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Common Household Pests

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Common Household Pests

By Josh Matta

Introduction

The following booklet is meant to familiarize members of my organization with several important pests that are found on our product labels. My role in R&D is to evaluate the insecticidal performance of consumer pest control products and move them through the development process from initial screening to EPA claims validation. Another important part of my job is to educate a diverse team colleagues on various topics in entomology. This document will allow me to have basic life history and other important information available for the most common pest questions that come my way.

Public Health and Structural Pests

There are approximately 20 species of public health/structural pests that we normally deal with when performance testing. The EPA has established a list of major pests and a set of testing guidelines that we must follow to make specific claims on a product label. This document includes some of the most important pests that we test including ants, bed bugs, cockroaches, fleas, flies, mosquitoes, ticks and wasps.

Ants



Argentine Ants - Whitney Cranshaw, Colorado State University, Bugwood.org

Introduction

Ants are one of the most common household pests and can be found in virtually any structure that contains food and water. There are more than 12,000 species of ants in the world.

Approximately 40 species are considered urban pests in the United States. Ants are important to the ecosystem in many ways. Some ants protect and care for other insects like aphids, scales, whiteflies, mealybugs and other pests that produce honeydew. Ants feed on pests and decomposing animals and they can also become food for other insects.

Ants belong to the order Hymenoptera and they are closely related to bees and wasps. Ants can be identified by the most common wingless adult workers that are seen foraging in and around homes. Ants can become winged when they leave nests to establish new colonies. Homeowners will often mistake winged ants for termites which can also be found mating away from their nests.



Winged Carpenter Ant – Joseph Berger, Bugwood.org

There are a few ways to easily distinguish between the two. An ant's body has a thin waist while the termite body has a broad waist. An ant's hindwings are smaller than its front wings, and a termite's front and hind wings are approximately the same size. Ants have elbowed antennae and termites do not have elbowed antennae.



Winged Termite - Gerald J. Lenhard, Louisiana State University, Bugwood.org

All ants undergo complete metamorphosis so they will pass through four distinct life stages: egg, larva, pupa, and adult.



Life Stages of Ants - USDA APHIS PPQ - Imported Fire Ant Station , USDA APHIS PPQ, Bugwood.org

Queen ants are the only reproductive individuals in a colony and are larger than the other ants. They are responsible for laying eggs and will sometimes feed and groom larvae. Larvae are worm-like in appearance and do not move.

Much of a colony is made up of workers, which are sterile females, that forage and gather food to bring back to the colony. They also work to build the colonies tunnels and help defend it. Male ants are much less predominant in the colony and are only there to mate with the queens.



Carpenter Ant Larvae - Whitney Cranshaw, Colorado State University, Bugwood.org

Ants are primarily found nesting outdoors in soil near sources of food and water. Only a few ant species will nest indoors. Ant species prefer varying foods and will eat anything from dead or live insects, to dead animals, sweets, fats, proteins, seeds, nuts and fruits.

Ants usually enter buildings to find food and water but will also enter to try to find warmth and shelter from the cold, rain, or heat. They will appear in great numbers indoors when available foods are depleted outside or unfavorable weather conditions exist.

Often a single mating queen will establish a new colony. She will hideaway underground for weeks at a time where she lays her eggs. When the eggs hatch, she will feed the larvae with her own wing muscles and fat body until the larvae pupate. The pupae will become female adult workers and they will tunnel out of the nest to begin collecting food for the colony's new batches

of eggs and broods of larvae. The colony will increase in size overtime and the workers will create new tunnels, chambers, and galleries for the colony to live. Overtime the colony will grow even larger and winged male and female ants will be produced so they can leave the nest, mate and form a new colony.



RIFA Pupae - USDA APHIS PPQ - Imported Fire Ant Station , USDA APHIS PPQ, Bugwood.org

Ants can cause damage to structures, food products, and plants. They enjoy many common food items found around the house. Homeowners can usually find ants invading kitchens and other areas in the warmer months of the year. Carpenter ant species can become established in wooden structures. Some ants can protect themselves with a venomous sting and so these species are important public health pests. Common household ants are the Argentine ant, pharaoh ant, odorous house ant, thief ant, fire ant, and pavement ant. The red imported fire ant and the carpenter ant are two other important species found in the U.S.

Carpenter Ant



Adult Carpenter Ant - David Cappaert, Bugwood.org

Carpenter ants are large bodied, dark colored ants that are very distinct. Foraging workers can be distinguished by their large mandibles and they are known to bite or pinch. There are around 12 species known in the US with only one or two primary species in each region. Approximately 13 species are known to invade and infest buildings, but most are not seen inside homes.

Carpenter ants build colonies in many places outdoors including large pieces of felled timber and wood. They prefer wood that is somewhat decayed and moist, but they will find and use the cracks and cavities found in new intact wood.

Most of the time these ants will only be seen inside of a building in search of food sources and may only enter homes by accident if they are brought in by firewood. The nest is usually found much further away from the home. The queen is usually found in this nest which is considered the primary nest. Nests that are found in a structure are considered a secondary nest or satellite nest. No egg laying occurs in the secondary nest.

Secondary indoor nests could be found within any wooden structure found around the house. Carpenter ants may have many colonies set up in wooded areas around a secondarily infested home. Carpenter ants dig galleries inside wood which makes them easily mistaken for termites. Carpenter ants produce a distinct, fine dust when building galleries. They prefer to cut galleries along the grain of the wood and into softer areas. Carpenter ants prefer to dig in moist or deteriorating wood because they do not consume the wood.



Carpenter Ant Dust - Edward H. Holsten, USDA Forest Service, Bugwood.org



Carpenter Ant Damage - R. Werner, USDA Forest Service, Bugwood.org

Winged reproductive carpenter ants will begin to swarm in the spring. However, carpenter ants can be found with wings at other times of the year. Winged males have been observed indoors as early as February or March, but females do not emerge until the spring. As the colony matures, adults will take on several sizes and forms in a nest. The colony is considered a mature colony when winged reproductive ants are formed. This can take up to six years for many colonies. The populations of some colonies can grow as high as 100,000 ants.

Winged reproductive ants are also referred to as alates. They are produced by the colony in late summer and spend the entire winter in the nest. Up to 300 alates can be produced by a colony and they will swarm in the spring. Because carpenter ants do not consume wood as part of their diet, their diet will consist mainly of animal proteins and plant foods. They will feed on insects, honeydew, sweets, and most human foods that can be found in a kitchen.

Foraging ants will travel very far from the primary nest in search of food and can be guided by trail pheromones, but they can also be seen foraging without trail pheromone.

In warmer weather carpenter ants are active at dusk and they can be found on trails headed toward their secondary colony. They can carry foods back to the nest but usually they will transport it in their crop and regurgitate the material for the queen, larvae, and non-foraging workers.

Carpenter ants can damage building structures as they nest, contaminate food, and become unsightly to homeowners. Damage caused by carpenter ants may not be as serious as a termite infestation, however, damage from carpenter ants is usually a symptom of underlying water damage because they do not like to move beyond softwood.

Argentine Ant



Argentine Ant - Eli Sarnat, PIAkey Invasive Ants of the Pacific Islands, USDA APHIS PPQ, Bugwood.org

The Argentine ant is considered a severe pest through much of the United States. It can be found in many other parts of the world and was introduced to the United States from South America.

Workers are approximately 1/8 of an inch long and light to dark brown in color. Queens are much larger, about a 1/4 inch long. There can be several fertile queens in a single nest. Unlike queens of other ant species, Argentine queens will feed themselves and will also feed immatures.

There are usually no winged ants produced by the colony because mating takes place within the nest.

Multiple queens within a nest gives the ants the ability to form new colonies through a process called budding. Fertile queens and some workers will leave the nest to start a new colony.

Nests are often found in soil close to a building where food and water sources are nearby. They will occasionally nest inside a structure, but this is uncommon.

Argentine ants forage for food in long well-built trails and may enter houses when environmental conditions become too wet or too dry. They prefer foods that are sweet like sugar, syrup, juices, and honeydew.

Argentine ants adapt well to urban environments. They are known to be aggressive and can eliminate other ants nearby. However, Argentine ant colonies will coexist with other Argentine ant colonies because their populations can become extremely large. These large populations are referred to as supercolonies. Control and suppression of these ants can be quite difficult or impossible.

Fire Ants



Southern Fire Ant - Eli Sarnat, Antkey, USDA APHIS PPQ, Bugwood.org

Ants in the *Solenopsis* genus are considered fire ants. Their ovipositor has become adapted to deliver a venomous sting that can cause allergic reactions in sensitive individuals. Fire ants are aggressive and can kill young animals and cause problems with humans. There are four species that are considered pests in the United States: the southern fire ant, the tropical fire ant, the red imported fire ant, and the black imported fire ant. The red and black imported fire ants are not native to the United States.

The southern fire ant is predominantly found in the southern states. These ants are brown to black in color with a yellow or red head. The workers are around 1/4 inch long. They build nests in loose soil, but they can be found invading woodwork in the masonry of homes. The entrances to soil nests appear to be craters found in random places over a three square foot area. Foragers are attracted to many types of food like meat, grease, butter, nuts, seeds and vegetables.

The tropical fire ant can be found across the state of Florida and in other coastal areas. Tropical fire ants vary in color and can be confused with the southern fire ant.

The red imported fire ant, or RIFA, is an important pest found in many urban and agricultural settings. They usually build their nests from soil and create large mounds. They are found in many parts of the south from Florida to southern California.

Red imported fire ants are less likely to be found in areas that experience moderate to hard frosts. They are known to inhabit many areas where people like to gather, such as fields, parks and lawns. They are very aggressive and will sting an animal many times when their mound is disturbed.

RIFA workers are dark red in color and vary in size up to a 1/4 inch in length. Many mounds can be found in a yard depending on the size of the property.

The red imported fire ant has only one queen per colony, but some colonies may have many reproductive queens. A colony may inhabit a single mound, or a colony can inhabit more than one mound connected by a tunnel system. These overlapping colonies can be problematic for researchers to distinguish.



Fire Ant Mounds - Jake Farnum, Bugwood.org

More than 500,000 workers can comprise a large colony and lay claim to a foraging habitat of over 100 yards in diameter. They are scavengers and predatory in nature and they can kill and eat insects, small animals, and dead carcasses. They are also known to feed on honeydew, plants and sweets.

The black imported fire ant is very similar to the other fire ant species discussed. They are dark in color with some yellow spotting. This species can be found creating nests inside warm buildings and homes, but this is rare. They have been displaced from much of their territory by the RIFA and are now found only in a small area of Mississippi and Alabama.



Red Imported Fire Ant - USDA APHIS PPQ - Imported Fire Ant Station , USDA APHIS PPQ, Bugwood.org

Pharaoh Ant



Pharaoh Ant - Eli Samat, PIKey Invasive Ants of the Pacific Islands, USDA APHIS PPQ, Bugwood.org

The pharaoh ant is an important species found in homes, hotels, restaurants, hospitals, and other dwellings. They are very small and enjoy a wide variety of foods. The pharaoh ant worker is yellow to reddish brown in color and approximately 1/12 of an inch long. They can be encountered in many areas across the globe and are easily transported with humans and their goods.

Nests are hard to find because they are well hidden in walls, floors, ceilings, or virtually anywhere that is out of reach. They enjoy habitats that are warm and moist so they can be found around hot water pipes or other sources of water.

Pharaoh ants are known to forage far from their nesting site. They follow trails that are marked with trail pheromones and can usually be found on windowsills, countertops, and baseboards.

Pharaoh ants can also be found nesting in areas outside of a building particularly if the environment is warm and has a good source of water. These ants are less likely to be found outside if the geography favors cold winters and cool summer nights.

Pharaoh ants have highly adaptable pallets and will feed on virtually anything found in kitchens. They have also been observed feeding on blood, body fluids, medical waste and intravenous feeding fluids in hospitals.

Pharaoh ants build very large colonies that can consist of hundreds of thousands of workers and many queens. The colonies will bud when the queen builds a new colony unit. The new colony unit could either become a distinct colony or workers can be shared between the two units.

Mature ants do not swarm and do not fly although they do possess wings. They will mate inside the nest throughout most of the year. Queen ants have been observed foraging for food, but they are usually found close to the nest and remain hidden.

Some insecticide treatments will just exacerbate the problem because of the colony's ability to bud. The insecticide can cause stress on the colony which triggers the ants to bud into sub colonies and scatter throughout a structure.

Pavement Ant



Pavement Ant - Joseph Berger, Bugwood.org

The pavement ant can be found throughout most of the US but only occasionally will become a pest in the south and the Pacific northwest. They are slow moving and build nests outdoors next to buildings and, like their name implies, in cracks in the pavement. They can also be found in walls, under floors, and in the insulation of homes. Pavement ants are small dark colored ants that are about 1/6 of an inch in size and have visible parallel lines on their heads that are a grooved texture. The queens can be up to 1/3 of an inch in size and have the sculpted lines on their heads as well.

Foragers will enter the dwelling through cracks in a foundation in search of food. They prefer oily and sweet foods and can respond to sugar or protein-based baits at different times. Residual sprays in mound drenches have been proven to be effective controls of this species.



Pavement Ants - Mohammed El Damir, Bugwood.org

Odorous House Ant



Odorous House Ants - Joseph Berger, Bugwood.org

The odorous house ant is a common household pest that can be found across the United States and into Canada. This ant is easily confused with the Argentine ant but is darker in color. The workers are up to 1/8 inch in size and are dark brown.

The odorous house ant gives off an unpleasant rotted coconut odor when it is crushed. They will build their nests indoors or outdoors and the colonies can become quite large. Outside the nest is usually built to a shallow depth. They will build nests inside of walls and underneath floors in structures. A single nest can have many queens.

Workers can be found traveling along established trails in search of sweet foods. They are seen moving indoors when their primary food, honeydew, becomes scarce.



Odorous House Ants - Michael Merchant, Texas Cooperative Extension, Bugwood.org

Harvester Ant



Harvester Ant - Joseph Berger, Bugwood.org

Harvester ants are found throughout warm and dry regions of the south. They can be spotted in fields and lawns where they will clear large areas around their nest. They are known to collect seeds that they store below ground and they rarely invade homes.

Harvester ants can become large, up to 1/2 inch long. They are red in color and they use long hairs found on their head to help clean themselves, carry food and water, and remove materials as they build their nests. They can be aggressive and will sting. These ants can be a pest when they invade lawns and other places that people frequent.

Bed Bugs



Bed Bugs - Allen Szalanski, Bugwood.org

Bed bugs were virtually eradicated in the United States in the 1940s with the use of DDT and other modern insecticides. Bed bugs remained relatively common in other parts of the world, but they began to see a resurgence in North America in the 1990s.

Bed bugs are blood feeding insects that will feed on humans, chickens, bats, and domestic animals. They inhabit human dwellings, bird nests, and bat caves and hide near their host. In the home they can be found in virtually any crack or crevice inside a bed or around a bedroom.

The common bed bug, *Cimex lectularius*, is the most important bed bug species found in North America and Europe. The tropical bed bug, *Cimex hemipterus*, is well established in places like Florida. Both species can be found infesting the same structure.

Bed bugs have piercing, sucking mouthparts that allow them to suck the blood from the host.

They secrete an anticoagulant through their mouthparts to dilate the blood vessels and capillaries from the host and keep it from coagulating while they feed. Bed bugs are great at going undetected as they feed but the host will show signs of trauma at the sight of the bite.

The Common Bed Bug



Bed Bug Feeding Gary Alpert, Harvard University, Bugwood.org

Adult bed bugs are flat, reddish brown in color, and approximately 1/4 inch long. They swell and become redder in appearance after a bloodmeal when their abdomen is stretched and undigested blood can be seen through the cuticle. Eggs are elongate and approximately 0.04 inches long. They are attached to a substrate with secretions produced by the female when they are laid.



Engorged Bed Bug - Gary Alpert, Harvard University, Bugwood.org

Bed bugs undergo incomplete metamorphosis and usually have five nymphal stages before becoming an adult. Each development stage or instar must obtain a blood meal in order to molt into the next larger nymphal stage. After a blood meal the bed bugs will take on a swollen appearance. The engorged bed bug can weigh up to 200% more than its original body weight.



First Instar Bed Bug Gary Alpert, Harvard University, Bugwood.org

Harborage areas contain dark red and brown stains from partially digested blood. These stains can also be seen in areas like bedding and clothing where they have fed on a host. Heavy infestations will usually have a distinct musty odor within the harborage area.



Bed Bug Harborage- Barbara Bloetscher, The Ohio State University, Bugwood.org

Adult bed bugs do not attempt to mate until the adult female has had a blood meal. Adult males are more attracted to females that have recently fed. Males will usually mate with multiple females and undergo an unusual mating behavior known as traumatic insemination where the male injects sperm into the side of a female's abdomen. Females will usually receive several inseminations from one or more males after she takes a blood meal. The female may receive up to 25 times more sperm than is needed for egg laying. This along with traumatic insemination leads to a significantly reduced life span.

The female will begin producing eggs in as little as three days. She will lay the eggs one at a time in her harborage area. Preferred harborage areas are found close to a host usually in places around a bed.

In the presence of a host and favorable environmental conditions the female will feed and mate about once per week. She will keep up this cycle for her entire life span of 6 to 12 months. A female will typically lay 2 eggs per day. The eggs take about 10 days to hatch at normal room temperature.

Under optimal conditions the full life cycle from egg to egg can be accomplished in as few as 45 days. Bed bugs are able to survive long periods under sub optimal conditions where a single nymphal instar can take several months to develop while it waits for a blood meal.



Bed Bug Eggs - Gary Alpert, Harvard University, Bugwood.org

Cockroaches



German Cockroaches - Daniel R. Suiter, University of Georgia, Bugwood.org

Introduction

There are approximately 4000 species of cockroaches on earth and about 70 species are found in the United States. Cockroaches have been on Earth for approximately 350 million years and some consider cockroaches to be one of the most successful animals on the planet.

Cockroaches can become pests in any structure if they are given enough food and water. They can transmit many diseases to humans because they are closely associated with human sewage and waste. They can pick up several types of bacteria and viruses when they walk through contaminated material and then deposit these on food. Cockroaches can be a major source of foodborne illness and are also an important source of allergens. These insects can also be extremely difficult to control.

Only a few cockroach species are known to invade and take up residence in dwellings on a regular basis. In the United States, cockroaches of primary concern are German, American, oriental, brown banded, smoky brown, Australian, brown, woods, field and Asian species. Most cockroaches are adapted to living outdoors and thrive in tropical and subtropical regions where the environment is humid and warm. It is usually uncommon for them to be active during the daytime, instead preferring to mate, feed, and drink through the night. Seeing roaches in the daytime could be cause for concern because their population density might be very high, and they could be in search of food and water.

Cockroaches have adapted the ability to consume a variety of foods with their chewing mouthparts. They are known to consume typical foods like sweets, fats, and proteins and they also very much enjoy cheeses baked goods, dead animals, hair, glues, leather, and vegetation.

They are typically found around unsanitary places of the home like garbage cans and sewage systems. They enjoy the protection found in cracks and crevices of a home that are warm and high in humidity. They will find harborage in most any basement crawlspace and inside walls. While cockroaches do tend to aggregate in protected areas, they are not considered a social insect. They will forage for food by themselves and do not necessarily depend on other cockroaches for survival.

Although cockroaches are well adapted to move in and out of structures, and some are even strong flyers, they will usually hitchhike to new areas on or in containers moved around by humans. They can be found traveling in many items that are moved in and out of a home like bags of clothes, furniture, and even groceries.

Cockroaches undergo incomplete metamorphosis in three stages: egg, nymph, and adult. Fertilized eggs are contained in a special capsule called the ootheca. The ootheca contain several eggs from where the first instar nymphs will emerge. The nymph grows gradually and will eventually shed its skin which is called a molt. With each molt, the nymph becomes a new slightly larger instar. Nymphs can molt a few times before finally becoming an adult capable of reproduction. The length of time from egg to adult varies between species.



American Cockroach Life Stages - Daniel R. Suiter, University of Georgia, Bugwood.org

German Cockroach



German Cockroaches (Nymph and Adult) - Michael Merchant, Texas Cooperative Extension, Bugwood.org

The German cockroach is considered one of the most important species of cockroach and quite possibly the most important urban pest in the world. They are closely associated with humans and human structures across the globe, and they are unable to survive outside the range of these human associations. It is believed that these cockroaches are unable to survive in cold

environments, and so will not be able to live in northern climates without some form of heat to keep them warm. Research has shown that German cockroaches were unable to colonize vacant ships in cool conditions.

The female cockroach carries the ootheca until the eggs are ready hatch. The ootheca is brown in color, 1/3 of an inch long, and contains 30-40 eggs. It is possible for the eggs to hatch and nymphs to emerge from the ootheca while the female is still carrying it.



German Cockroach Female with Ootheca - Kansas Department of Agriculture, Bugwood.org

The nymphs are wingless and range from dark brown to black in color. They have dark parallel markings that run the length of the pronotum. They will typically molt six times and can develop into an adult in about 60 days.

Adults are approximately 1/2 an inch in length and brown in color with two parallel lines running the length of the pronotum. Males are thin with a tapered abdomen that protrude just past the wings. Females are stout with a rounded abdomen that is covered by her wings.

The entire life cycle (egg, nymph, adult) can be completed in in about 100 days but this depends on several environmental conditions like nutrition, temperature, and strain. Adults will breed continuously, and several generations can grow together simultaneously. A typical field population will have an 80:20 nymph to adult ratio.



German Cockroach Ootheca - Gary Alpert, Harvard University, Bugwood.org

German cockroaches feed on many types of food and have been observed feeding on things like crumbs, clothing, furniture, and even cosmetics if normal food sources like sugars, carbohydrates, proteins, and fats are not available. With adequate water, adults can live for up to a month without food, but nymphs require food within several days.

Most German cockroaches do not forage very far from their harborage, but researchers have found that there is some data to suggest that different life stages will display different foraging behavior. Adult males tend to travel more often and further from the harborage, followed by non-gravid adult females, followed by larger nymphs, followed by gravid females that may never leave the harborage.



German Cockroach - Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

American Cockroach



American Cockroach - Clemson University - USDA Cooperative Extension Slide Series , Bugwood.org

The largest peridomestic cockroach in the United States is the American cockroach, *Periplaneta americana* (Linnaeus). They reach an average length of 1½ inches. These cockroaches were brought to the United States from Africa in the 1600s and have since spread across the world through trade. They can be found in the basements, sewers, and drains of many commercial

buildings particularly in those that are used to prepare and store food. These cockroaches do not usually inhabit homes, but occasional sightings can occur after rainstorms.

In the South, the American cockroach can be found outdoors in damp, cool areas under trees and leaves. They spend much of their time outdoors but will wander inside in search of food, water, or shelter. In the North, they are likely to be found in basements, steam tunnels, and other damp areas like floor drains.

They can survive comfortably on food resources found in trash containers and find refuge in wooded areas around the home. Mass migrations can occur during extreme weather events. They can make their way into houses through sewage pipes and attics. They tend to rest in dark, moist environments within the house such as under sinks, pipes and bathrooms.

It can take nearly two years for an American cockroach to become an adult and the adults can live for up to a year. The eggs are laid by the adult female shortly after they are formed. The ootheca is either dropped in a suitable area or glued to a surface using mouth secretions. The egg case is brown to black and measures approximately 5/16 inches. Females can produce an ootheca approximately a week after mating and in her prime the female can lay two ootheca per week, with an average of 14 to 16 eggs per ootheca. She will do this monthly for several months of her life.



American cockroach ootheca Gary Alpert, Harvard University, Bugwood.org

The ootheca has enough water for the eggs to fully develop into nymphs. Nymphs will emerge in six to eight weeks. The nymphs molt anywhere from 6 to 14 times before becoming an adult. Newly molted individuals are white and become reddish-brown shortly after molting. The nymphs are wingless but do grow a pair of wing pads around the 3rd or 4th instar. It can take up to 600 days for the nymph to reach full maturity.



Freshly Molted American Cockroach - Daniel R. Suiter, University of Georgia, Bugwood.org

Adults are large and reddish brown in color. Adults have well developed wings but usually do not attempt flight. The male is slightly longer than the female because the wings extend slightly beyond the abdomen. Adults can live approximately 400 days, and a female can produce 150 offspring.

American cockroaches will feed on many foods, but they mostly prefer decaying organic matter. They have been observed feeding on glue, books, paper, clothing, starchy materials, syrup, and sweets. Adults are able to live for up to three months without food and up to a month without water.

Fleas

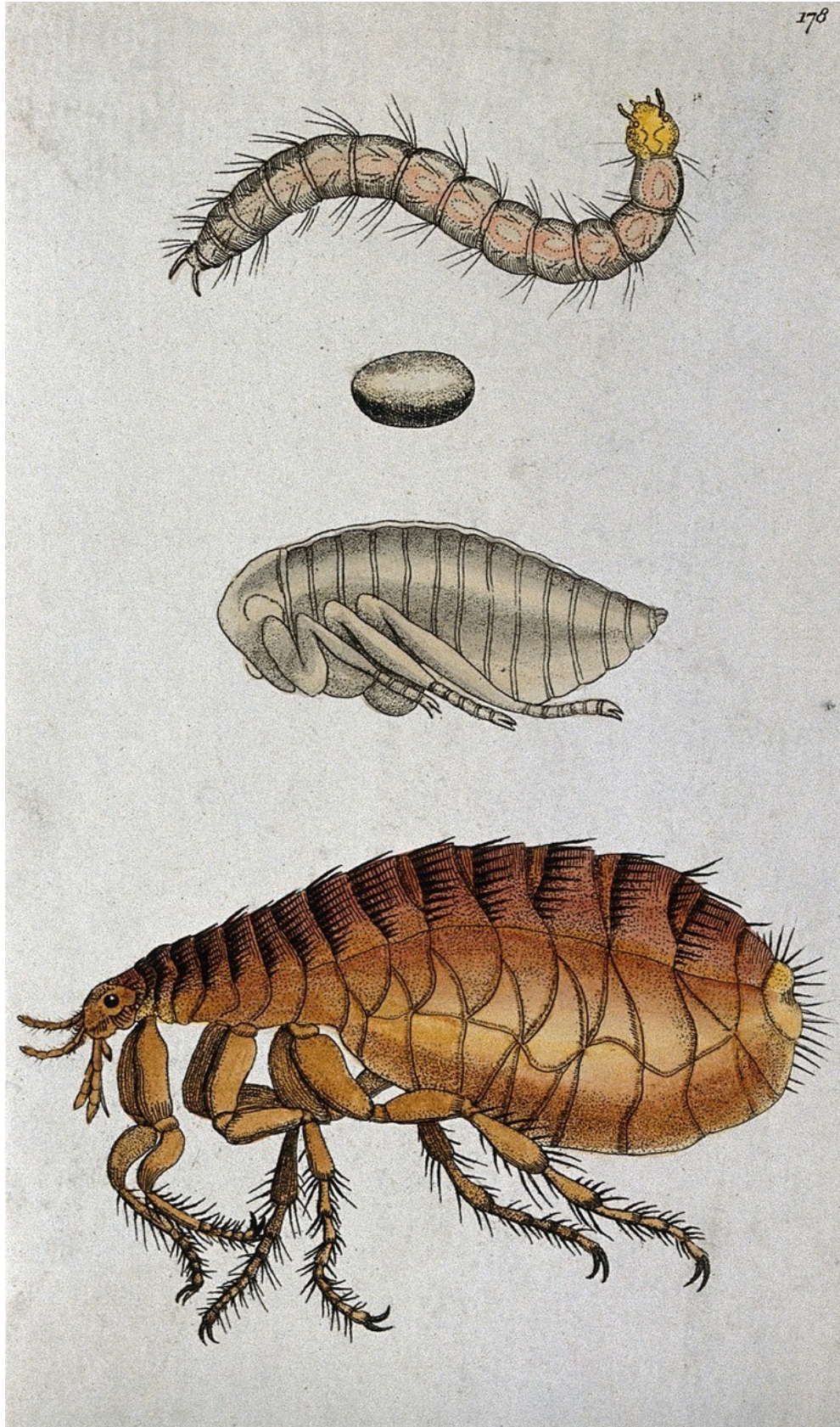


Dog Fleas - Pest and Diseases Image Library , Bugwood.org

Fleas are closely associated with humans and domestic animals. They prefer non-human hosts but will feed on humans during heavy infestations and in the absence of a preferred host.

Fleas are small, dark colored, wingless, and flattened laterally. They have specialized hind legs that enable them to jump long distances. These insects have piercing, sucking mouthparts which allows them to suck blood from their host. Females require a blood meal before producing eggs.

Fleas undergo complete metamorphosis and pass through distinct egg, larva, pupa and adult stages. The eggs are smooth, round, and light in color. Fleas will lay eggs on their host, but they will eventually fall to the ground where they will hatch in places like carpet or bedding.



Flea Life Stages - Wellcome Collection. Attribution 4.0 International (CC BY 4.0)

The female flea will lay as many as 300 eggs in her lifetime. The eggs will hatch a couple of days after being laid if the temperature and humidity are favorable. Fleas can go from egg to adult in as little as 30 days.

The small wormlike larvae feed on organic debris but prefer dried adult flea feces known as flea dirt. They develop over 5-15 days and prefer places protected from sunlight and rain. A mature larva will pupate in a silk cocoon before becoming an adult. The silky cocoon easily binds dirt and debris which aids in camouflage.



Cat Flea Larva - Pest and Diseases Image Library , Bugwood.org

Adult fleas will emerge from the cocoon in one or two weeks, but adults can also stay within the cocoon for up to a year. Adults will emerge when they feel the warmth or vibrations of a host.

This can lead to many hungry adult fleas emerging in just a few hours. They will begin to feed very soon after emerging from the cocoon.

Fleas enjoy a warm and humid environment and can easily infest a home given the right conditions. Flea larvae are sensitive to dryness so in northern regions they may die off in the winter when indoor conditions become dry. In the southern states, fleas will remain active year-round.

House Flies



House Fly Adults - Jim Occi, BugPics, Bugwood.org

The house fly, *Musca domestica*, is known around the world for its close association with human activities. They are commonly found around homes, stables and farms where they feed on animal feces and garbage. They are considered a nuisance and a public health pest because they can transport more than 100 pathogens. Flies can be linked to outbreaks of diarrhea, shigellosis, food poisoning, typhoid fever, dysentery, tuberculosis, anthrax, ophthalmia, and parasitic worms.

The house fly undergoes complete metamorphosis with a distinct egg, larval, pupal and adult stages. In optimal conditions the house fly can complete its life cycle in as few as 7 days with 20 generations per year. The adult house fly is approximately 1/4 inch long and the female is larger than the male. Their eyes are red, and their thorax has four black stripes. House flies are attracted

to many types of food, but they are only able to consume liquids due to the sponge in their mouthparts. They are able to breakdown and liquefy solid foods with regurgitated saliva.



House Fly Life Stages - Clemson University - USDA Cooperative Extension Slide Series, Bugwood.org

Adults can live up to 2 months. They require food before copulation and the female will begin to lay eggs in as little as four days. The female requires a protein source for egg production. Adult flies are inactive at night and will rest near the ceilings of indoor spaces and aggregate in trees and shrubs in outdoor areas.

The eggs are small and laid individually in small groups of 75-100 eggs. It is typical for several flies to lay eggs close to one another which could lead to large groups of larvae and pupae. The eggs will hatch 12-24 hours after being laid.

Larvae are commonly referred to as maggots. They do very well in substrates like manure which is full of nutrients and moisture. They are cream colored and go through three instars before pupating. The larvae can grow in as little as four days given the right environmental conditions. Mature larvae will find a dry space away from their growth media to pupate.

The pupal stage develops in a hard case that is formed from the last larval skin and the case darkens as the pupae matures. The pupae can develop in as little as 2 days and can take up to 27 days at cooler temperatures. In an ideal situation two or more generations can grow in a month. These flies can overwinter as larvae and pupae in manure piles or other protected areas.

Mosquitoes



Aedes albopictus - Susan Ellis, Bugwood.org

Introduction

Mosquitoes belong to the order Diptera which are considered true flies. Mosquitoes are close relatives to other true fly species including the housefly. Mosquitoes are well established across virtually every habitat and climate on the planet, from the tropics to the arctic.

They are a major nuisance and public health pests because they spread many of the most important human pathogens including the causal agents of malaria, yellow fever, encephalitis, dengue, and filariasis. Most of these diseases have been eradicated in the U.S. with the institution

of mosquito control practices. There are approximately 150 species of mosquitoes found in the U.S. but only a few are important for their role in disease transmission.

Like other true flies, mosquitoes possess only a single pair of wings. They can be easily distinguished from their close relatives by their long proboscis that is used to blood feed. Male mosquitoes do not feed on blood because their mouthparts are not adapted for this purpose. Male mosquitoes will normally feed on plant juice and nectar. Most adult female mosquitoes require a blood meal before they can lay eggs.

Mosquitoes are holometabolous and have distinct egg, larval, pupal and adult life stages. Female mosquitoes will lay eggs on the surface of water or close to the water's edge where they will eventually come into contact with water after a flood. Eggs can be laid singly or glued together in a group to form a raft.



Culex pipiens Laying Eggs in a Raft - Susan Ellis, Bugwood.org

The larvae will hatch a short time after being laid or coming into contact with floodwater. Most larvae need to surface frequently to breathe air, but some species have adapted ways to gather oxygen underwater from plants. Larvae develop through four instars and after the last molt they will become pupae.



Mosquito Larvae - Jim Occi, BugPics, Bugwood.org

Mosquito pupae do not feed but they are capable of tumbling away from danger or predators.

They breathe through small tubes at the top of their head and after one or two days they will shed their skin and an adult will emerge at the water surface.



Adult Mosquito Emerging - John C. French Sr., Retired, Universities Auburn, GA, Clemson and U of MO, Bugwood.org

Aedes aegypti



Aedes aegypti Proboscis - Pest and Diseases Image Library , Bugwood.org

Aedes aegypti, commonly referred to as the yellow fever mosquito, originated in Africa and was brought to the United States on European ships used for exploring and colonizing the new world. It is the primary vector for yellow fever which is a disease in tropical regions of Africa and South America. *Aedes aegypti* is found in 23 states across the southern US and up the east coast to New York. Some areas saw a sharp decline in yellow fever mosquito populations as the Asian tiger mosquito invaded many habitats. The yellow fever mosquito can be found in tropical and sub-tropical regions across the globe. They are an important vector because they are well established in places that are heavily urbanized and are known as container breeders. They will breed in virtually any man-made water filled container like flowerpots, tires, swimming pools,

and drainage ditches. It is important to empty any water storing containers that can be found near a property to reduce breeding sites.

The *Aedes aegypti* mosquito is a small to medium sized mosquito with white markings that resemble a violin. The female is larger than the male and is also capable of blood feeding. The male is only capable of nectar feeding.

Like all mosquitoes, *Aedes aegypti*, undergoes complete metamorphosis with a distinct egg, larva, pupa, an adult stage. The female mosquito lays her eggs in damp areas where the eggs will eventually become flooded. She will lay up to 200 eggs at varying distances above the waterline and will also lay them in different areas to give them a better chance of eventually contacting water. The eggs can dry out for several months until the area becomes flooded.

Aedes aegypti larvae will breathe through a tube located at their posterior end while hanging upside down at the water surface. Their diet consists of primarily algae and microscopic organisms. They will pass through four instars in as few as four days if the temperature is warm but could remain in the larval stage up to four months in colder weather. The mosquito pupae do not feed but they are mobile and will tumble away from danger if threatened. The adult will emerge from the pupal case in a day or two after pupating. Adults are active during the day and are the primary vectors for important diseases like dengue hemorrhagic fever, chikungunya, and zika.

Culex quinquefasciatus



Culex quinquefasciatus - Pest and Diseases Image Library , Bugwood.org

Culex quinquefasciatus is also known as the southern house mosquito. This species can be found in subtropical regions of the United States. *Culex quinquefasciatus* will also mate with *Culex pipiens* in an area called the hybrid zone. The two produce viable offspring that are considered a subspecies. *Culex quinquefasciatus* is found not only in North America but they can be found in South America, Australia, Asia, Africa, the Middle East, and New Zealand.

Culex quinquefasciatus are roughly 3/16th inches long and light brown in color. Gravid females are active during the night and will lay their eggs on standing water that can be found in any

typical container found around a home. Females will lay a group of 100 or more eggs that are cemented together and float on the surface of the water like a raft.

The eggs will hatch in as little as 24 hours after being laid. Larvae feed on microscopic organisms in the water and can take as little as five days to develop. The larvae will go through four instars before they pupate. Pupae are dark, comma shaped, and do not feed. Adults will emerge from the pupal skin in a little more than a day. Both males and females will eat sugar found in plants. The female also needs a blood meal from a mammal or bird for egg development.

Anopheles quadrimaculatus



Bloodfeeding *Anopheles quadrimaculatus* - Copyright © 2006 Sean McCann

Anopheles quadrimaculatus is referred to as the common malaria mosquito because it was the primary vector for malaria in the United States before malaria was eradicated in the 1950s.

Anopheles quadrimaculatus is also known to transmit dog heartworm, Cache Valley virus, and eastern equine encephalitis.

These mosquitoes can be found throughout the eastern United States up to southern Canada and down to parts of Mexico. The largest concentration of *Anopheles quadrimaculatus* is found in the southeastern United States.

Anopheles quadrimaculatus are very dark in color and have four darker spots on their wings. They are easy to identify when they are taking a blood meal because of the way that they sit on the skin. They have four distinct life stages: egg, larva, pupa, and adult. The eggs larvae and pupae are all found in the water. In the right conditions it can take as little as five days to go from egg to adult.

Females will lay eggs individually on water. The eggs are equipped with specialized floats on two sides. The eggs will hatch a couple days after being laid. First instar larvae will emerge from the egg and they will spend most of their days lying flat horizontally across the surface of the water where they filter feed. They lay this way because they do not have a breathing tube at the end of their abdomen like many other mosquito species so they must absorb oxygen through special hairs on their abdomen. The larvae will go through four instars before becoming pupae. The pupae do not feed and are mobile if they need to move away from predators.

An adult will emerge from the pupal case and begin to fly soon after. Adult males and females will feed on sugar and nectar from plants. The females require a blood meal in order to lay eggs. Females are active and feed at night on many types of mammals but prefer cattle, deer, horses, rabbits, and dogs.

Anopheles quadrimaculatus are most active during the summer because of the slower development during the winter. Adult fertilized females can overwinter in colder climates and will begin seeking a blood meal in the spring.

Ticks

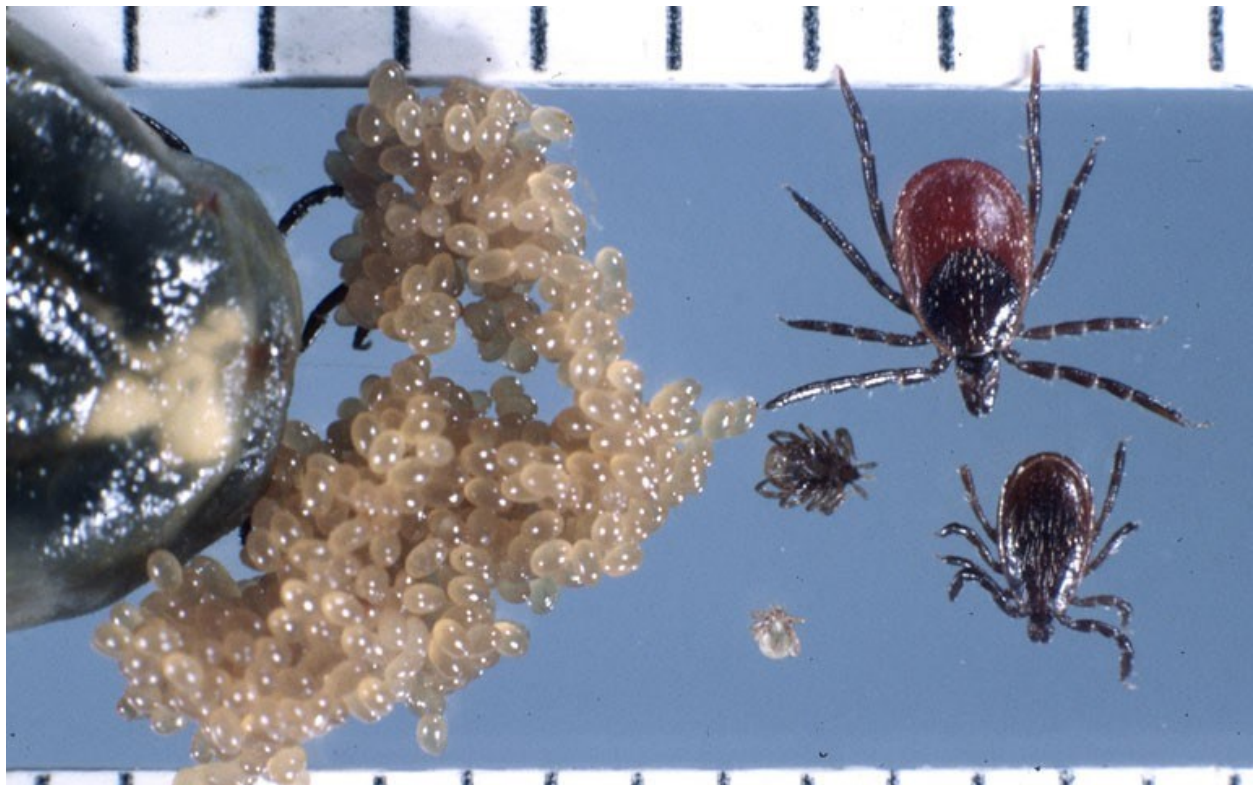


Adult Deer Tick - Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Introduction

Ticks are arachnids in the order Acarina and are very closely related to mites although they are much larger. All ticks feed on vertebrate blood and most of the ticks we are concerned with belong to two families, hard ticks and soft ticks.

Ticks have a four-stage life cycle with egg, larva, nymph and adult. Ticks will usually mate while they are living on an animal and the female will drop off to lay eggs in the ground. Female hard ticks feed once and can lay as many as 10,000 eggs. Soft ticks will feed several times and lay a smaller clutch of eggs. Larvae will hatch from eggs in as little as two weeks in the right conditions.



Tick Life Stages - Jim Occi, BugPics, Bugwood.org

A tick's first larval stage is referred to as a seed tick. These young ticks have only six legs and must find a host to obtain a blood meal. Larvae are able to go long periods of time without feeding if they can't find a suitable host. After the blood meal they will drop to the ground and molt into a nymph.

Nymphs look much like the adult as both have eight legs. However, the nymphs are unable to mate, and they also have the ability to go without a blood meal for a long period of time. Hard ticks only have a single instar while soft ticks can have several. After the final instar they will become an adult.

Adult ticks will feed for several days before they reproduce. Male hard ticks will die soon after mating and female ticks die after laying their eggs.

Ticks will spend a great deal of their lives near the ground where they search for a suitable host. They are often seen questing, where they move to a higher area like tall grass, with their forelegs outstretched trying to grab a passing host.



Questing American Dog Tick - Jim Occi, BugPics, Bugwood.org

Deer Tick



Engorged Deer Tick - Scott Bauer, USDA Agricultural Research Service, Bugwood.org

The deer tick or blacklegged tick, *Ixodes scapularis*, is best known for its association with the spread of Lyme disease. The disease is caused by a spirochete that is carried by the tick and passed to humans through a bite. These ticks are found in the eastern part of the U.S., from Florida to Texas and Minnesota to Maine. The ticks prefer blood meals from white-tailed deer, so they are found in close proximity to white-tailed deer habitat.

Adult deer ticks are very small, and dark brown to black in color. Females are larger than males and are orange to red in color. Deer ticks are a three-host tick. The larvae, nymph, and adult will each feed on a different host as they develop. Eggs are typically laid beginning in May and six-legged larvae will begin to emerge in the summer months. The larvae search for a host and feed for several days before they drop off and overwinter in leaf litter. The following spring these

larvae will molt into a nymph, search for a host, feed for a few days, and fall from the host. The nymph will molt into an adult which becomes active in the fall months. The adult searches for a host, feeds for several days before falling off, and will lay eggs in the spring.



Deer Tick - Scott Bauer, USDA Agricultural Research Service, Bugwood.org

Brown Dog Tick



Brown Dog Tick - Charles Olsen, USDA APHIS PPQ, USDA APHIS PPQ, Bugwood.org

The brown dog tick, *Rhipicephalus sanguineus*, is considered the most widespread species of tick and can be found in many parts of the world. Unlike most other ticks, brown dog ticks can complete their entire life cycle indoors. This allows them to infest kennels and homes in a wide range of climates, although warmer climates are preferred. Brown dog ticks prefer a canine blood meal but will feed on a variety of other hosts. The brown dog tick is the vector for many pathogens that cause diseases in dogs including canine ehrlichiosis and canine babesiosis. They can transmit rocky mountain spotted fever to humans.

Brown dog tick eggs are round and dark brown in color. The larvae have six legs and are approximately 1/4 inches long. Nymphs and adults look the same in appearance but the nymphs are smaller. They have eight pairs of legs and are red to brown in color with an elongated body. It is common for people to think that there are multiple tick species to blame for a brown dog tick infestation. This may be due to multiple life stages being present at the same time. Ticks can also look quite different when they are engorged with blood. Female body size can increase a hundred-fold after taking a blood meal.

The brown dog tick is considered a three-host tick, where each life stage feeds on a host before falling off and moving to the next stage. Their life cycle starts by mating on a host when stimulated by a blood meal. The female will feed on the host for a week and then fall off and find a suitable place for her eggs to incubate. She will begin laying the eggs a few days after falling off and will continue to lay them for up to 18 days. The female will coat the eggs with a special secretion that keeps the eggs from desiccating. The female will lay 4000 eggs on average, but some can lay up to 7000. The female dies soon after she finishes laying her eggs. The eggs will hatch in 6-23 days and the larvae will begin to look for a host. The larvae feed on the host for 5-15 days before falling off and molting into a nymph. The nymph will search for a host and blood feed for 3-13 days before falling off and molting into an adult. The adult will find a suitable host and begin the cycle over again. Brown dog ticks average two generations per year but development time is dependent on environmental factors including temperature, humidity, and host availability.

In the U.S. the primary hosts are dogs and they are required for the ticks to establish a large population. They tend to feed around the head, back, ears, and toes, so dog owners should check these areas on the dog to help prevent an infestation. Brown dog ticks will also feed on other

hosts if dogs are not around or removed. In other parts of the world the ticks are more likely to be found on other mammals and humans.

Lone Star Tick



Lone Star Tick Susan Ellis, USDA APHIS PPQ, Bugwood.org

The lone star tick, *Amblyomma americanum*, feeds on many host animals and humans. It is capable of transmitting several important pathogens. These ticks are found across many parts of the southern United States and are beginning to move northward. They can be found in many places where white-tailed deer are established.

Adult lone star ticks are brown and about as large as a dog tick. The female lone star tick has a white spot in the center of her back which gives the species its common name. Lone star ticks are three host ticks, where each stage, larva, nymph, and adult will feed on different hosts. After taking a blood meal the life stage will fall to the ground and molt or lay eggs.

The adult female tick will lay eggs several days after her blood meal and can lay approximately 5000 eggs near the ground. She looks for a substrate with high humidity and appropriate climate for her eggs. The eggs will hatch, and the larvae will rest for a period before searching for a host.

The life stages of lone star ticks will increase and peak at certain times of the year. Peak adult activity has been observed from May to July, nymphs from May to August, and larvae from July to September. In tropical regions of Florida there can be larvae, nymph, and adult stages active during most months of the year.

Wasps, Yellowjackets, and Hornets



Paper Wasp - Susan Ellis, Bugwood.org

Introduction

Wasps in the family Vespidae are considered the most dangerous species of stinging Hymenoptera. They can be identified by the way they hold their wings lengthwise and often parallel to the body when they are at rest.

This family of wasps are social insects that build nests from wood pulp mixed with saliva produced by the female wasp. In temperate regions a new colony is produced every year. Queens from a previous colony will leave the colony and overwinter in protected areas like tree bark, attics, and other sheltered places.

Queens emerge in early spring and find exposed areas of wood such as fences, siding on houses, or dead tree limbs where the bark has been removed. They chew the wood and combine the fibers with salivary secretions to create a paper-like nest. The queen will build her nest creating several cells where she will place an individual egg in each cell. After the egg hatches a larva will emerge and develop inside the cell. Early in the colony development the queen takes care of the entire nest. She will forage for food and bring it back to feed the larvae until they pupate. Larvae depend on food sources made of protein while adult wasps feed on liquids like nectar, honeydew, or liquid from the bodies of insects that are fed to the larvae.

The queen is the only adult that can produce eggs for the colony. Eventually female workers emerge from the cells. Adult female workers are sterile, but they are important because they build and maintain the nest, forage for food and water, and care for the brood.

Late in the summer the colony produces young queens that mate with adult males. These queens will leave the parent colony and overwinter as the parent colony dies off. Many overwintering

queens do not make it through a full winter but if they do survive, they will begin a new nest in the spring.



Paper Wasp Nest- David Cappaert, Bugwood.org

Queens are known to kill, attack, and replace other queens in the same species during early nest production in the spring season. Competition for habitat helps limit the number of new colonies in an area. Fluctuations in weather can also negatively impact wasp success. Yellow jackets can be negatively impacted by large amounts of rain that could decimate their underground nests. Wasp populations can also succumb to excess dryness, cold, and extreme overwintering conditions.

Paper Wasp



Paper Wasp (*Polistes carolina*) - Johnny N. Dell, Bugwood.org

Paper Wasps belong to the genus *Polistes* and build simple paper nests. The nests are considered simple because they consist of a single layer of cells that open downward and are not covered. The nests are usually found underneath the eaves of houses and other similar areas. The nests rarely grow larger than eight inches and usually have less than 200 workers.

The genus *Polistes* belongs to the subfamily Polistinae. There are 21 genera in the subfamily that inhabit the New World. *Polistes* is the most common genus in North America with 17 species located in warmer areas of the continent and they can be found in many places across the United States.

Paper wasps have a long slender body shape and are colored brown to red with some yellow markings. Paper wasps build their nests from wood mixed with saliva and press it into fine layers resembling paper. Hexagon shaped cells are arranged in a single layer with the openings toward the ground. The queen is the only reproductive individual and she is larger than the sterile female workers. Female workers leave the nest in search of food, water, and nest building materials. Typical food sources are immature insects like small caterpillars, cicadas, and beetle larvae.



Paper Wasps Nest - Ward Upham, Kansas State University, Bugwood.org

Many inseminated females from the same brood can overwinter together in sheltered areas. In the spring, the queen, also called the foundress, may start a new colony with her sisters that will become subordinate foundresses. They will temporarily fill the roles of workers, suppress ovary development, and become non-reproductive. If the primary queen should die, then one of the sister queens can become reproductive again. In this case, the arrival of subordinate queens to the

nest determines the order of succession. The second to the nest will become the second in command and will overtake greater responsibility for the colony if the foundress dies. They will then be able to have fully functioning ovaries and begin to reproduce.

A foundress will mate only one time and store sperm in her spermatheca. The spermatheca is a reproductive storage organ. She will lay eggs in worker cells and these eggs receive limited amounts of nutrition. Workers mature near the end of the fall. Queens then lay unfertilized eggs which develop into males. Fertilized eggs will receive adequate nutrition and become future foundresses. Males will mate with foundresses of other nests and only rarely with those of the same nest. Males will then die off as the foundresses overwinter.

Paper wasps are considered to be beneficial insects as they can help pollinate plant crops and prey on plant damaging pests. Although they could benefit gardeners, they are not reared to aid in these activities. They tend to build nests around homes, but they are not very aggressive. Homeowners usually believe that they are at risk of stings if a nest goes unchecked.

Yellowjacket



Eastern Yellowjacket (*Vespula maculifrons*) - Jon Yuschock, Bugwood.org

Yellowjackets are a genus of wasp that build their nests below ground and workers can be seen exiting a hole at the soil surface. The nests are usually started in a hole in the ground like an empty animal borough. The colony will fill the cavity and can enlarge the hole as the colony grows. Yellowjackets can also build nests in wall voids or other areas around a structure but tend to stay near ground level. In warmer climates, nests can become very large and colonies can grow to several thousand workers in a single season and can survive for more than a year.

Yellowjacket species forage for many types of food to bring back to the colony. Some species will feed on live prey, but other species will forage for meat that can be found in garbage or camping areas. New queens are produced by the colony in late summer and this is when the demand for carbohydrates increases. Yellow jackets can be observed feeding on sugary drinks late in the summer.

Single yellowjackets tend to ignore humans when foraging and stings usually happen by accident. Humans are usually stung when they disturb a nest. Many experts consider the yellowjacket to be the most dangerous social hymenopteran in the US because of their nesting and foraging behavior.



Eastern Yellowjacket Nest in Hay - Terry S. Price, Georgia Forestry Commission, Bugwood.org

Bald-Faced Hornet



Baldfaced Hornet - Johnny N. Dell, Bugwood.org

The bald-faced hornet, *Dolichovespula maculate*, is a large social wasp. This species is not considered a true hornet because it is not a member of the *Vespa* genus, so it is actually a yellowjacket. The bald-faced hornet receives its common name from the white markings on its face and is called a “hornet” because of its large size and the fact that it builds an aerial nest. In general, the term hornet is used for species that construct nests in places above the ground and yellowjacket is used to describe species that build subterranean nests.

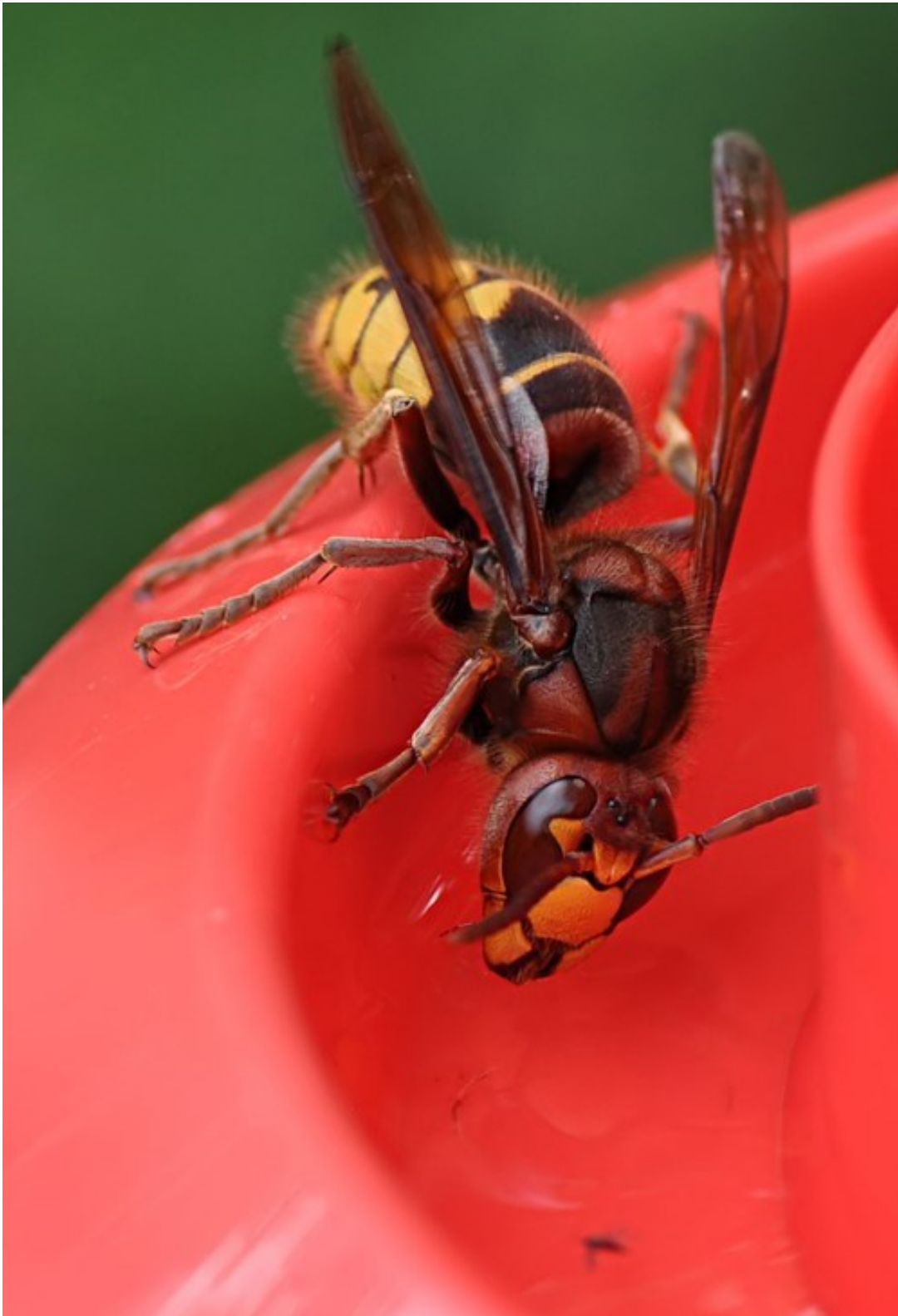
Bald-faced hornets build colonies that can grow very large and they can be found throughout the United States. They are black in color with three white stripes on their face. They range in size from 3/4 to 1 inch in length.

One of the most recognized social wasp nests are large, brown, inverted teardrop-shaped structures that can be found hanging from a tree. These nests are built by the bald-faced hornet. They chew wood pulp to create a paper material for nest construction. They build their nests in places that are high above the ground. The nest grows for several months and reach maximum size by the end of the summer. Nests can grow two feet tall and house a few hundred workers.



Baldfaced Hornets Nest - Jerry A. Payne, USDA Agricultural Research Service, Bugwood.org

Hornet



European Hornet - Jon Yuschock, Bugwood.org

Hornets are a group of wasps in the *Vespa* genus. The European hornet, *Vespa crabro germana*, is the only true hornet and largest paper wasp found in the United States. Its body is colored brown with orange markings. The species was first introduced along the East Coast, but it has moved to the midwestern states. This species does not build an exposed nest but prefers to build nests in places like wall voids, stumps, hollow logs, and natural cavities.

References:

Ants

- “Ants and Other Hymenopterous Pests- Chapter 10.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 229–244.
- Collins, Laura, and Rudolf H. Scheffrahn . *Red Imported Fire Ant - Solenopsis Invicta*, University of Florida, Dec. 2016, entnemdept.ufl.edu/creatures/urban/ants/red_imported_fire_ant.htm.
- Daugherty, Matt, and Kim Hung. “Argentine Ant.” *Argentine Ant (Linepithema Humile)*, University of California, Jan. 2020, cistr.ucr.edu/invasive-species/argentine-ant.
- Jacobs, Steve. *Odorous House Ant (Department of Entomology)*, The Pennsylvania State University, Jan. 2014, ento.psu.edu/extension/factsheets/odorous-house-ant.
- Nickerson, J. C., and D. L. Harris. *Pharaoh Ant - Monomorium Pharaonis (Linnaeus)*, University of Florida, Dec. 2017, entnemdept.ufl.edu/creatures/urban/ants/pharaoh_ant.htm.
- Nickerson, J. C. *Florida Harvester Ant - Pogonomyrmex Badius*, University of Florida, Dec. 2017, entnemdept.ufl.edu/creatures/urban/ants/harvester_ant.htm.
- Potter, Mike. *ENTFACT-603: Carpenter Ants*, University of Kentucky, Nov. 1997, entomology.ca.uky.edu/ef603.
- Rust, M. K., and D.-H. Choe. *Ants*, University of California Statewide IPM Program, Oct. 2012, ipm.ucanr.edu/PMG/PESTNOTES/pn7411.html.
- University of California. *Pharaoh Ant - Monomorium Pharaonis*, University of California, 2019, ipm.ucanr.edu/TOOLS/ANTKEY/pharaoh.html.
- Vitone, Tyler, and Andrea Lucky. *Pavement Ant - Tetramorium Caespitum (Linnaeus)*, University of Florida, Aug. 2017, entnemdept.ufl.edu/creatures/MISC/ANTS/pavement_ant.htm.

Bed Bugs

- “Bed Bugs and Other Blood-Feeding Bugs - Chapter 13.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 318–322.

Brooks, Shawn E. Brooks E. Brooks. *Bed Bug - Cimex Lectularius Linnaeus*, University of Florida, Apr. 2017, entnemdept.ufl.edu/creatures/urban/bed_bug.htm.

Sutherland, A. M., et al. *Bed Bugs*, University of California Statewide IPM Program, May 2013, ipm.ucanr.edu/PMG/PESTNOTES/pn7454.html.

Cockroaches

Barbara, Kathryn A. *American Cockroach - Periplaneta Americana (Linnaeus)*, University of Florida, Apr. 2017, entnemdept.ufl.edu/creatures/urban/roaches/american_cockroach.htm.

“Cockroaches - Chapter 7.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 145–157.

National Pest Management Association. *Cockroaches 101: Identifying Types of Cockroaches*, Mar. 2019, www.pestworld.org/news-hub/pest-articles/cockroaches-101/.

Sutherland, Andrew M., et al. *Cockroaches*, University of California Statewide IPM Program, Sept. 2019, ipm.ucanr.edu/PMG/PESTNOTES/pn7467.html.

Valles, Steven. *German Cockroach - Blattella Germanica (Linnaeus)*, University of Florida, Dec. 2017, entnemdept.ufl.edu/creatures/urban/roaches/german.htm.

Fleas

“Fleas, Ticks and Other Ectoparasites - Chapter 12.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 292–296.

Potter, Michael F. *Flea Control and Prevention*, University of Kentucky College of Agriculture, June 2018, entomology.ca.uky.edu/ef602.

Zentko, Diana C., and Dina L. Richman. *Cat Flea - Ctenocephalides Felis (Bouché)*, University of Florida, Jan. 2018, entnemdept.ufl.edu/creatures/urban/occas/catflea.htm.

House flies

“Flies and Mosquitoes - Chapter 14.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 332–337.

Sanchez-Arroyo, Hussein, and John L. Capinera. *House Fly - Musca Domestica Linnaeus*, University of Florida, Apr. 2017, entnemdept.ufl.edu/creatures/urban/flies/house_fly.HTM.

Mosquitoes

“Flies and Mosquitoes - Chapter 14.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 349–359.

Hill, Stephanie, and Roxanne Connelly. *Southern House Mosquito - Culex Quinquefasciatus Say*, June 2019, entnemdept.ufl.edu/creatures/aquatic/southern_house_mosquito.htm.

Rios, Leslie M., and C. Roxanne Connelly. *Common Malaria Mosquito - Anopheles Quadrimaculatus Say*, University of Florida, Oct. 2018, entnemdept.ufl.edu/creatures/aquatic/Anopheles_quadrimaculatus.htm.

Zettel, Catherine, and Phillip Kaufman. *Yellow Fever Mosquito - Aedes Aegypti (Linnaeus)*, University of Florida, Mar. 2019, entnemdept.ufl.edu/creatures/aquatic/aedes_aegypti.htm.

Ticks

“Fleas, Ticks and Other Ectoparasites - Chapter 12.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 300–304.

Holderman, Christopher J., and Phillip E. Kaufman. *Lone Star Tick - Amblyomma Americanum (Linnaeus)*, University of Florida, Nov. 2013, entnemdept.ufl.edu/creatures/urban/medical/lone_star_tick.htm.

Jacobs, Steve. *Four Common Ticks in Pennsylvania. (Department of Entomology)*, The Pennsylvania State University, July 2012, ento.psu.edu/extension/factsheets/ticks.

Patnaude, Michael R., and Thomas N. Mather. *Blacklegged Tick or Deer Tick - Ixodes Scapularis Say*, University of Florida, Dec. 2017, entnemdept.ufl.edu/creatures/urban/medical/deer_tick.htm.

Tian, Yuexun, et al. *Brown Dog Tick - Rhipicephalus Sanguineus Latreille*, University of Florida, Dec. 2018, entnemdept.ufl.edu/creatures/urban/medical/brown_dog_tick.htm.

Wasps and Hornets

“Ants and Other Hymenopterous Pests- Chapter 10.” *Truman's Scientific Guide to Pest Management Operations*, by Gary W. Bennett et al., 7th ed., Questex Media Group, LLC, 2010, pp. 256–260.

Grissell, E. E. *Yellowjackets and Hornets - Vespula - Dolichovespula*, University of Florida, Nov. 2013, entnemdept.ufl.edu/creatures/urban/occas/hornet_yellowjacket.htm.

Kaczor, Jessica. *Bald-Faced Hornet*, The Pennsylvania State University, 31 Aug. 2014, www.psu.edu/dept/nkbiology/naturetrail/speciespages/bald_faced_hornet.html.

Paulus, Lizzie, and Andrea Lucky. *Polistes Carolina, Paper Wasp, Red Wasp*, University of Florida, Nov. 2015, entnemdept.ufl.edu/creatures/MISC/WASPS/Polistes_carolina.htm.