In this presentation we will discuss the basics of mite biology and anatomy and learn some of the ways mites can damage plants or be beneficial as predators or fungus feeders. We will also introduce you to the citrus Hindu mite, the citrus brown mite, and the red palm mite. The citrus Hindu mite and citrus brown mite are not known to occur in the U.S. whereas the red palm mite is currently found in South Florida. All three are exotic plant feeding mites of economic importance.
What Are Mites?

- Very small arthropods usually with **eight** legs
- Usually live in very specialized habitats
- Live on plants, animals, stored products, soil and water
- Include
  - Beneficial plant-dwelling
  - Mites that cause no visible injury to plants
  - Plant pests

Most mites are very small arthropods that can usually only be seen with a microscope. **Mites are arachnids like spiders and scorpions, and usually have eight legs. Larval mites have six legs and mites in the superfamily Eriophyoidea only have four legs.** Mites are not insects although they are sometimes mistaken for insects.

Most mites live in the soil, but they also live on animals, plants, stored products such as grain, sugar, or pet food. Plant-dwelling mites aren’t necessarily plant pests. Many plant-dwelling mites are predators of plant pest mites, some may feed on plants but don’t cause noticeable damage, and others can be beneficial by feeding on fungal pathogens.

Mites usually have very specialized habitats and are only found in the particular place in which they are adapted to live. For example, an animal pest mite will not live on a plant. Some mites, such as the two-spotted spider mite (*Tetranychus urticae*), are able to live on many different types of plants whereas others, such as the blueberry bud mite (*Acalitus vaccinii*), can only live in a certain part of a particular plant.

Some plant-dwelling mites are beneficial because they eat plant feeding mites or help control fungus on leaves. Some of these mites may be used as biocontrol agents.

Mites can be difficult to find on a plant due to their small size and tendency to hide in fairly inaccessible parts of the plant. Correct identification can be difficult because many species look similar. Field identification is even more difficult because most mites look the same to the naked eye or under a hand-lens.
This scanning electron micrograph (SEM) is of a flat mite, *Tenuipalpus pacificus*. This species is a pest of orchids in Florida and worldwide.

This image helps illustrate the basic anatomy of most mites. Mites have two body regions: gnathosoma ("head") and idiosoma ("body"). The gnathosoma or "head" includes specialized feeding mouthparts which includes pedipalps and chelicerae. Chelicerae are used to pierce the plant. Plant-feeding mites cannot “chew” and partially digest their food before ingesting it. The idiosoma or “body” ranges in shape from roundish (most plant mites) to wormlike. Most mites have four pairs of legs (eight in total) attached to the ventral side of the idiosoma, but some groups have two or three pairs of legs. The idiosoma and legs of mites have some various types of setae ("hair").

Mites in the superfamily Eriophyoidea have four legs, rather than eight, and their body is described as cigar-shaped or wormlike. Eriophyoid mites are smaller than most other mites, and tend to live in hidden places on a plant. Later in the presentation we will mention citrus rust mites and grape erineum mites, both of which are eriophyoid mites.
How Mites Damage Plants

- Break cuticle with mouthparts or suck out plant juice
- Transmit pathogens
- Induce malformed plant parts

Plant-feeding mites can cause injury in several ways. They may injure the plant’s leaf or fruit surface by piercing the plant cells with their chelicerae and sucking out the contents. Many small holes remain on the leaf or fruit surface through which the plant may lose water after the mite has finished feeding. Leaves may become shriveled and die, and fruit may develop unsightly lesions.

In addition, some plant-feeding mites can transmit plant pathogens, though this is uncommon. This means that although the mite’s feeding activity may not cause any noticeable plant injury, the disease that develops after the mite has transmitted the plant pathogen does.

*Citrus leprosis virus* is an example of a plant pathogen that is spread to citrus by mites in the genus *Brevipalpus*. The feeding activity does not appear to cause injury to the citrus plants at low population levels. Symptoms of citrus leprosis disease develop at the mite feeding site if the mite transmitted the virus.

Plants may produce galls or other malformed plant parts in response to mite feeding. The mite may shelter within these malformed plant parts to feed and reproduce.
Some mites such as the two-spotted spider mite (*Tetranychus urticae*) suck cell contents (“plant sap”) from the leaf. This causes a stippled appearance on the leaf where the mite has drained the cell contents in a particular area.

Affected leaves may become shriveled, dry, and fall from the plant as water and nutrients are lost to mite feeding. This can cause the whole plant to decline if the infestation is severe.

Fruit rind is another potential feeding site for mites. For example, the citrus rust mite (Eriophyidae) (*Phyllocoptruta oleivora*) feeds on the citrus fruit rind and leaves which develop a bronzed appearance in response.
The false spider mite (Tenuipalpidae) *Brevipalpus phoenicis* doesn’t cause obvious feeding damage at low population levels, but it can transmit *Citrus leprosis virus* to the plant it’s feeding on, which causes citrus leprosis disease. The mite can only transmit *Citrus leprosis virus* if it has fed on other plant tissue with the virus. *Brevipalpus phoenicis* and other *Brevipalpus* species are known to transmit plant viruses to more than 37 ornamental plant species in 18 families in addition to the *Citrus leprosis virus*. 

The False Spider Mite *Brevipalpus phoenicis* transmits *Citrus leprosis virus* - the cause of citrus leprosis disease
Mite Damage

Erineum mites cause grape leaves to make galls

Tiny erineum mites live within these galls

This grape leaf has developed little galls called erinea in response to feeding by grape erineum mites (Eriophyidae) (*Colomerus vitis*). These tiny mites shelter within the pockets created by the erinea galls to feed and reproduce. Erinea are one example of the ways mite feeding can cause plants to develop malformed plant parts.

As mentioned previously, the grape erineum mite is an eriophyid mite that has only four legs and the body is tiny and "worm like". Eriophyid mites are very specialized and occur on specific parts of specific plants and cause distinctive damage.
Most mite species develop according to the following generalized life cycle:

The six-legged larva hatches from the egg and then molts into two or three eight-legged nymph stages before reaching the adult stage.

Depending on the temperature and availability of food, this cycle usually takes from 8 to 14 days for many plant pests.

The mated adult female lays eggs which develop into males and females, with a female-biased sex ratio. Eggs from unmated females develop into males and the unmated female then mates with the males when they mature so she can produce female eggs. This biology makes many plant-feeding mites potential invasive pests.

Adult males are commonly smaller than females and usually necessary to make a species identification.
Examples of Invasive Mite Pests

Citrus Hindu Mite  
*Schizotetranychus hindustanicus*

Citrus Brown Mite  
*Eutetranychus orientalis*

Red Palm Mite  
*Raoiella indica*

There are many mite pests in the U.S., some of them native, some were introduced. In addition, there are mite pests in the world that have not reached the U.S.

The citrus Hindu mite (*Schizotetranychus hindustanicus*), citrus brown mite (*Eutetranychus orientalis*), and red palm mite (*Raoiella indica*) are considered invasive species to the U.S. The Cooperative Agricultural Pest Survey (CAPS) Program for Florida has included these mites on their watchlist due to the probability of them coming into Florida through commercial plant trade with countries in the Caribbean. Nursery growers who import plants from the Caribbean as part of their business are asked to pay particularly close attention to their imported plants for these mites.

The best way to keep invasive mite pests from becoming established in the U.S. is to find and eradicate them before they become established. You can help with prevention and eradication of invasive mite pests by becoming familiar with mite pests that are considered at risk of introduction or establishment in the U.S.

The citrus Hindu mite and citrus brown mite are not known to occur in the U.S. at this time. The red palm mite is currently found only in South Florida but there is concern that this mite will spread to other areas. We will discuss each mite in more detail in the upcoming slides.
The citrus Hindu mite, *Schizotetranychus hindustanicus*, was originally reported from India but was recently discovered in Venezuela, Brazil, and Colombia. Citrus Hindu mite was found on lemons in Brazil but was not found on oranges growing in the same grove.

The adults and immature stages are yellowish or yellowish green in color with dark internal spots on the sides of the body. The female body is oval and somewhat flattened with stubby legs. The male is pear-shaped, paler and smaller than the female. His legs are long (especially the first pair).

The eggs are rather round, though slightly flattened, and clear to light yellow in coloration. Just before hatching, the larvae become yellowish green and have two small red spots (which are the eyes). The larvae are yellowish green after hatching and globular in shape. As they feed, they become darker and more oval in shape.

In laboratory conditions, the life cycle takes 14 to 15 days from egg to adult with females laying eggs (11 to 13) for about 9 days. However, what happens in the field can be dramatically different.

Control methods, means of dispersal, and the full host range are not fully known for this pest. The citrus Hindu mite has been reported to feed on sorghum (*Sorghum bicolor*), coconut (*Cocos nucifera*), *Acacia* spp., Persian lilac (*Melia azedarach*), and neem (*Azadirachta indica*) in addition to citrus (key lime, mandarin, sweet orange, Tahiti lime, and lemon). Citrus Hindu mite reared in laboratory conditions on orange, Persian lime, and lemon leaves reportedly completed their life cycle in approximately 30 days. Notably, each female mite laid a very low number of eggs in this study and the authors speculate that citrus Hindu mite may not be an important pest of citrus.

Research into the importance of citrus Hind mite as a pest of citrus, this mite’s full host range, and control methods is ongoing.
Citrus Hindu mite feeding causes uniform silvery splotches on the fruit and leaves and the underside of the leaves are covered in circular webbing nests (ranging in size from 1 to 3mm) under which the mites live and reproduce. This mite is known as a nest-webbing mite because of this behavior. This behavior also makes it easier to spot when scouting in the field. Unfortunately, it also means that predatory mites have a hard time getting to them.

Fruit injury is expected to reduce fresh market value and leaf injury may reduce the tree’s photosynthetic potential.

The impact of the citrus Hindu mite on citrus cultivation is not clear. Citrus Hindu mite has reportedly caused significant damage in Venezuela, primarily on lemon, though no economic damage data is currently published from any country encountering this pest. Regulatory agencies in Venezuela, Brazil, and Colombia are monitoring for citrus Hindu mite and evaluating the effect of this pest on their citrus industries. Preventing new introductions is always advisable over managing a new pest once it has arrived; therefore it is prudent to be aware of this pest so that you can quickly report any symptoms you suspect could be caused by citrus Hindu mite.
Citrus brown mite (Eutetranychus orientalis) is a major pest of citrus and nearly 200 other plants in parts of Africa, southern Europe, the Middle East, Asia, and Australia. Its place of origin is not known. It is also known as the Oriental red mite or ORM.

Like other members of this genus, the females are broadly oval and somewhat flattened. Their coloration ranges from green to orange or brown and with irregular dark green spots found on her back near the margins. Males are slender, triangular in shape, with noticeable long legs (they are very active on) the leaves. Both males and females hold the first two pairs of legs straight out in front of them and the back two pairs straight out. Citrus brown mite can be easily confused with the Texas citrus mite (Eutetranychus banksi), a species widespread in North and South America.

Female citrus brown mites begin to lay eggs when only a few days old with the female living between 1 and 3 weeks. The eggs themselves are flat and disk shaped and pale or a light green in color. They are laid along the main veins of the host plant leaves and hatch in about a week (or less depending on climate). The length of the entire life cycle is around 10-12 days. Under optimal conditions, E. orientalis can produce between 10 and 30 generations in a year.
Citrus Brown Mite
*Eutetranychus orientalis*

- Usually feed on the upper side of leaf along the midrib then spread to side veins
- At least 216 hosts, with preference to members of Rutaceae and Fabaceae
- Hosts include:
  - Lemons, mandarins, oranges
  - Pears, peaches, olives, and almonds

This pest usually feeds on the upper side of the leaf along the midrib and then spreads to the side veins. Their feeding causes the leaves to become yellow, with pale yellow streaks developing along the midrib and veins. Heavy infestations or lesser infestations in dry areas can cause the leaves to drop and eventually defoliate a tree.

There are at least 216 plant species belonging to 66 different plant families that are hosts for this pest; however, they seem to have a preference for Rutaceae and Fabaceae. Citrus hosts includes: lemons (*Citrus limon*), mandarins (*C. reticulata*), and oranges (*C. sinensis*). Other hosts include: almonds (*Prunus dulcis*), bananas (*Musa paradisiaca*), cassava (*Manihot esculenta*), cotton (*Gossypium*), figs (*Ficus carica*), guavas (*Psidium guajava*), mulberries (*Morus*), olives (*Olea europaea*), pawpaws (*Carica papaya*), peaches (*Prunus persica*), pears (*Pyrus* spp.), plumeria (*Plumeria* spp.), quinces (*Cydonia oblonga*), castor oil plant (*Ricinus communis*), sunflowers (*Helianthus annuus*), sweet potatoes (*Ipomoea batatas*), and watermelons (*Citrullus lanatus*).

Citrus brown mite, like most spider mites, is spread by wind currents and on infested plant material. In countries where this mite is a problem, acaricides and predatory mites are used to control the citrus brown mite. Even though control measures do exist, mites are in general very difficult to control.
Red Palm Mite
*Raoiella indica*

- Introduced to:
  - Caribbean in 2004
  - Florida in 2007
- Feed on leaves
- Severe yellowing, reduced fruit yield
- Dispersed by wind or on infested plant material
- Pest on palms, bananas, plantains, gingers, and heliconias

Red palm mite, *Raoiella indica*, arrived in the Caribbean probably from Reunion Island around 2004 and has devastated palms throughout the Caribbean, it was detected in Florida in 2007.

Red palm mite prefers coconut palms, *Cocos nucifera*. Red palm mites also feed on banana and plantain, *Musa* spp., gingers and heliconias. Other hosts in Florida include date palms (*Phoenix canariensis* and *Phoenix dactylifera*), fishtail palms (*Caryota* spp.), Australian arenga palm (*Arenga australasica*), red cabbage palm (*Livistona mariae*), Mexican fan palm (*Washingtonia robusta*), and many other palm species.

The red palm mite is easily spread by wind and on infested plant material and due to the ornamental palm trade, it is highly likely this mite will continue to spread. It has already spread into northeastern South America.

Chemical control is usually not practical for this mite because treating very large palms is expensive and difficult. Chemical control may be necessary in palm nurseries. Predatory mites and other natural enemies can provide some control.
This bright red mite is easy to see up close against the green leaf tissue, especially because there can be millions of mites or more on a single coconut palm. Both adult and juvenile mites are a vibrant red color.

The mite feeds through the plant’s stomata, which are small openings in the leaves that allow the plant to exchange gases for photosynthesis. The image on the right shows this occurring, with a scanning electron microscope (SEM) image. This type of feeding is different from some other plant-feeding mites that feed on the cells on the leaf surface. The red palm mite’s stomatal feeding is thought to interfere with photosynthesis. The mite’s feeding causes severe yellowing of the leaves and reduced fruit production. Yellowed areas progress to brown, dead foliage as the mite continues to feed.

This type of damage can be mistaken for nutritional deficiencies, so it is important to look for the mites themselves.
The Florida Department of Agriculture and Consumer Services, Division of Plant Industry reports that as of 2020 the red palm mite is known from Brevard, Broward, Charlotte, Collier, Glades, Hendry, Hillsborough, Indian River, Lee, Manatee, Martin, Miami-Dade, Monroe, Orange, Palm Beach, Pinellas, Sarasota, and St. Lucie Counties in Florida.

The red palm mite has been detected in Florida on over 30 palm species, banana, gingers and heliconias. Due to the heavy red palm mite infestations, the mites are being found on non-host plants though they cannot reproduce on any dicots and most non-palm monocots.
I think it would be good to add in a slide here that wraps up what to do if you think you have a mite, maybe some info on some how to scout. Just something that makes sense to end on.
The Digital Diagnostic Identification System (DDIS) connects extension clientele, extension agent, specialists, plant disease clinics, and government officials. Users can submit electronic samples through the system to get rapid identification of insect, weed, mushroom, plant pathogens, and abiotic disorder samples. The general public and shareholders must contact their local county extension agent before signing up as extension clientele.
 Reporting a Pest in Florida

UF/IFAS Faculty

• Local county extension office
  – https://sfyl.ifas.ufl.edu/find-your-local-office/

• Insect ID Lab- Lyle Buss
  – http://entnemdept.ufl.edu/insectid/

• UF/IFAS Plant Diagnostic Center- Dr. Carrie Harmon
  – https://plantpath.ifas.ufl.edu/extension/plant-diagnostic-center/

The UF/IFAS faculty is responsible for reporting diseases, insects, weeds, nematodes, or any other invasive species to the Florida Department Agriculture and Consumer Services, Division of Plant Industry (FDACS, DPI). Reporting this information is essential to protect Florida agriculture, communities and natural areas.

Local county extension agents can assist in identifying plant pests or submitting a pest sample to the correct department or agency for identification. Local extension agents can also sign up for DDIS and receive samples electronically.

Lyle Buss is the insect identifier at the University of Florida. Visit the link to download the sample submission form or email him with questions.

Dr. Carrie Harmon is the head of the plant diagnostic center in Gainesville, Florida. Visit the PDC website to download the sample submission forms. She highly recommends calling prior to sample submission.

The diagnosticians and identifiers in each area will also provide management strategies for the sample. If an invasive pest is found, they will send it FDACS, DPI for further testing.
• FDACS, DPI Responsibility
  o Announcing detection or establishment of new invasive species.
  o Reporting is a legal obligation under Florida Statute 581.091.

• Submission Form

Florida Department of Agriculture and Consumer Services: Division of Plant Industry is a regulatory agency dedicated to the detection and prevention of introduction and spread of pests and diseases that can affect Florida’s native and commercially grown plants. Announcing the establishment of new invasive species can affect Florida’s agricultural producers and trade of agricultural products.

FDACS, DPI provides online submission forms to fill out and send to the agency for proper identification. DPI provides useful videos of how to properly handle the specimens before shipping them for identification.
FDACS, DPI Contact

• Division of Plant Industry Helpline
  – DPIHelpline@FDACS.gov
  – 1-888-397-1517

• Dr. Leroy Whilby, Bureau Chief of Entomology, Nematology and Plant Pathology
  – Leroy.whilby@fdacs.gov
  – 352-395-4661

• Dr. Paul Skelley, Chief Entomologist and Assistant Bureau Chief of Entomology, Nematology and Plant Pathology
  – Paul.skelley@fdacs.gov
  – 352-395-4678

The DPI contacts provided will assist in determining the next steps if the pest found is of regulatory concern. Additionally, FDACS, DPI has a hotline with both a phone number and email for questions and concerns.
This presentation was originally published in May 2014 was updated in December 2020.
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