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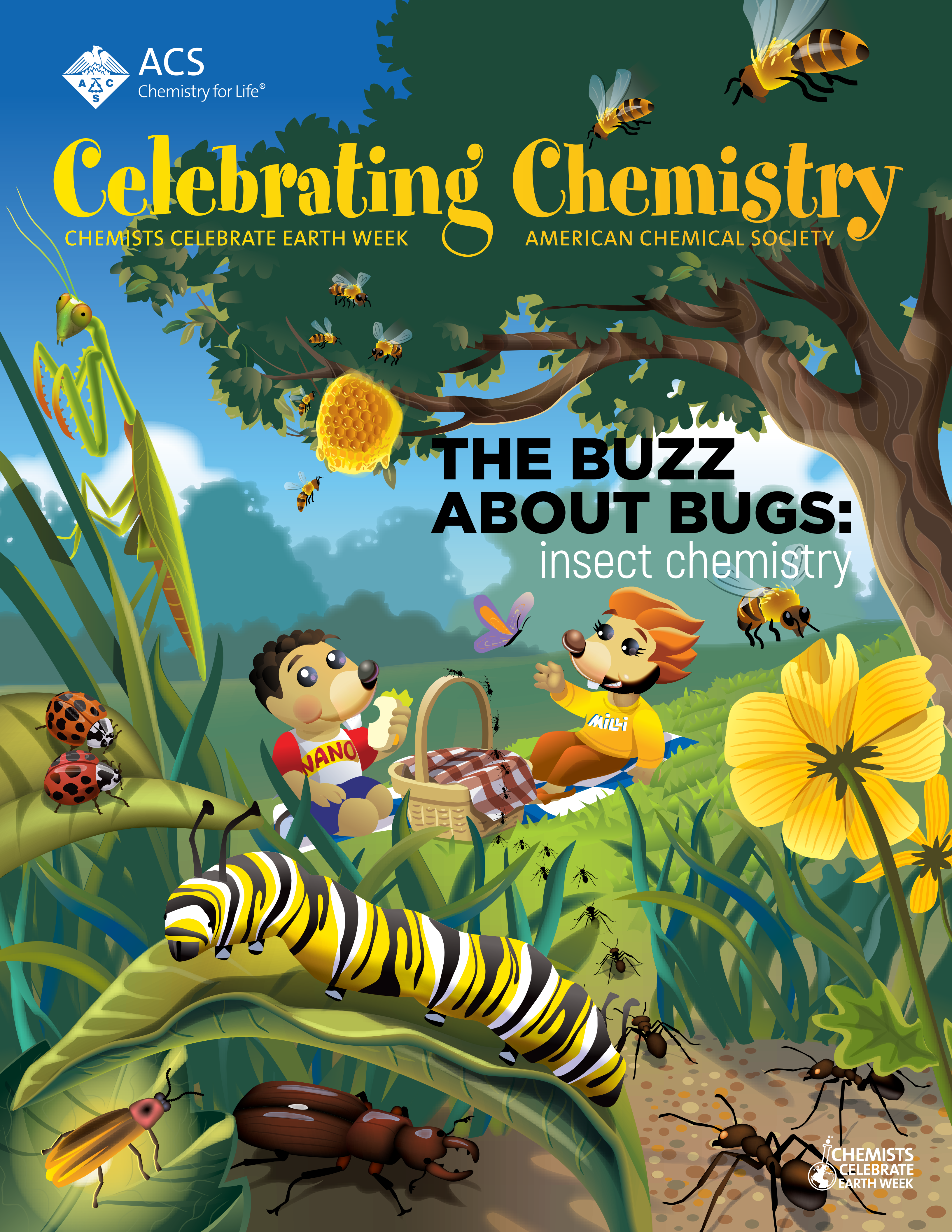
THE BUZZ ABOUT BUGS:
insect chemistry



THE BUZZ ABOUT BUGS: insect chemistry

By Regina Malczewski

Insects are found almost everywhere and in all environments. They inhabited the earth before the dinosaurs — and are still with us today! We know of about 1 million species, but biologists think there are over 90 times that many that we just haven't yet classified! Insects make up more than 80% of all living things on earth, and altogether weigh 70 times more than all the people do. That's a lot to buzz about!

We should probably talk about the word *bug*. It is used in different ways, and not all of them are accurate. True bugs are a type of insect that has a straw-shaped mouth and segmented antennae, like stink bugs and bedbugs. On the other hand, people often use the word bug to describe any kind of creepy-crawly pest, like spiders or centipedes … even though they are not insects at all!

Insect body parts have names a lot like ours — the head, thorax (chest), and abdomen. But insects are also very different from us in many ways, including:

- They have a hard outer skeleton, instead of an internal one like humans. All insects have six legs that have joints, compound eyes, and one pair of antennae. Creatures with different numbers of legs (such as spiders or centipedes) might look similar to insects, but are actually in a different group.
- They use their compound eyes to sense the world around them. Their eyes don't see as well as ours, but they do provide sight in many directions at one time. Meanwhile, their antennae can sense touch, air motion, heat, sound, and chemical compounds that represent taste or smell.
- Insects usually start out as eggs that grow into worm-like larvae before they grow wings and take final form. The Splendor beetle spends 30 years in the larval stage!

Most insects have wings, and when they rub their wings together they make a buzzing sound. Dragonflies can fly up to 18 mph (29 km/h), and each of their four wings can move separately for astounding flight ability. They have the largest eyes of all insects — with 30,000 "facets" — that take up so much of the head they look like a helmet.

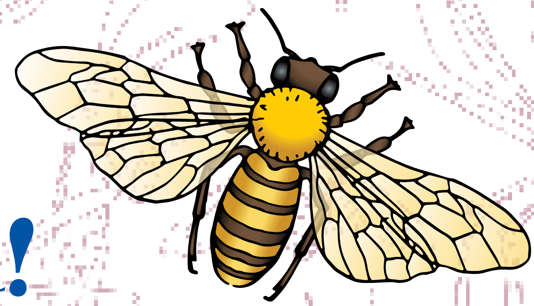
Insect chemistry can be "enlightening" (fireflies), sticky, destructive, or deadly (termites and insect venom). One benefit of insects is the beauty and wonder they provide. What would we do without butterflies? Their wings are very special: highly waterproof and made of tiny crystals that interact with light. The top hard shell of the jewel (wood-boring) beetle is similarly iridescent and is used for necklaces — and believe it or not, in some places, people even wear these insects as live decorations!

But insects are also busy doing more. Bees make honey and are responsible for pollinating $15 billion worth of U.S. crops every year. Insects are a protein-rich food and are even considered delicacies in some places. Some bugs provide chemicals or chemical mixtures that we use for items from lipsticks and nail polishes to dyes. Think of the silkworm, cultivated since 2,600 BC. Its silk has been harvested for use in sutures (also known as stitches), parachutes, and clothing. Post-harvest leftovers are used to feed livestock, and the worm itself is fried and available as street food in China.

Insects can also "bug" us — they eat crops, they can cause disease, and their bites or stings sometimes cause allergic reactions. Termites attack about 600,000 U.S. homes each year, and billions of dollars are spent either to prevent infestation or repair their damage. Their "spit" contains chemicals (enzymes) that break down the cellulose in wood, with help from microbes that live in their guts. Special chemicals called pheromones are used by some insects to attract mates or communicate. These chemicals can be used to trap or manage pests like the gypsy moth, which has destroyed more than a million acres of forest per year in the United States since 1980.

The next time you hear buzzing, consider the diversity and impact of all the insects that live on our planet. Important to **chemistry**, ecology, and so much more, let's take a bow to bugs! Be both a chemist and an **entomologist** (a scientist who studies insects), and learn about the insects mentioned in this article and more in this issue of *Celebrating Chemistry*. And keep buzzing about insect chemistry for Chemists Celebrate Earth Week 2022!

Regina Malczewski, Ph.D. *is a retired biochemist who worked at Dow Corning Corporation in Midland, MI.*



Pollinators Wanted!

By Sara M. Delgado Rivera

Plants are one of the main sources of food for humans and many other living organisms. They also absorb carbon dioxide from the air and give us oxygen through a chemical process called **photosynthesis**. In addition, they give us shade and delight us with their colorful flowers and leaves. The health and reproduction of plants are important to all of us!

Seed plants need both male parts and female parts to reproduce. When this happens, it starts the process that produces seeds, fruits, and finally a new plant. The male parts produce a dusty powder called **pollen**. This pollen needs to be transferred to the female parts in a process called **pollination**. A few plants can perform self-pollination, but over three-quarters of the flowering plants on earth need help with this process.

The work of transporting pollen can be carried out by wind, water, or different living organisms, called **pollinators**. Pollinators pick up pollen from one flower and carry it to another. There are a variety of living organisms that can perform this important work, including birds, bats, and other small mammals, but the most common are insects.

The most familiar type of pollinating insect are bees, but there are many other insects that also work as pollinators, and not all of them pollinate the same type of plants. Did you know that mango trees are primarily pollinated by a type of fly, known as a fruit fly? In addition to flies, butterflies, moths, beetles, and even wasps are also pollinators.

Protecting pollinators is incredibly important to our survival. Farmers spend millions of dollars each year to make sure there are enough bees or other insects to pollinate their crops successfully. Insect pollinators are being affected by shrinking habitats and food supplies, due to deforestation and high urbanization, in addition to the atmospheric effects of global warming and the excessive use of pesticides and other poisons.

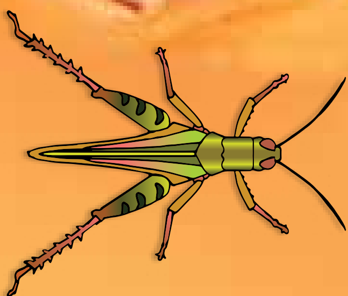
There are many ways you can help to conserve pollinators. Here are some tips:

1. Make your own home garden or help to maintain or create a community or school garden that is friendly to pollinators. There are some organizations like P2 (Pollinators Partnership), that can help you choose the plants that will best attract pollinators in your area.
2. You can consume honey and other organic products from local farmers to support them and their farms.
3. Spread the word and teach others about the importance and necessity of protecting pollinators. We need them as much as they need us!

***Sara M. Delgado Rivera** is a chemistry professor at University of Puerto Rico at Rio Piedras, University of Sagrado Corazon, and University of Ana G. Méndez, Carolina Campus.*

Do Science Safely Safety First!

- Ask an adult for permission to do the activity and for help when necessary.
- Read all directions and safety recommendations before starting the activity.
- Wear appropriate personal protective equipment (safety glasses, at a minimum), including during preparation and clean up.
- Tie back long hair and secure loose clothing, such as long sleeves and drawstrings.
- Do not eat or drink food when conducting this activity.
- Clean up and dispose of materials properly when you are finished with the activity.
- Thoroughly wash hands after conducting the activity.



A Bug Buffet?

By Regina Malczewski

Entomophagy is practiced by over two billion people worldwide — and no, it's not an internet trend — it's *bug-eating*! Using insects for food is common in tropical places where bugs or their larvae (immature forms) are large; some larvae can be 5½ inches (14 cm) long. The 1,900 species that are eaten are considered tasty by those who consume them. About one-third of the insects that people eat are beetles, followed in popularity by butterflies or moths (as caterpillars), bees, wasps, and ants.

As the world population grows (it will reach between 9 and 10 billion people by 2050), and with over one billion people currently going hungry worldwide, we need to consider new food sources for the future.

Eating insects is preferable to eating cattle, for several reasons. They cause less environmental damage, because forests aren't cut down to raise them, and they don't give off greenhouse gases. They reproduce and develop much faster. And they convert the food they eat into edible tissue five times more efficiently. They can also be grown on waste and are less likely than Western food sources to pass on diseases to people.

But are insects good for you to eat? Their nutritional value depends on their developmental stage, their habitat, and their diet — but some (like mealworms) have the same protein, vitamin, and mineral content as fish or meat. Termites are high in fat, but their protein content is higher than beef. In addition, bugs don't have to be eaten whole. In Africa, you can snack on locust legs that have been crushed and mixed with peanut butter and salt — yum! Most bugs are prepared by boiling or frying. Crickets can be roasted and ground to make a protein powder. Mixed with starches from cassava or coconuts, cricket flour can increase the protein content of baked goods.

Insects are not yet grown broadly for food, though. Not enough research has been done to decide what kinds of insects would be best, and which would be most economical to produce for consumption. Besides that, insects, like other food sources, are being affected by pollution, loss of habitat, and climate change.

Before you turn up your nose at the thought of eating insects, you should know that you already do! The U.S. Food and Drug Administration (FDA) allows a certain amount of contamination in the food we eat. A one-ounce box of raisins in your lunch, on average, contains four fruit fly eggs and one whole insect! It's estimated that Americans eat about two pounds of bugs per year in foods like spinach, broccoli, rice, and pasta.

Insects have been feeding people for thousands of years, and may become more important in our diets as time goes on. You might even see grasshoppers or beetles on the menu at your favorite restaurant in the near future. *Bon appetit!*

Regina Malczewski, Ph.D. *is a retired biochemist who worked at Dow Corning Corporation in Midland, MI.*

Bugs to Dye For

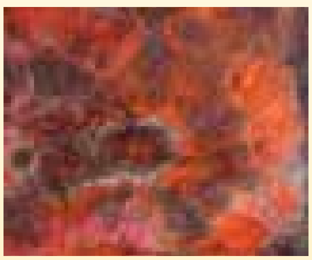
By Veronica I. Jaramillo
and Kit Cheung

Introduction

Have you ever eaten bugs? It is quite likely that you have! Some yogurts, juices, and ice creams that include the words "cochineal extract" or "carmine" use dried bugs to enhance pink or reddish colors in foods. Cochineal bugs are used today to color many things including food, beverages, and cosmetics. Native and Indigenous people, including Incas and Aztecs in Central and South America, used cochineal bugs to color fabrics and other materials. They even found a way to get other colors, besides pink or red, from these same bugs. Try this activity to discover how they did it!

Materials

- dried cochineal bugs (available for purchase online or at craft stores)
- snack-size zip-closing plastic bag
- storage-grade quart-size (about 1 liter) zip-closing plastic bag
- rolling pin (or sealed metal food can)
- several small plastic cups or bowls
- piece of white, 100% cotton fabric (about 6" x 6", or 15 cm x 15 cm) – like part of an old T-shirt, pillowcase, or cotton squares
- 2 measuring spoons (1 tablespoon, or about 15 mL, and ½ teaspoon, or about 7.5 mL)
- measuring cup (1 cup, or 250 mL)
- plastic pipet or eye dropper
- baking soda
- vinegar
- warm tap water
- marker for labelling
- coffee filters (optional)



Procedure

Extract the cochineal dye

1. Place 1 tsp. of dried cochineal bugs in the snack-size zip-closing plastic bag. Remove as much air as possible and securely seal the bag.
2. Using a rolling pin or thermos, roll over the bugs in the bag to crush them into a powder.
3. Place smashed cochineal bug powder into the quart-size zip-closing bag. Add 1 cup of warm tap water to the bag.
4. Shake vigorously for several minutes, then allow to settle.
5. Open the zip-closing bag and carefully pour the liquid into an empty cup, leaving the crushed bug body parts in the bag. Chemists call this type of process **decanting**.
6. The red-colored liquid in the receiving cup is the cochineal dye that will be used to make additional solutions. Label this "Cochineal Dye Solution" and set aside.

Optional: Set aside the towel/filter with the big bug parts; you can allow them to dry, smash some more and make more dye as above.

Change the color of the dye solutions by adding acids and bases

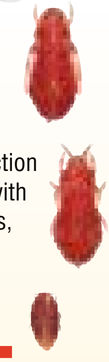
1. Make a **basic** solution with baking soda by dissolving ½ tbsp. baking soda in 1 cup of water (label "Baking Soda").
2. Set up three small cups or bowls as "dye pots." Mark cups as "Cochineal Dye", "Vinegar and Cochineal Dye," and "Baking Soda and Cochineal Dye." Add 1 tbsp. of cochineal dye solution to each
3. Add ½ tsp. vinegar (an acid) to cup "Vinegar and Cochineal Dye." What color results?
4. Add ½ tsp. baking soda solution (made in step #1) to cup "Baking Soda and Cochineal Dye." What color results?

Safety Suggestions

- ✓ Safety glasses required
- ✓ Protective clothing and gloves suggested
- ✓ Caution: hot liquids
- ✓ Do not eat or drink any of the materials used in this activity
- ✓ Thoroughly wash hands after this activity

Disposal: Neutralize all solutions (*See the How Does It Work?* section on page 9) before pouring down the drain. Wash reusable items with soap and water. Disposable items, such as zip-closing plastic bags, may be disposed of safely with the household trash or recycling.

Note: Cover your workspace and protect your clothing to avoid unwanted stains from the insect dye.



Dye your cotton

1. Dip a small cotton sample into the cup labeled "Cochineal Dye."
2. Dip another small cotton sample into the cup labeled "Vinegar and Cochineal Dye."
3. Dip another small cotton sample into the cup labeled "Baking Soda and Cochineal Dye."
4. Experiment with using droppers or spoons to apply the liquid in each of the cups to cotton cloth in new patterns. Label the droppers or spoons used in each of the liquids.
5. Set aside and allow to dry.
6. Enjoy and appreciate your dyed sample!

What did you observe?

What did you notice when the vinegar mixed with the cochineal dye solution? What do you think other acids (like lemon juice or carbonated soft drink) might do if added to a fresh solution of cochineal dye? What happened when you added the baking soda to cochineal dye solution?

How does it work?

The extracted dye from the female cochineal bugs is used to color foods, makeup, and clothing. Cochineal dye is great because it can be used to get various colors when mixed with different solutions. Vinegar is an acid, and adding it changes the cochineal dye to an orange color. The baking soda is a base, and turns the cochineal dye purple. The cochineal dye is an example of an indicator. Chemists use the color changes of **indicators** to categorize substances as acids or bases.

How do you know if cochineal dye is in your foods, make-up, or clothing? Check the ingredient label for the different names cochineal dye goes by: cochineal, carmine, carminic acid, Natural Red 4, or E120.

What else can you do?

Use your colorful cochineal dye for other projects, like tie-dye or the activity on page 9 in this edition of *Celebrating Chemistry.*

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Kit Cheung *is an undergraduate student at Pasadena City College.*

KNOW YOUR BUG

BUILD YOUR BUG

CUT APART OR TRACE THE BUG PARTS TO CREATE A NEW BUG!

TO ASSEMBLE THE BUG PARTS AS IN NATURE, SEE THE FULL-BODIED BUGS ON OTHER PAGES.

Ill Will from Insects?

By Regina Malczewski

Ouch! You were bitten by a mosquito, and now you have an itchy red bump on your skin! Are insects out to get us? Why do those bites and stings itch and hurt so much? While some insects (like mosquitos) need to suck blood to survive, most other insects bite only to protect themselves or their territories. They pierce our skin using their mouth parts or stingers, and inject venoms that contain a complex mixture of chemicals — including formic acid, hormones, and enzymes that affect our bodies. The venom of the fire ant alone contains 46 different proteins!

Stinging or biting bugs include lice, ticks, bedbugs, and many winged insects. Most reactions are relatively harmless, and depend on the bug and the victim. Our immune systems react with redness, swelling (including blisters), itching, and burning. In cases of severe allergies, people can experience vomiting, breathing issues, muscle spasms, fever, and rapid heartbeat. These are symptoms of anaphylactic shock and require medical attention. The use of an EpiPen, a medical device that contains the hormone norepinephrine, helps the user's body fight these symptoms. People who are very young or are old are the most susceptible to harm from bug bites, and summer is the season when most bites occur.

Dangerous bites don't always inject chemicals. Sometimes they deliver microbes into our blood. Certain mosquitoes in warm climates carry a parasite that causes malaria, a flu-like disease that affects 290 million people every year, and kills more than 400,000. Deer ticks harbor the bacterium responsible for Lyme disease, and fleas on rats carry a microbe that causes bubonic plague. That disease killed millions in Europe in the 1300s and 1600s, and still infects 5,000 people around the world each year. Fly poop can contain the organisms that cause sleeping sickness, cholera, and typhoid fever.

But, for all their stinging, biting, and diseases, it is possible to protect ourselves from insects. Keep your house clean. Wear long pants and long-sleeved shirts when you are in forested or wilderness areas. Avoid getting too close to bee nests or hives, keep foods and drinks covered, wear neutral color clothing, and avoid sweet-smelling lotions and perfumes.

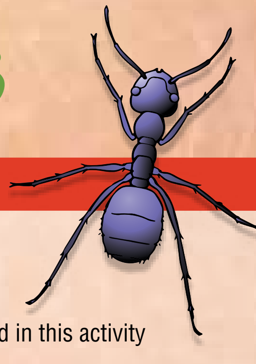
If you want to have insect-free adventures outdoors, use natural bug sprays (or candles, necklaces, or wipes) that contain materials like OLE (oil of lemon eucalyptus), citronella, peppermint, or clove oil. When you come back inside after spending time outdoors, have your parent or guardian help check your body for ticks. If you have been bitten or stung, remove any stinger, wash the area, and apply an ice pack; anti-itch creams can be used as needed.

We need to learn to coexist with insects, since they are so important for ecological balance and human well-being. But we also need to manage our interactions with them in responsible and earth-friendly ways, and help keep ourselves safe too!

Regina Malczewski, Ph.D. *is a retired biochemist who worked at Dow Corning Corporation in Midland, MI.*

Taking the Sting Out of Bites

By Veronica I. Jaramillo, Kit Cheung, and Edith Kippenhan



Introduction

Bites or stings from certain bugs, such as red fire ants or bees, can be extra irritating. The reason is that in addition to containing venoms, they are also acidic. Acids can break down human tissue. The acid from fire ants (known as formic acid) reacts with your skin and damages it. Other compounds in their venom react with your skin and nerves. No wonder these bites and stings hurt so much!

Some common remedies to treat bites include soap, baking soda, rubbing alcohol, and calamine lotion. Do any of these remedies counteract the acid in the bite? Let's investigate!

Materials

- cochineal or red cabbage indicator (explained below)
- 4 clear plastic cups — 2 oz. (about 60 mL) or smaller works well
- measuring spoons (1 tablespoon, or about 15 mL, and ¼ teaspoon, or about 1.25 mL)
- vinegar
- baking soda
- rubbing alcohol (approx. 70%)
- liquid hand soap
- calamine lotion
- filtered water or distilled water
- snack size zip-closing plastic bag
- measuring cup
- plastic pipet or eye dropper
- marker for labelling

Procedure

To track what is happening with the acid, we will use an indicator that is made from natural, cochineal dye (which has been extracted from the body of a female cochineal insect). Cochineal dye will change colors if the solution is acidic, basic, or neutral.

You will need an indicator to do this experiment. You can make your own using the cochineal insects from the activity on page 5 in this edition of *Celebrating Chemistry*. If you don't have access to cochineal insects, you can make another kind of indicator by soaking a few chopped or torn leaves of red cabbage in ¾-cup (about 200 mL) of warm tap water for five minutes, then removing the solids.

Since we do not want to use the real acid from bug bites, we will substitute vinegar. Vinegar is a common acid you can find in your kitchen. When you spill some vinegar on your skin, it normally does not sting. That is because the amount of acid in vinegar is fairly small, only 3-5%, but it is a good model for the acid from an insect bite.

1. Label 4 clear plastic cups: "baking soda," "rubbing alcohol," "liquid hand soap," and "calamine lotion."
2. Add 1 tbsp. of vinegar to each of the four cups.
3. Use a pipet or dropper to add 10 drops of your indicator solution (juice from cochineal bugs) to each of the four labeled plastic cups. Swirl gently. Record observations in table below.
4. Add ¼ tsp. of baking soda to the appropriate cup and swirl. Record your observations in the table.
5. Add ¼ tsp. of rubbing alcohol to the appropriate cup and swirl. Record your observations.
6. Add two pumps of the liquid hand soap to the appropriate cup and swirl. Record your observations.
7. Add ¼ tsp. of calamine lotion to the appropriate cup and swirl. Record your observations in the table.

Safety Suggestions

- ✓ Safety goggles required
- ✓ Protective clothing and gloves suggested
- ✓ Caution: hot liquids
- ✓ Do not eat or drink any of the materials used in this activity
- ✓ Thoroughly wash hands after this activity
- ✓ Gloves

Disposal: Neutralize all solutions before pouring down the drain. Wash reusable items with soap and water. Disposable items, such as zip-closing plastic bags, may be disposed of safely with the household trash or recycling.

Note: Cover your workspace and protect your clothing to avoid unwanted stains from the insect dye.

What did you observe?

Observation Table

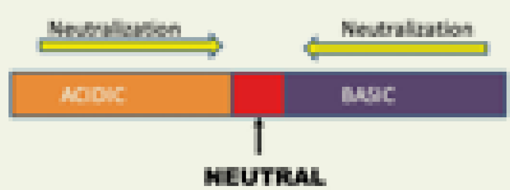
Cup	Remedy to be Tested	Color before addition of remedy	Color after addition of remedy	Was there a color change? (Yes or No)
#1	baking soda			
#2	rubbing alcohol			
#3	hand soap			
#4	calamine lotion			

How does it work?

Acids, bases, and neutral substances can all be compared on a spectrum called the pH scale. "Neutral" is where most of our body fluids are: neither acid nor base, but in the middle of the scale. Acids and bases are chemical opposites. If you add a base to an acid, it will help neutralize it. If you add an acid to a base, the same thing happens. "Neutralization" moves acidic or basic materials toward the middle of the scale.

Cochineal dye is orange when it's in an acidic environment, red when neutral, and purple when it's in base. If you add too much neutralizing agent when starting with an acid, you can end up basic, which is another non-ideal situation for living things. Baking soda is a base, so adding the amount we did neutralizes the vinegar, but goes beyond where we want to be. Neither the alcohol nor the soap did much to neutralize the acid, but the calamine lotion does.

So, let's review! The best of our treatments for counteracting the acid in a bite would be baking soda and calamine lotion. Alcohol and soap are commonly recommended to help with bites because they serve a very important role — preventing infection! As a bonus, alcohol cools the skin as it evaporates, easing the annoying itchy feeling.



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The Adventures of Meg A. Mole, Future Chemist

Riccardo Papa

Professor and Lab Director of the of the Sequencing and Genotyping Facility

In honor of this year's Chemists Celebrate Earth Week theme, "The Buzz About Bugs: Insect Chemistry," I traveled all the way to the University of Puerto Rico, Rio Piedras, to meet with Dr. Riccardo Papa, Professor and Lab Director of the Sequencing and Genotyping Facility.

Dr. Papa studies *Heliconius* butterflies, also known as longwings. His lab is "dedicated to the study of genetics and genomics" using these butterflies. More specifically, he and his team are exploring the "source of variation in natural selection and adaptation … and why and how the patterns and colors on a butterfly's wing can change over generations."

So where is this work done? Dr. Papa explained that most of their studies are conducted "at the Department of Biology at the UPR-Rio Piedras, the Botanical Garden, and the Molecular Research Science building." The Botanical Garden was a really neat place to visit. I learned a lot about butterflies and saw some beautiful insects! There are many botanical gardens all over the world, where many children can experience some aspect of Dr. Papa's work.

Growing up, Dr. Papa was interested in science. He spent a lot of time "collecting insects and looking at their behaviors and shapes." It was his "love for nature and biodiversity" that made him want to pursue a science career. He shared that the best thing about being a scientist is that you can "always do new things and make new discoveries." Most of all, he enjoys "the interaction with young students."

As I was leaving to head back home, I asked Dr. Papa if he had any advice for kids. He replied, "Understand the beauty and delicate balance of nature, and learn to respect and protect the diversity of life forms." Well said!

Fun Facts

- **Favorite pastime/hobby:** Surfing, paddle boarding, sailing, and painting
- **Favorite food:** Pasta (I am Italian)
- **Very interesting project you were a part of:** Discovery of the molecules that create colors on butterfly wings
- **About your family:** Very international: Wife from California, son and dog from Puerto Rico, and me from Italy. We speak three languages in the house: English, Spanish, and Italian.

Word Search

Try to find the words listed below – they can be horizontal, vertical or diagonal, and read forward or backward!

U	E	U	L	E	S	M	O	Z	B	R	T	M	N	H
M	S	N	Z	P	F	X	S	H	O	C	O	V	O	V
B	N	I	T	M	M	Y	D	T	H	L	Z	W	I	B
L	Q	K	X	O	O	F	A	D	E	L	U	L	T	A
V	Q	L	N	F	M	N	Q	C	W	V	Q	X	A	P
N	Z	K	I	D	I	O	U	G	C	N	K	N	N	U
W	E	L	K	L	W	L	P	Y	K	K	N	I	I	A
J	J	L	L	S	E	S	R	H	V	W	J	N	L	D
J	K	O	L	H	N	T	Z	T	A	D	K	S	L	U
Q	P	K	D	O	S	T	G	D	V	G	F	E	O	S
D	U	B	B	I	P	Z	S	J	X	O	Y	C	P	K
U	F	H	M	C	R	V	X	V	F	Y	D	T	M	P
G	O	E	E	N	T	O	M	O	L	O	G	I	S	T
P	H	U	I	O	N	H	L	I	D	X	V	K	I	O
C	S	I	S	E	H	T	N	Y	S	O	T	O	H	P

CHEMISTRY	INSECT	POLLEN
ENTOMOLOGIST	MOLECULE	POLLINATION
ENTOMOPHAGY	PHOTOSYNTHESIS	POLLINATOR

For answers to the word search, please visit **www.acs.org/celebratingchemistry**.

Amazing Aromas

By Susan Hershberger

Safety Suggestions

- ✓ Safety goggles required
- ✓ Do not eat or drink any of the materials used in the science part of this activity
- ✓ Thoroughly wash hands after this activity

Introduction

Insects help plants get pollinated, so that they can make seeds. Insects do not really know they are doing this valuable job for plants, because their focus is on looking for food, such as nectar from flowers. How do plants attract the insects and get their help? It is mostly from the scent, color, and shape of their flowers. In this activity, you will assemble some common aromas from natural fruits and flowers and from products that use scents (which may be artificial) as part of their ingredients. Using just your sense of smell, can you identify the source, and match the real aroma to the aroma in specific products? It's not easy!

Materials

- 3 scented items such as candles, soaps, or lotions. You could also use candies, beverages, or dessert mixes that contain common fruit flavors.
- 3 corresponding real, natural items. For example, if you find a vanilla candle, use natural vanilla extract. If you find rose-scented shampoo, find a real rose from a rose plant. If you find an orange candy or gelatin mix, find a small piece of real orange. If you find strawberry lotion, get a real strawberry.
- 6 small jars, containers, or cups that are hard to see though. Paper can be taped on the outside.
- Assistant to help you
- Scarf or bandana to use as a blindfold
- Small amount of warm tap water (optional)

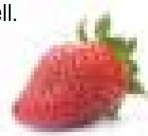
Procedure

Prepare your samples

1. Put a small amount of each scented product in three of the small cups or containers. Put a small amount of each natural product in each of the other three small cups. Make sure the contents are hard to see, but keep the containers open to allow the odor to be detected.
2. Check if you can detect the aroma by gently waving or fanning the cup under your nose. Chemists call this technique wafting. This is a safer way to sample the aroma than putting your nose in a jar and taking a big sniff.
3. If you cannot detect any aroma, possibly because a candy has a hard shell, you can cut the sample into small pieces and even add a little warm water to the cut pieces. The warm water helps the aroma molecules turn into a gas or vapor so your nose can detect the aroma.
4. Once you have detected the odor of each of the of three scented products and the corresponding natural items in cups, you are ready to test both the products and your sense of smell.

Test the real aroma and the aroma in products

1. For the fairest test, wear a blindfold.
2. Ask your assistant to gently wave, under your nose, the containers with the samples.
3. Your first job to guess which aroma you are detecting. Ask your assistant to write down words you used to describe each aroma.
4. Second, try to guess whether you are detecting the natural aroma, or if the aroma is in a product.
5. Since you are blindfolded, your assistant can write your response down in the data table.
6. Repeat the same process with the other samples, going in any order.
7. Can you tell which samples have the same aroma? Tell your assistant which are pairs. It is OK to ask to go back to smell a previous sample.



What did you observe?

Sample	Aroma detected?	Natural or product sample?	Describe the aroma. Which sample is this sample paired with?
1.			
2.			
3.			
4.			
5.			
6.			

How does it work?

The aromas of flowers and fruits are chemical compounds made of different combinations of several elements — mainly carbon, hydrogen, and oxygen. The aroma of each substance is a direct result of the way the atoms are arranged and grouped together. Different arrangements of these same elements make up the different aromas. These compounds become gases easily, which allows them to be detected by our sense of smell. Bees and other pollinators detect these aromas, too!

It is very important for insects to be able to identify the correct scents and shapes so that they can navigate to the correct flowers. Otherwise, they will not be successful in pollinating the flowers. Luckily, insects have very accurate sensory organs and are able to find the right flowers.

You were faced with the challenge of identifying natural odors, but also trying to separate them from their artificial versions. Chemists work very hard to make artificial flavors and odors as close to the natural ones as possible. For example, natural vanilla flavor is expensive, so scientists try to copy the aroma or flavor with imitations for specific products such as candles, soaps, and even foods like vanilla ice cream. The same is true of many other scents and flavors. Manufacturers will often use an artificial version of a taste or odor because they are cheaper and easier to control and use.

Hopefully you now have a better idea what it is like to be a bee trying to find the perfect flower to pollinate. Maybe you'll also have a better appreciation how complex and wonderful our natural world is!

Susan Hershberger, Ph.D. *is Director of the Center for Chemistry Education at Miami University in Oxford, OH.*

Words to Know

Atom – the smallest unit of a chemical element that has the characteristics of the element.

Chemical bond – forces of attraction between atoms or molecules that create compounds.

Chemical reaction – the process of rearranging atoms between substances to make different substances.

Chemistry – the study of matter, its properties, and its changes.

Element – a pure substance, such as copper or oxygen, made from a single type of atom. Elements are the basic building blocks of all matter.

Entomologist – a scientist who studies insects.

Entomophagy – the practice of eating insects.

Indicator – a substance that changes color depending on whether it is in an acid, a base, or a neutral solution.

Insect – an animal that has six legs; a body made up of a thorax, head, and abdomen; and often one or two pairs of wings.

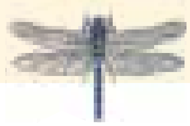
Molecule – the smallest unit of a chemical compound. They are made from two or more atoms.

Photosynthesis – the chemical process plants and other bacteria use to turn carbon dioxide, light, and water into energy in the form sugar, and release oxygen into the air.

Pollen – a dusty powder produced by plants when they reproduce.

Pollination – the process of transferring pollen from the male parts of a plant to its female parts, allowing the plant to reproduce. Pollination happens by wind, water, or pollinators.

Pollinator – an organism that picks up pollen from one flower and carries it to another. Insects, birds, bats, and bees are common examples.



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Celebrating Chemistry is a publication of the ACS Office of Science Outreach in conjunction with the Committee on Community Activities (CCA). The Office of Science Outreach is part of the ACS Division of Education. The Chemists Celebrate Earth Week (CCEW) edition of *Celebrating Chemistry* is published annually and is available free of charge online or in print through your local CCEW Coordinator. Visit **www.acs.org/ccew** to learn more.

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ACKNOWLEDGMENTS

The articles and activities used in this publication were written by theme team members of the ACS Committee on Community Activities (CCA) under the leadership of **Holly Davis**.
Meg A. Mole's interview was written by **Kara KasaKaitas**.

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