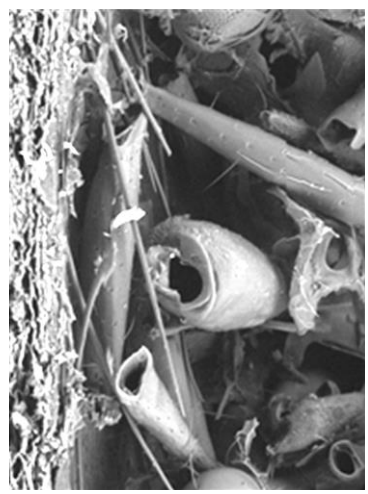
In the zoo, the painted ladies' flight pattern is dead on, but their timing is terrible. Have the 24/7 overhead lights in the lobby overridden their innate photoperiod even though the lights in the cabinet are set for a 16-h light: 8-h dark regime? We have cut the light period back to 14 h to better mimic Mississippi's day length and now drape the cabinet at night with a room-darkening curtain. Will the adults that emerge from the next set of pupae fly in the afternoon? Stay tuned to *The Gloworm* to learn if we really have reached the end of the butterwalk era.

Carnivorous Plants Have the Most Incredible Leaf Factories Imaginable

by Dr. John Guyton

My fascination with pitcher plants began over 35 years ago when I dissected one and sorted out its diet. Recently a youngster showed me his Venus fly trap. When I asked him how it ate its food, he responded, "It chews it like we do," pointing to its "teeth." He went on to say his dad was getting them hamburgers for lunch so he could feed his fly trap.

I love the question, Are carnivorous plants autotrophs? Carnivorous plant leaves, e.g., pitchers, pads, or tendrils, may be the most sophisticated factories on the planet. They perform normal autotrophic functions as well as the digestion of insects for nutrients that are not plentiful in the soil. Their leaves use sunlight, water, carbon dioxide, and nutrients from the soil to produce the sugars and starches they need to live, grow, and reproduce. Carnivorous plants live in nitrogen-poor soil, so their leaves contain digestive enzymes to break down the bodies of insects and other animals and extract the nitrogen and phosphorus. They can live for a while without insects, but with them they grow larger and more prolific.



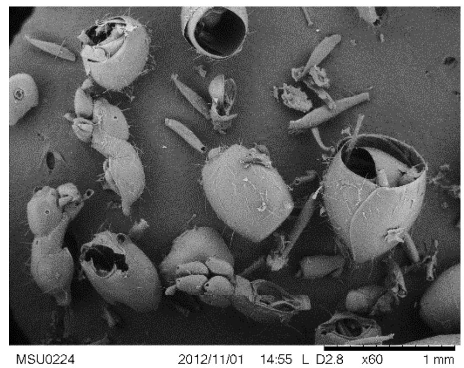
Fire ant exoskeleton pieces inside a pitcher plant (*Sarracenia alata*). Note the plant tissue and downward pointing trap hairs on left side. SEM photos by John Guyton.

Research has revealed that absorption of nutrients by the roots is enhanced when the leaves feed on insects. Detritus and other materials that fall onto carnivorous traps have been shown to have a positive effect on plant growth. Harder and Zemlin[1] sprinkled pine pollen on some carnivorous plants and noted they responded with more growth and better flowering. Mississippi's carnivorous plants are common in coastal pine savannas where pine pollen is abundant.

Pitcher plant (*Sarracenia alata*) and green lizard. Photo by John Guyton.

Before plants can take advantage of their insect prey they must digest them. Enzymes (relatively unstable proteins that expedite chemical reactions) in a watery solution make this possible. These enzymes work with ambient heat and without caustic chemicals or a long processing time. The suffix on an enzyme's name, -*ase*, indicates it assists in breaking down the compound in the enzyme's prefix. The enzyme "protease" breaks down protein into simpler nitrogenous compounds. Similarly, lipase reduces fats or lipids.[2] As evident from the scanning electron microscope picture above of fire ant exoskeleton components, the enzyme chitinase was not so efficient. As you likely have surmised, the connective tissues between the exoskeleton sections that allows it to flex are the Achilles heels of the fire ants' exoskeletons and are more easily digested. Once this connective tissue is breached, the enzymes are off to the races.

Now, where do these enzymes come from? Lindquist mentions that pitchers and the leaf surface of bladderworts are teeming with microorganisms.[3] Schnell discusses possible external and plant sources.[2] Microorganisms such as bacteria and fungi often secrete enzymes to break down materials they will use for food. Such microorganisms are found in the intestinal tracks of insects. Various arthropods and insects such as the pitcher plant moth and caterpillar, assassin bugs, and midge larvae that contribute bacteria-loaded frass are adapted to living in or on carnivorous plants in a mutualistic arrangement. Many carnivorous plants also make their own digestive enzymes. And, as is obvious, these enzymes are very effective!



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Note: Thanks to the Mississippi State University Institute for Imaging & Analytical Technologies (I^{2}AT) for use of their scanning electron microscope.

Gloworm Editor Wins Best Arthropods in Action Photo Award

John Guyton's photo of a female Chinese mantid with a headless male on her back, which he called "Snack Pack," won Best Arthropods in Action at the 2015 Entomological Society of America Southeastern Branch Insect Photo Salon. Guyton also served on the local arrangements committee and as official photographer for the SEB meeting.

WHAT'S NEW AT THE ZOO?

New Arthropods Arrive Just in Time for Spring Tours by Lois Connington

Standardized testing is over, which means it's the time of year to welcome lots of student tours. With the increased traffic come our new critters (pictured clockwise from left): Honduran curlyhair tarantula (*Brachypelma albopilosum*), dune scorpion (*Smeringus mesaensis*), Chilean rosehair tarantula (*Grammostola rosea*) just beginning her outreach duties, and tiger centipede (*Scolopendra polymorpha)*.

Each of the new acquistions is already expressing its unique personality. The curlyhair has burrowed so deep into the coconut fiber under her hide that she has erected a barricade, but is very agreeable to handling. Next door, the rosehair is climbing the walls, literally. The dune scorpion, much larger than we had expected, initially occupied the hide we built on top of the slate structure, only to squeeze itself into the lowest slot after all. Meanwhile, the tiger centipede has settled in nicely in its new cage where it enjoys hiding under the leaves we provided. Come see them the next time you are nearby.

Photos by John Guyton

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

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