

Ants and their Subfamilies

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First Edition, 2012

ISBN 978-81-323-4087-4

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Published by:

White Word Publications

4735/22 Prakashdeep Bldg,

Ansari Road, Darya Ganj,

Delhi - 110002

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Ant

Ants

Temporal range: 130–0 Ma
Cretaceous - Recent



Meat eater ant feeding on honey

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Suborder:	Apocrita
Superfamily:	Vespoidea
Family:	Formicidae Latreille, 1809

Subfamilies

- Aenictogitoninae
- Agroecomyrmecinae
- Amblyoponinae (incl. "Apomyrminae")
- Aneuretinae
- Cerapachyinae
- Dolichoderinae
- Ecitoninae (incl. "Dorylinae" and "Aenictinae")
- Ectatomminae
- Formicinae
- Heteroponerinae
- Leptanillinae
- Leptanilloidinae
- Martialinae
- Myrmeciinae (incl. "Nothomyrmeciinae")
- Myrmicinae
- Paraponerinae
- Ponerinae
- Proceratiinae
- Pseudomyrmecinae

Ants are social insects of the family **Formicidae** along with the related wasps and bees, belong to the order Hymenoptera. Ants evolved from wasp-like ancestors in the mid-Cretaceous period between 110 and 130 million years ago and diversified after the rise of flowering plants. More than 12,500 out of an estimated total of 22,000 species have been classified. They are easily identified by their elbowed antennae and a distinctive node-like structure that forms a slender waist.

Ants form colonies that range in size from a few dozen predatory individuals living in small natural cavities to highly organised colonies which may occupy large territories and consist of millions of individuals. These larger colonies consist mostly of sterile wingless females forming castes of "workers", "soldiers", or other specialised groups. Nearly all ant colonies also have some fertile males called "drones" and one or more fertile females called "queens". The colonies are sometimes described as superorganisms because the ants appear to operate as a unified entity, collectively working together to support the colony.

Ants have colonised almost every landmass on Earth. The only places lacking indigenous ants are Antarctica and a few remote or inhospitable islands. Ants thrive in most

ecosystems, and may form 15–25% of the terrestrial animal biomass. Their success in so many environments has been attributed to their social organisation and their ability to modify habitats, tap resources, and defend themselves. Their long co-evolution with other species has led to mimetic, commensal, parasitic, and mutualistic relationships.

Ant societies have division of labour, communication between individuals, and an ability to solve complex problems. These parallels with human societies have long been an inspiration and subject of study.

Many human cultures make use of ants in cuisine, medication and rituals. Some species are valued in their role as biological pest control agents. However, their ability to exploit resources brings ants into conflict with humans, as they can damage crops and invade buildings. Some species, such as the red imported fire ant, are regarded as invasive species, establishing themselves in areas where they are accidentally introduced.

Etymology

The word *ant* is derived from *ante* of Middle English which is derived from *æmette* of Old English and is related to the Old High German *āmeiza*, hence the modern German *Ameise*. All of these words come from West Germanic **amaitjo*, and the original meaning of the word was "the biter" (from Proto-Germanic **ai-*, "off, away" + **mait-* "cut"). The family name *Formicidae* is derived from the Latin *formīca* ("ant") from which the words in other Romance languages such as the Portuguese *formiga*, Italian *formica*, Spanish *hormiga*, Romanian *furnică* and French *fourmi* are derived. It has been hypothesized that a Proto-Indo-European word **morwi-* was used, cf. Sanskrit *vamrah*, Latin *formīca*, Greek *myrmex*, Old Church Slavonic *mraviji*, Old Irish *moirb*, Old Norse *maurr*.

Taxonomy and evolution



Ants fossilised in Baltic amber

The family Formicidae belongs to the order Hymenoptera, which also includes sawflies, bees and wasps. Ants evolved from a lineage within the vespoid wasps. Phylogenetic analysis suggests that ants arose in the mid-Cretaceous period about 110 to 130 million years ago. After the rise of flowering plants about 100 million years ago they diversified and assumed ecological dominance around 60 million years ago. In 1966, E. O. Wilson and his colleagues identified the fossil remains of an ant (*Sphecomyrma freyi*) that lived in the Cretaceous period. The specimen, trapped in amber dating back to more than 80 million years ago, has features of both ants and wasps. *Sphecomyrma* was probably a ground forager but some suggest on the basis of groups such as the Leptanillinae and Martialinae that primitive ants were likely to have been predators underneath the surface of the soil.

During the Cretaceous period, a few species of primitive ants ranged widely on the Laurasian super-continent (the northern hemisphere). They were scarce in comparison to

other insects, representing about 1% of the insect population. Ants became dominant after adaptive radiation at the beginning of the Tertiary period. By the Oligocene and Miocene ants had come to represent 20-40% of all insects found in major fossil deposits. Of the species that lived in the Eocene epoch, approximately one in ten genera survive to the present. Genera surviving today comprise 56% of the genera in Baltic amber fossils (early Oligocene), and 92% of the genera in Dominican amber fossils (apparently early Miocene).

Termites, though sometimes called *white ants*, are not ants and belong to the order Isoptera. Termites are actually more closely related to cockroaches and mantids. Termites are eusocial but differ greatly in the genetics of reproduction. The similar social structure is attributed to convergent evolution. Velvet ants look like large ants, but are wingless female wasps.

Distribution and diversity

Region	Number of species
Neotropics	2162
Nearctic	580
Europe	180
Africa	2500
Asia	2080
Melanesia	275
Australia	985
Polynesia	42

Ants are found on all continents except Antarctica, and only a few large islands such as Greenland, Iceland, parts of Polynesia and the Hawaiian Islands lack native ant species. Ants occupy a wide range of ecological niches, and are able to exploit a wide range of food resources either as direct or indirect herbivores, predators and scavengers. Most species are omnivorous generalists but a few are specialist feeders. Their ecological dominance may be measured by their biomass, and estimates in different environments suggest that they contribute 15-20% (on average and nearly 25% in the tropics) of the total terrestrial animal biomass, which exceeds that of the vertebrates.

Ants range in size from 0.75 to 52 millimetres (0.030–2.0 in), and vary in colour. Most ants are red or black, but a few species are green and some tropical species have a metallic lustre. More than 12,000 species are currently known (with upper estimates of about 22,000), with the greatest diversity in the tropics. Taxonomic studies continue to resolve the classification and systematics of ants. Online databases of ant species, including AntBase and the Hymenoptera Name Server, help to keep track of the known and newly described species. The relative ease with which ants can be sampled and studied in ecosystems has made them useful as indicator species in biodiversity studies.

Morphology

Ants are distinct in their morphology from other insects in having elbowed antennae, metapleural glands, and a strong constriction of their second abdominal segment into a node-like petiole. The head, mesosoma and metasoma or gaster are the three distinct body segments. The petiole forms a narrow waist between their mesosoma (thorax plus the first abdominal segment, which is fused to it) and gaster (abdomen less the abdominal segments in the petiole). The petiole can be formed by one or two nodes (the second alone, or the second and third abdominal segments).



Bull ant showing the powerful mandibles and the relatively large compound eyes that provide excellent vision.

Like other insects, ants have an exoskeleton, an external covering that provides a protective casing around the body and a point of attachment for muscles, in contrast to

the internal skeletons of humans and other vertebrates. Insects do not have lungs; oxygen and other gases like carbon dioxide pass through their exoskeleton through tiny valves called spiracles. Insects also lack closed blood vessels; instead, they have a long, thin, perforated tube along the top of the body (called the "dorsal aorta") that functions like a heart, and pumps haemolymph towards the head, thus driving the circulation of the internal fluids. The nervous system consists of a ventral nerve cord that runs the length of the body, with several ganglia and branches along the way reaching into the extremities of the appendages.

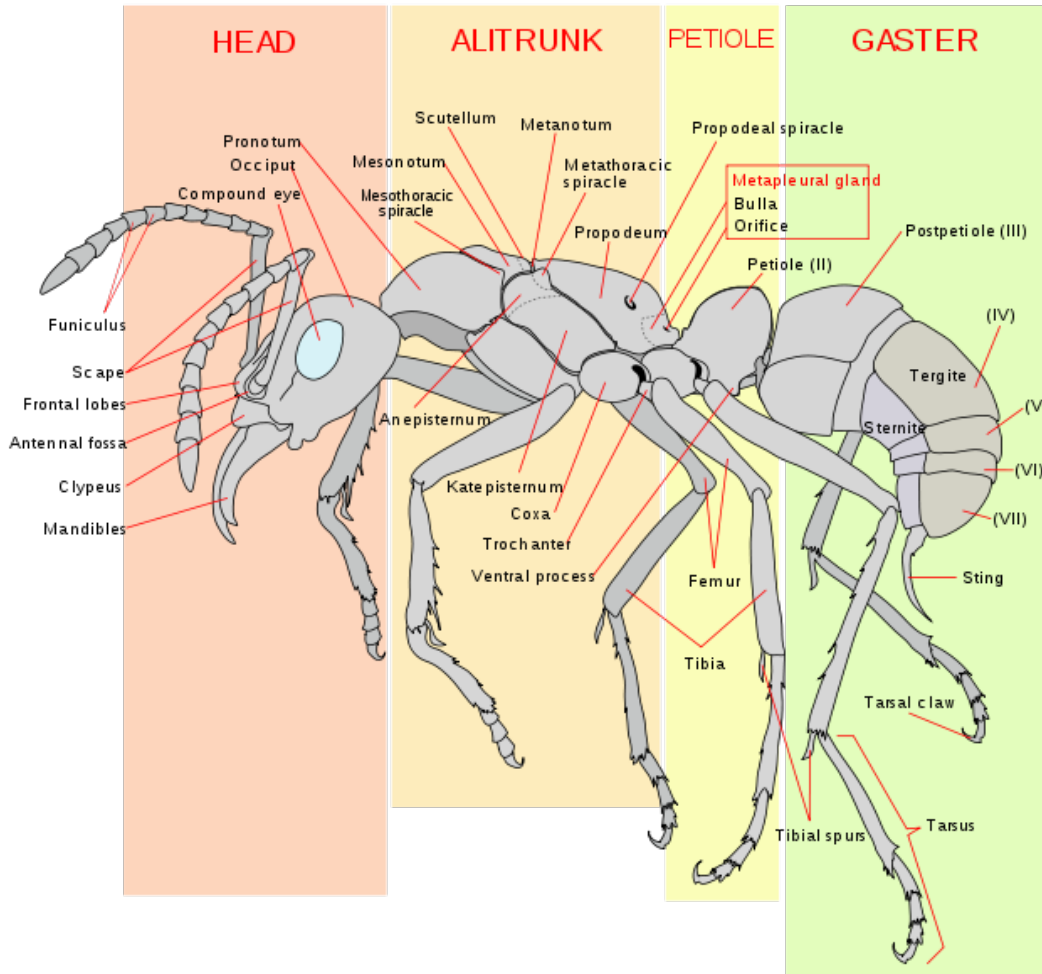


Diagram of a worker ant (*Pachycondyla verena*)

An ant's head contains many sensory organs. Like most insects, ants have compound eyes made from numerous tiny lenses attached together. Ants' eyes are good for acute movement detection but do not give a high resolution. They also have three small ocelli (simple eyes) on the top of the head that detect light levels and polarization. Compared to vertebrates, most ants have poor-to-mediocre eyesight and a few subterranean species are completely blind. Some ants such as Australia's bulldog ant, however, have exceptional vision. Two antennae ("feelers") are attached to the head; these organs detect chemicals,

air currents and vibrations; they are also used to transmit and receive signals through touch. The head has two strong jaws, the mandibles, used to carry food, manipulate objects, construct nests, and for defence. In some species a small pocket (infrabuccal chamber) inside the mouth stores food, so it can be passed to other ants or their larvae.

All six legs are attached to the mesosoma ("thorax"). A hooked claw at the end of each leg helps ants to climb and hang onto surfaces. Most queens and male ants have wings; queens shed the wings after the nuptial flight, leaving visible stubs, a distinguishing feature of queens. However, wingless queens (ergatoids) and males occur in a few species.

The metasoma (the "abdomen") of the ant houses important internal organs, including those of the reproductive, respiratory (tracheae) and excretory systems. Workers of many species have their egg-laying structures modified into stings that are used for subduing prey and defending their nests.

Polymorphism



Seven Leafcutter ant workers of various castes (left) and two Queens (right)

In the colonies of a few ant species, there are physical castes—workers in distinct size-classes, called minor, median, and major workers. Often the larger ants have disproportionately larger heads, and correspondingly stronger mandibles. Such individuals are sometimes called "soldier" ants because their stronger mandibles make them more effective in fighting, although they are still workers and their "duties" typically do not vary greatly from the minor or median workers. In a few species the median workers are absent, creating a sharp divide between the minors and majors.

Weaver ants, for example, have a distinct bimodal size distribution. Some other species show continuous variation in the size of workers. The smallest and largest workers in *Pheidologeton diversus* show nearly a 500-fold difference in their dry-weights. Workers cannot mate; however, because of the haplodiploid sex-determination system in ants, workers of a number of species can lay unfertilised eggs that become fully fertile haploid males. The role of workers may change with their age and in some species, such as honeypot ants, young workers are fed until their gasters are distended, and act as living food storage vessels. These food storage workers are called *repletes*. This polymorphism in morphology and behaviour of workers was initially thought to be determined by environmental factors such as nutrition and hormones which led to different developmental paths; however, genetic differences between worker castes have been noted in *Acromyrmex* sp. These polymorphisms are caused by relatively small genetic changes; differences in a single gene of *Solenopsis invicta* can decide whether the colony will have single or multiple queens. The Australian jack jumper ant (*Myrmecia pilosula*) has only a single pair of chromosomes (males have just one chromosome as they are haploid), the lowest number known for any animal, making it an interesting subject for studies in the genetics and developmental biology of social insects.

Development and reproduction



Meat eater ant nest during swarming

The life of an ant starts from an egg. If the egg is fertilised, the progeny will be female (diploid); if not, it will be male (haploid). Ants develop by complete metamorphosis with the larval stages passing through a pupal stage before emerging as an adult. The larva is

largely immobile and is fed and cared for by workers. Food is given to the larvae by trophallaxis, a process in which an ant regurgitates liquid food held in its crop. This is also how adults share food, stored in the "social stomach", among themselves. Larvae may also be provided with solid food such as trophic eggs, pieces of prey and seeds brought back by foraging workers and may even be transported directly to captured prey in some species. The larvae grow through a series of moults and enter the pupal stage. The pupa has the appendages free and not fused to the body as in a butterfly pupa. The differentiation into queens and workers (which are both female), and different castes of workers (when they exist), is influenced in some species by the nutrition the larvae obtain. Genetic influences and the control of gene expression by the developmental environment are complex and the determination of caste continues to be a subject of research. The developmental environment Larvae and pupae need to be kept at fairly constant temperatures to ensure proper development, and so are often moved around the various brood chambers within the colony.

A new worker spends the first few days of its adult life caring for the queen and young. It then graduates to digging and other nest work, and later to defending the nest and foraging. These changes are sometimes fairly sudden, and define what are called temporal castes. An explanation for the sequence is suggested by the high casualties involved in foraging, making it an acceptable risk only for ants that are older and are likely to die soon of natural causes.



Fertilised meat eater ant queen beginning to dig a new colony

Most ant species have a system in which only the queen and breeding females have the ability to mate. Contrary to popular belief, some ant nests have multiple queens while

others can exist without queens. Workers with the ability to reproduce are called "gamergates" and colonies that lack queens are then called gamergate colonies; colonies with queens are said to be queen-right. The winged male ants, called drones, emerge from pupae along with the breeding females (although some species, like army ants, have wingless queens), and do nothing in life except eat and mate. Most ants are univoltine, producing a new generation each year. During the species specific breeding period, new reproductives, winged males and females leave the colony in what is called a nuptial flight. Typically, the males take flight before the females. Males then use visual cues to find a common mating ground, for example, a landmark such as a pine tree to which other males in the area converge. Males secrete a mating pheromone that females follow. Females of some species mate with just one male, but in some others they may mate with anywhere from one to ten or more different males. Mated females then seek a suitable place to begin a colony. There, they break off their wings and begin to lay and care for eggs. The females store the sperm they obtain during their nuptial flight to selectively fertilise future eggs. The first workers to hatch are weak and smaller than later workers, but they begin to serve the colony immediately. They enlarge the nest, forage for food and care for the other eggs. This is how new colonies start in most species. Species that have multiple queens may have a queen leaving the nest along with some workers to found a colony at a new site, a process akin to swarming in honeybees.



Ants mating

A wide range of reproductive strategies have been noted in ant species. Females of many species are known to be capable of reproducing asexually through thelytokous parthenogenesis and one species, *Mycocepurus smithii* is known to be all-female.

Ant colonies can be long-lived. The queens can live for up to 30 years, and workers live from 1 to 3 years. Males, however, are more transitory, and survive only a few weeks. Ant queens are estimated to live 100 times longer than solitary insects of a similar size.

Ants are active all year long in the tropics but, in cooler regions, survive the winter in a state of dormancy or inactivity. The forms of inactivity are varied and some temperate species have larvae going into the inactive state (diapause), while in others, the adults alone pass the winter in a state of reduced activity.

Behaviour and ecology

Communication



Weaver ants collaborating to dismember a red ant (the two at the extremities are pulling the red ant, while the middle one cuts the red ant until it snaps).

Ants communicate with each other using pheromones. These chemical signals are more developed in ants than in other hymenopteran groups. Like other insects, ants perceive smells with their long, thin and mobile antennae. The paired antennae provide information about the direction and intensity of scents. Since most ants live on the ground, they use the soil surface to leave pheromone trails that can be followed by other ants. In species that forage in groups, a forager that finds food marks a trail on the way back to the colony; this trail is followed by other ants, these ants then reinforce the trail when they head back with food to the colony. When the food source is exhausted, no new trails are marked by returning ants and the scent slowly dissipates. This behaviour helps ants deal with changes in their environment. For instance, when an established path to a food source is blocked by an obstacle, the foragers leave the path to explore new routes.

If an ant is successful, it leaves a new trail marking the shortest route on its return. Successful trails are followed by more ants, reinforcing better routes and gradually finding the best path.

Ants use pheromones for more than just making trails. A crushed ant emits an alarm pheromone that sends nearby ants into an attack frenzy and attracts more ants from further away. Several ant species even use "propaganda pheromones" to confuse enemy ants and make them fight among themselves. Pheromones are produced by a wide range of structures including Dufour's glands, poison glands and glands on the hindgut, pygidium, rectum, sternum and hind tibia. Pheromones are also exchanged mixed with food and passed by trophallaxis, transferring information within the colony. This allows other ants to detect what task group (*e.g.*, foraging or nest maintenance) other colony members belong to. In ant species with queen castes, workers begin to raise new queens in the colony when the dominant queen stops producing a specific pheromone.

Some ants produce sounds by stridulation, using the gaster segments and their mandibles. Sounds may be used to communicate with colony members or with other species.

Defence



A *Plectroctena* sp attacks another of its kind to protect its territory

Ants attack and defend themselves by biting and, in many species, by stinging, often injecting or spraying chemicals like formic acid. Bullet ants (*Paraponera*), located in Central and South America, are considered to have the most painful sting of any insect,

although it is usually not fatal to humans. This sting is given the highest rating on the Schmidt Sting Pain Index. The sting of Jack jumper ants can be fatal, and an antivenom has been developed. Fire ants, *Solenopsis* spp., are unique in having a poison sac containing piperidine alkaloids. Their stings are painful and can be dangerous to hypersensitive people.



A weaver ant in fighting position, mandibles wide open

Trap-jaw ants of the genus *Odontomachus* are equipped with mandibles called trap-jaws, which snap shut faster than any other predatory appendages within the animal kingdom. One study of *Odontomachus bauri* recorded peak speeds of between 126 and 230 km/h (78 - 143 mph), with the jaws closing within 130 microseconds on average. The ants were also observed to use their jaws as a catapult to eject intruders or fling themselves backwards to escape a threat. Before the strike, the ant opens its mandibles extremely widely and locks them in this position by an internal mechanism. Energy is stored in a thick band of muscle and explosively released when triggered by the stimulation of sensory hairs on the inside of the mandibles. The mandibles also permit slow and fine movements for other tasks. Trap-jaws are also seen in the following genera: *Anochetus*, *Orectognathus*, and *Strumigenys*, plus some members of the Dacetini tribe, which are viewed as examples of convergent evolution. A Malaysian species of ant in the *Camponotus cylindricus* group has enlarged mandibular glands that extend into their gaster. When disturbed, workers rupture the membrane of the gaster, causing a burst of secretions containing acetophenones and other chemicals that immobilise small insect attackers. The worker subsequently dies. Suicidal defences by workers are also noted in a Brazilian ant *Forelius pusillus* where a small group of ants leaves the security of the nest after sealing the entrance from the outside each evening.



Ant mound holes prevent water from entering the nest during rain

In addition to defence against predators, ants need to protect their colonies from pathogens. Some worker ants maintain the hygiene of the colony and their activities include undertaking or *necrophory*, the disposal of dead nest-mates. Oleic acid has been identified as the compound released from dead ants that triggers necrophoric behaviour in *Atta mexicana* while workers of *Linepithema humile* react to the absence of characteristic chemicals (dolichodial and iridomyrmecin) present on the cuticle of their living nestmates.

Nests may be protected from physical threats such as flooding and over-heating by elaborate nest architecture. Workers of *Cataulacus muticus*, an arboreal species that lives in plant hollows, respond to flooding by drinking water inside the nest, and excreting it outside. *Camponotus anderseni* which nests in the cavities of wood in mangrove habitats deals with submergence under water by switching to anaerobic respiration.

Learning

Many animals can learn behaviours by imitation but ants may be the only group apart from mammals where interactive teaching has been observed. A knowledgeable forager of *Temnothorax albipennis* leads a naive nest-mate to newly discovered food by the process of tandem running. The follower obtains knowledge through its leading tutor. Both leader and follower are acutely sensitive to the progress of their partner with the

leader slowing down when the follower lags, and speeding up when the follower gets too close.

Controlled experiments with colonies of *Cerapachys biroi* suggest that individuals may choose nest roles based on their previous experience. An entire generation of identical workers was divided into two groups whose outcome in food foraging was controlled. One group was continually rewarded with prey, while it was made certain that the other failed. As a result, members of the successful group intensified their foraging attempts while the unsuccessful group ventured out less and less. A month later, the successful foragers continued in their role while the others moved to specialise in brood care.

Nest construction



Leaf nest of weaver ants, Pamalican, Philippines

Complex nests are built by many ants, but other species are nomadic and do not build permanent structures. Ants may form subterranean nests or build them on trees. These nests can be found in the ground, under stones or logs, inside logs, hollow stems or even acorns. The materials used for construction include soil and plant matter, and ants carefully select their nest sites; *Temnothorax albipennis* will avoid sites with dead ants, as these may indicate the presence of pests or disease. They are quick to abandon established nests at the first sign of threats.

The army ants of South America and the driver ants of Africa do not build permanent nests, but instead alternate between nomadism and stages where the workers form a temporary nest (bivouac) from their own bodies, by holding each other together.

Weaver ant (*Oecophylla* spp.) workers build nests in trees by attaching leaves together, first pulling them together with bridges of workers and then inducing their larvae to produce silk as they are moved along the leaf edges. Similar forms of nest construction are seen in some species of *Polyrhachis*.

Food cultivation



Myrmecocystus, honeypot ants, store food to prevent colony famine

Most ants are generalist predators, scavengers and indirect herbivores, but a few have evolved specialised ways of obtaining nutrition. Leafcutter ants (*Atta* and *Acromyrmex*) feed exclusively on a fungus that grows only within their colonies. They continually collect leaves which are taken to the colony, cut into tiny pieces and placed in fungal gardens. Workers specialise in tasks according to their sizes. The largest ants cut stalks, smaller workers chew the leaves and the smallest tend the fungus. Leafcutter ants are sensitive enough to recognise the reaction of the fungus to different plant material, apparently detecting chemical signals from the fungus. If a particular type of leaf is toxic to the fungus the colony will no longer collect it. The ants feed on structures produced by

the fungi called *gongylidia*. Symbiotic bacteria on the exterior surface of the ants produce antibiotics that kill bacteria that may harm the fungi.

Navigation

Foraging ants travel distances of up to 200 metres (700 ft) from their nest and usually find their way back using scent trails. Some ants forage at night. Day foraging ants in hot and arid regions face death by desiccation, so the ability to find the shortest route back to the nest reduces that risk. Diurnal desert ants (*Cataglyphis fortis*) use visual landmarks in combination with other cues to navigate. In the absence of visual landmarks, the closely related Sahara desert ant (*Cataglyphis bicolor*) navigates by keeping track of direction as well as distance travelled, like an internal pedometer that counts how many steps they take in each direction. They integrate this information to find the shortest route back to their nest. Several species of ants are able to use the Earth's magnetic field. Ants' compound eyes have specialised cells that detect polarised light from the Sun, which is used to determine direction. These polarization detectors are sensitive in the ultraviolet region of the light spectrum. In some army ant species, a group of foragers that get separated from the main column can sometimes turn back on themselves and form a circular ant mill. The workers may then run around continuously until they die of exhaustion.

Locomotion

Worker ants do not have wings and reproductive females lose their wings after their mating flights in order to begin their colonies. Therefore, unlike their wasp ancestors, most ants travel by walking. Some species are capable of leaping. For example, Jerdon's jumping ant (*Harpegnathos saltator*) is able to jump by synchronising the action of its mid and hind pairs of legs. There are several species of gliding ant including *Cephalotes atratus*; this may be a common trait among most arboreal ants. Ants with this ability are able to control the direction of their descent while falling.

Other species of ants can form chains to bridge gaps over water, underground, or through spaces in vegetation. Some species also form floating rafts that help them survive floods. These rafts may also have a role in allowing ants to colonise islands. *Polyrhachis sokolova*, a species of ant found in Australian mangrove swamps, can swim and live in underwater nests. Since they lack gills, they breathe in trapped pockets of air in the submerged nests.

Cooperation and competition



Meat-eater ants feeding on a cicada. Social ants cooperate and collectively gather food.

Not all ants have the same kind of societies. The Australian bulldog ants are among the biggest and most basal of ants. Like virtually all ants they are eusocial, but their social behaviour is poorly developed compared to other species. Each individual hunts alone, using its large eyes instead of its chemical senses to find prey.

Some species (such as *Tetramorium caespitum*) attack and take over neighbouring ant colonies. Others are less expansionist but just as aggressive; they invade colonies to steal eggs or larvae, which they either eat or raise as workers/slaves. Extreme specialists among these slave-raiding ants, such as the Amazon ants, are incapable of feeding themselves and need captured workers to survive. Captured workers of the enslaved species *Temnothorax* have evolved a counter strategy, destroying just the female pupae of the slave-making *Protomognathus americanus*, but sparing the males (who don't take part in slave-raiding as adults).



A worker *Harpegnathos saltator* (a jumping ant) engaged in battle with a rival colony's queen.

Ants identify kin and nestmates through their scent, which comes from hydrocarbon-laced secretions that coat their exoskeletons. If an ant is separated from its original colony, it will eventually lose the colony scent. Any ant that enters a colony without a matching scent will be attacked.

Parasitic ant species enter the colonies of host ants and establish themselves as social parasites; species like *Strumigenys xenos* are entirely parasitic and do not have workers, but instead rely on the food gathered by their *Strumigenys perplexa* hosts. This form of parasitism is seen across many ant genera, but the parasitic ant is usually a species that is closely related to its host. A variety of methods are employed to enter the nest of the host ant. A parasitic queen can enter the host nest before the first brood has hatched, establishing herself prior to development of a colony scent. Other species use

pheromones to confuse the host ants or to trick them into carrying the parasitic queen into the nest. Some simply fight their way into the nest.

A conflict between the sexes of a species is seen in some species of ants with the reproductives apparently competing to produce offspring that are as closely related to them as possible. The most extreme form involves the production of clonal offspring. An extreme of sexual conflict is seen in *Wasmannia auropunctata*, where the queens produce diploid daughters by thelytokous parthenogenesis and males produce clones by a process where a diploid egg loses its maternal contribution to produce haploid males that are clones of the father.

Relationships with other organisms



The spider *Myrmarachne plataleoides* (here a female) mimics weaver ants to avoid predators

Ants form symbiotic associations with a range of species, including other ant species, other insects, plants, and fungi. They are preyed on by many animals and even certain fungi. Some arthropod species spend part of their lives within ant nests, either preying on ants, their larvae and eggs, consuming the ants' food stores, or avoiding predators. These inquilines can bear a close resemblance to ants. The nature of this ant mimicry (myrmecomorphy) varies, with some cases involving Batesian mimicry, where the mimic reduces the risk of predation. Others show Wasmannian mimicry, a form of mimicry seen only in inquilines.



An ant collects honeydew from an aphid

Aphids and other hemipteran insects secrete a sweet liquid called honeydew when they feed on plant sap. The sugars in honeydew are a high-energy food source, which many ant species collect. In some cases the aphids secrete the honeydew in response to the ants' tapping them with their antennae. The ants in turn keep predators away and will move the aphids between feeding locations. On migrating to a new area, many colonies will take the aphids with them, to ensure a continued supply of honeydew. Ants also tend mealybugs to harvest their honeydew. Mealybugs can become a serious pest of pineapples if ants are present to protect mealybugs from their natural enemies.

Myrmecophilous (ant-loving) caterpillars of the family Lycaenidae (e.g., blues, coppers, or hairstreaks) are herded by the ants, led to feeding areas in the daytime, and brought inside the ants' nest at night. The caterpillars have a gland which secretes honeydew when the ants massage them. Some caterpillars produce vibrations and sounds that are perceived by the ants. Other caterpillars have evolved from ant-loving to ant-eating: these myrmecophagous caterpillars secrete a pheromone that makes the ants act as if the caterpillar is one of their own larvae. The caterpillar is then taken into the ants' nest where it feeds on the ant larvae.



An ant transporting an aphid

Fungus-growing ants that make up the tribe Attini, including leafcutter ants, cultivate certain species of fungus in the *Leucoagaricus* or *Leucocoprinus* genera of the Agaricaceae family. In this ant-fungus mutualism, both species depend on each other for survival. The ant *Allomerus decemarticulatus* has evolved a three-way association with the host plant *Hirtella physophora* (Chrysobalanaceae), and a sticky fungus which is used to trap their insect prey.

Lemon ants make devil's gardens by killing surrounding plants with their stings and leaving a pure patch of lemon ant trees (*Duroia hirsuta*). This modification of the forest provides the ants with more nesting sites inside the stems of the *Duroia* trees. Some trees have extrafloral nectaries that provide food for ants, which in turn protect the plant from herbivorous insects. Species like the bullhorn acacia (*Acacia cornigera*) in Central America have hollow thorns that house colonies of stinging ants (*Pseudomyrmex ferruginea*) that defend the tree against insects, browsing mammals, and epiphytic vines. Isotopic labelling studies suggest that plants also obtain nitrogen from the ants. In return, the ants obtain food from protein and lipid rich Beltian bodies. Another example of this type of ectosymbiosis comes from the *Macaranga* tree, which has stems adapted to house colonies of *Crematogaster* ants.

Many tropical tree species have seeds that are dispersed by ants. Seed dispersal by ants or myrmecochory is widespread and new estimates suggest that nearly 9% of all plant species may have such ant associations. Some plants in fire-prone grassland systems are particularly dependent on ants for their survival and dispersal as the seeds are transported

to safety below the ground. Many ant-dispersed seeds have special external structures, elaiosomes, that are sought after by ants as food. A convergence, possibly a form of mimicry, is seen in the eggs of stick insects. They have an edible elaiosome-like structure and are taken into the ant nest where the young hatch.



A Meat ant tending a common leafhopper nymph

Most ants are predatory and some prey on and obtain food from other social insects including other ants. Some species specialise in preying on termites (*Megaponera* and *Termitopone*) while a few Cerapachyinae prey on other ants. Some termites, including *Nasutitermes corniger*, form associations with certain ant species to keep away other predatory ant species. The tropical wasp *Mischocyttarus drewseni* coats the pedicel of its nest with an ant-repellant chemical. It is suggested that many tropical wasps may build their nests in trees and cover them to protect themselves from ants. Stingless bees (*Trigona* and *Melipona*) use chemical defences against ants. Army ants forage in a wide roving column attacking any animals in that path that are unable to escape. *Eciton burchellii* is the swarming ant most commonly attended by "ant-following" birds such as antbirds and woodcreepers.

Flies in the Old World genus *Bengalia* (Calliphoridae) prey on ants and are kleptoparasites, snatching prey or brood from the mandibles of adult ants. Wingless and legless females of the Malaysian phorid fly (*Vestigipoda myrmolarvoidea*) live in the nests of ants of the genus *Aenictus* and are cared for by the ants.

Fungi in the genera *Cordyceps* and *Ophiocordyceps* infect ants, causing them to climb up plants and sink their mandibles into plant tissue. The fungus kills the ant, grows on its remains, and produces a fruiting body. It appears that the fungus alters the behaviour of the ant to help disperse its spores in a microhabitat that best suits the fungus.

Strepsipteran parasites also manipulate their ant host to climb grass stems, to help the parasite find mates. A nematode (*Myrmeconema neotropicum*) that infects canopy ants (*Cephalotes atratus*) causes the black coloured gasters of workers to turn red. The parasite also alters the behaviour of the ant, and makes them carry their gasters high. The conspicuous red gasters are mistaken by birds for ripe fruits such as *Hyeronima alchorneoides* and eaten. The droppings of the bird are collected by other ants and fed to their young leading to the further spread of the nematode.



Spiders sometimes feed on ants

South American poison dart frogs in the genus *Dendrobates* feed mainly on ants, and the toxins in their skin may come from the ants. Several South American antbirds follow army ants to feed on the insects that are flushed from cover by the foraging ants. This behaviour was once considered mutualistic, but later studies show that it is instead kleptoparasitic, with the birds stealing prey. Birds indulge in a peculiar behaviour called anting that is as yet not fully understood. Here birds rest on ant nests, or pick and drop ants onto their wings and feathers; this may remove ectoparasites. Anteaters, pangolins and several marsupial species in Australia have special adaptations for living on a diet of ants. These adaptations include long, sticky tongues to capture ants and strong claws to break into ant nests. Brown bears (*Ursus arctos*) have been found to feed on ants, and

about 12%, 16%, and 4% of their faecal volume in spring, summer, and autumn, respectively, is composed of ants.

Relationship with humans



Weaver ants are used as a biological control for citrus cultivation in southern China

Ants perform many ecological roles that are beneficial to humans, including the suppression of pest populations and aeration of the soil. The use of weaver ants in citrus cultivation in southern China is considered one of the oldest known applications of biological control. On the other hand, ants can become nuisances when they invade buildings, or cause economic losses.

In some parts of the world (mainly Africa and South America), large ants, especially army ants, are used as surgical sutures. The wound is pressed together and ants are applied along it. The ant seizes the edges of the wound in its mandibles and locks in place. The body is then cut off and the head and mandibles remain in place to close the wound.

Some ants of the family Ponerinae have toxic venom and are of medical importance. The species include *Paraponera clavata* (*Tocandira*) and *Dinoponera* spp. (false *Tocandiras*) of South America and the *Myrmecia* ants of Australia.

In South Africa, ants are used to help harvest rooibos (*Aspalathus linearis*), which are small seeds used to make a herbal tea. The plant disperses its seeds widely, making manual collection difficult. Black ants collect and store these and other seeds in their nest, where humans can gather them *en masse*. Up to half a pound (200 g) of seeds can be collected from one ant-heap.

Although most ants survive attempts by humans to eradicate them, a few are highly endangered. These are mainly island species that have evolved specialized traits and include the critically endangered Sri Lankan relict ant (*Aneuretus simoni*) and *Adetomyrma venatrix* of Madagascar.

It has been estimated by E.O. Wilson that the total number of individual ants alive in the world at any one time is between one and ten quadrillion (short scale). According to this estimate, the total biomass of all the ants in the world is approximately equal to the total biomass of the entire human race.

As food



Roasted Ants in Colombia



Ant larvae on sale in Isaan, Thailand

Ants and their larvae are eaten in different parts of the world. The eggs of two species of ants are the basis for the dish in Mexico known as *escamoles*. They are considered a form of insect caviar and can sell for as much as USD 40 per pound (USD 90/kg) because they are seasonal and hard to find. In the Colombian department of Santander, *hormigas culonas* (roughly interpreted as "large-bottomed ants") *Atta laevigata* are toasted alive and eaten.

In areas of India, and throughout Burma and Thailand, a paste of the green weaver ant (*Oecophylla smaragdina*) is served as a condiment with curry. Weaver ant eggs and larvae as well as the ants themselves may be used in a Thai salad, *yum* (ยำ), in a dish called *yum khai mod daeng* (ยำไข่มดแดง) or red ant egg salad, a dish that comes from the Isaan or north-eastern region of Thailand. Saville-Kent, in the *Naturalist in Australia* wrote "Beauty, in the case of the green ant, is more than skin-deep. Their attractive, almost sweetmeat-like translucency possibly invited the first essays at their consumption by the human species". Mashed up in water, after the manner of lemon squash, "these ants form a pleasant acid drink which is held in high favor by the natives of North Queensland, and is even appreciated by many European palates".

In his *First Summer in the Sierra*, John Muir notes that the Digger Indians of California ate the tickly acid gasters of the large jet-black carpenter ants. The Mexican Indians eat the replete workers, or living honey-pots, of the honey ant (*Myrmecocystus*).

As pests



The tiny pharaoh ant is a major pest in hospitals and office blocks; it can make nests between sheets of paper

Some ant species are considered pests, and because of the adaptive nature of ant colonies, eliminating the entire colony is nearly impossible. Pest management is therefore a matter of controlling local populations, instead of eliminating an entire colony, and most attempts at control are temporary solutions.

Ants classified as pests include the pavement ant, yellow crazy ant, sugar ants, the Pharaoh ant, carpenter ants, Argentine ant, odorous house ants, red imported fire ant and European fire ant. Populations are controlled using insecticide baits, either in granule or liquid formulations. Bait is gathered by the ants as food and brought back to the nest where the poison is inadvertently spread to other colony members through trophallaxis.

Boric acid and borax are often used as insecticides that are relatively safe for humans. Bait may be broadcast over a large area to control species like the red fire ant that occupy large areas. Nests of red fire ants may be destroyed by following the ants' trails back to the nest and then pouring boiling water into it to kill the queen. This works in about 60% of the mounds and requires about 14 litres (3 imp gal; 4 US gal) per mound.

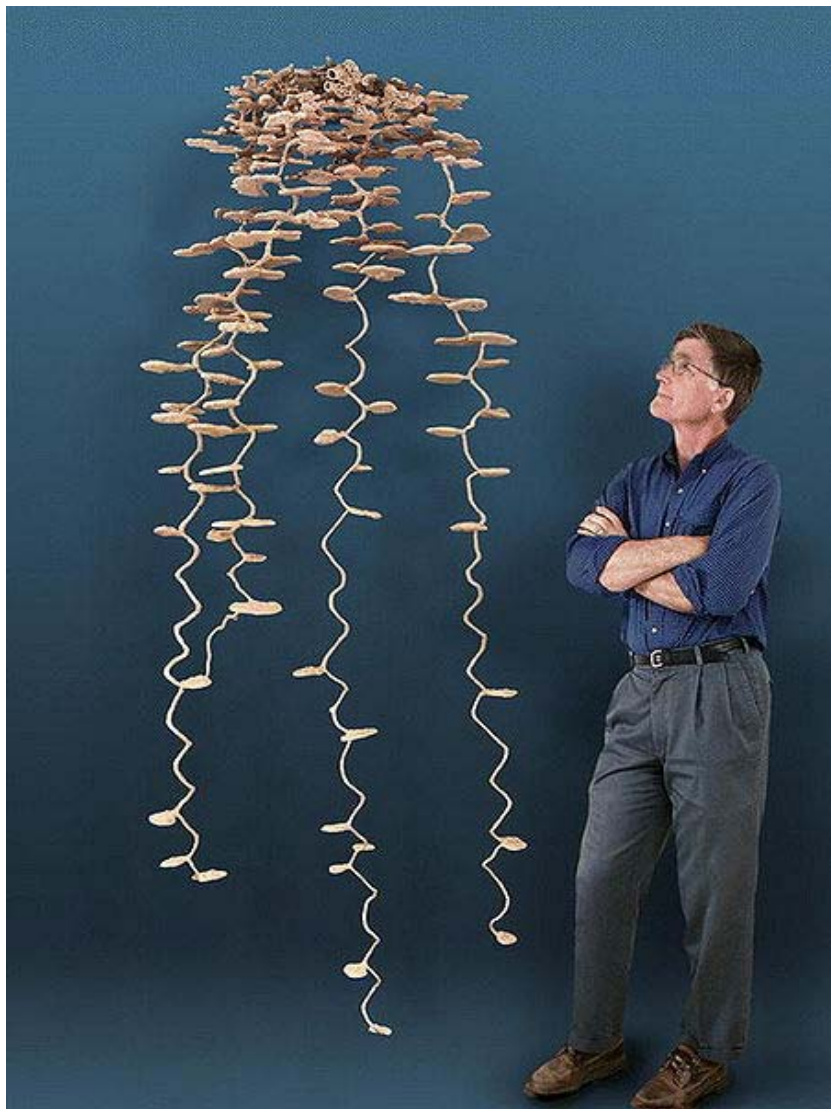
In science and technology

Myrmecologists study ants in the laboratory and in their natural conditions. Their complex and variable social structures have made ants ideal model organisms. Ultraviolet vision was first discovered in ants by Sir John Lubbock in 1881. Studies on ants have tested hypotheses in ecology, sociobiology and have been particularly important in examining the predictions of theories of kin selection and evolutionarily stable strategies. Ant colonies can be studied by rearing or temporarily maintaining them in formicaria, specially constructed glass framed enclosures. Individuals may be tracked for study by marking them with colours.

The successful techniques used by ant colonies have been studied in computer science and robotics to produce distributed and fault-tolerant systems for solving problems. This area of biomimetics has led to studies of ant locomotion, search engines that make use of "foraging trails", fault-tolerant storage and networking algorithms.

Chapter- 2

Ant Colony



A plaster cast of an ant nest



Ant hill and ant tracks, Oxley Wild Rivers National Park, NSW

An **ant colony** is an underground lair where ants live, breathe, eat and mate. Colonies consist of a series of underground chambers, connected to each other and the surface of the earth by small tunnels. There are rooms for nurseries, food storage, and mating. The colony is built and maintained by legions of worker ants, who carry tiny bits of dirt in their mandibles and deposit them near the exit of the colony, forming an ant-hill. Food carried in by workers is retrieved from the surrounding environment and can be traced from colony to colony by the use of isotopes.

Ant colonies are eusocial, and are very much like those found in other social Hymenoptera, though the various groups of these developed sociality independently through convergent evolution. Eggs are laid by one or sometimes more queens. Queens

are different in structure; they are the largest ants of the colony as a consequence of their egg-laying. Most of the eggs that are laid by the queens grow up to become wingless, sterile females called "workers". Periodically, swarms of new winged queens and males (the alates) are produced in most species, which leave to mate. The males die shortly thereafter, while the surviving queens either found new colonies or occasionally return to their old one. The surviving queens can live up to around 21 years.

People raise ant colonies in captivity for research and as a hobby. An "ant terrarium" used for this purpose is called a formicarium. They are often made thin enough that one can see the entire colony inside their nest. These are also called ant farms.

Unicoloniality and supercolonies

Most commonly, ants from different nests exhibit aggression toward each other. However, some ants exhibit the phenomenon called unicoloniality, where worker ants freely mix between different nests. A group of nests where ants do not exhibit mutual aggression is known as a supercolony — this form of organization is known as supercoloniality, and ants from different supercolonies of the same species do exhibit mutual aggression. Populations in supercolonies do not necessarily span a contiguous area.

Until 2000, the largest known ant supercolony was on the Ishikari coast of Hokkaidō, Japan. The colony was estimated to contain 306 million worker ants and one million queen ants living in 45,000 nests interconnected by underground passages over an area of 2.7 km² (670 acres). In 2000, an enormous supercolony of Argentine ants was found in Southern Europe (report published in 2002). Of 33 ant populations nested along the 6,004-kilometre (3,731 mi) stretch along the Mediterranean and Atlantic coasts in Southern Europe, 30 belonged to one supercolony with estimated millions of nests and billions of workers, interspersed with three populations of another supercolony. The researchers claim that this case of unicoloniality cannot be explained by loss of their genetic diversity due to the genetic bottleneck of the imported ants. In 2009, it was demonstrated that the largest Japanese, Californian and European Argentine ant supercolonies were in fact part of a single global "megacolony".

Another supercolony, measuring approximately 100 km (62 mi) wide, was found beneath Melbourne, Australia in 2004.

Ant-hills



A clay ant hill



A giant ant hill in Zambia

An *ant-hill*, in its simplest form, is a pile of earth, sand, pine needles, or clay or a composite of these and other materials that build up at the entrances of the subterranean dwellings of ant colonies as they are excavated. A colony is built and maintained by legions of worker ants, who carry tiny bits of dirt and pebbles in their mandibles and deposit them near the exit of the colony. They normally deposit the dirt or vegetation at the top of the hill to prevent it from sliding back into the colony, but in some species they actively sculpt the materials into specific shapes, and may create nest chambers within the mound.

In some areas of the world including English-speaking countries of Africa, in common speech the term *ant-hill* (also written as "anthill") refers to a termite mound. Note that termites are not ants.

Giant ant hills like the one on the right found in Zambia are often used to make clay bricks as the clay in the anthills is above the surface which saves time digging large holes in the ground to get to it. They are built by termites which are photosensitive so it is safe to dig into their hills without them attacking anyone.

Chapter- 3

Sri Lankan Relict Ant and Dolichoderinae

Sri Lankan relict ant



Conservation status



Critically Endangered (IUCN 2.3)

Scientific classification

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta
Order: Hymenoptera
Family: Formicidae
Subfamily: Aneuretinae
Genus: *Aneuretus*
Species: *A. simoni*

Binomial name

Aneuretus simoni

Emery, 1893

The **Sri Lankan relict ant** (*Aneuretus simoni*) is a species of evolutionarily ancient ant that is placed in a separate tribe of its own within the Formicidae family. The genus is monotypic, with the only species endemic to Sri Lanka where it is known from just a few locations. It is one of the few ant species that are considered endangered.



A winged queen

The species is the only extant genus in the tribe Aneuretini (other members include the extinct *Protaneuretus*, *Paraneretus* and *Mianeuretus*). They are believed to be intermediate in their phylogenetic position between the Myrmeciinae-Ponerinae and the Dolichoderinae. The workers show very distinct dimorphism with "majors" being much larger than the "minors" and lacking few workers intermediate in size. The minor workers are found in the largest numbers within a nest and have a small compound eye having only about 30 ommatidia (units within the compound eye). The antennae have 12 segments with the segments increasing gradually in size from the base to the tip. The clypeus is broad and flat, lacking any central ridge. The mouthparts show Dolichoderine affinities. There are outward facing spines on the propodeum. The petiole node is separated from the anterior peduncle by swellings on the sides and tops. They have a well developed sting that is similar in structure to that of the Dolichoderinae. Workers are yellow to orange coloured and the surface has striations running transversely. The queen is larger than the major and has reduced propodeal spines and a much broader head than the major worker. The pupae are characteristic in being enclosed in cocoons. They are predatory and forage mainly on the ground in leaf-litter. Major workers are rare and there

are at the most two per colony. The social organization of the colony was found to be similar to that of the Dolichoderinae.

They are known from only a few areas in central Sri Lanka. In Gilimale forest, E O Wilson and other researchers found that the colonies were mainly at the edge of forest clearings. The nests are small and have only a small number of individuals, ranging from two to a hundred. The nests are most often made mainly within rotting and crumbly wood pieces or logs fallen on the ground. The few areas in which they live are often disturbed by humans. The species has not been recorded in many of the areas where it was formerly collected and it was recommended for conservation by E O Wilson. A study in 1985 recorded the species at just one location, Gilimale.

"Twenty years later one of my undergraduate students, Anula Jayasuriya, a native Sri Lankan, found the species rare or absent in the same localities. I recommended placement of *Aneuretus simoni* in the Red Data Book of the International Union for Conservation of Nature and Natural Resources, and in time it became one of the first of several ants to be officially classified as a threatened or endangered species."

– E O Wilson, 1994

Dolichoderinae

Dolichoderinae



Iridomyrmex purpureus feeding on honey

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Family:	Formicidae
Subfamily:	Dolichoderinae

Diversity

24 genera

Dolichoderinae is a subfamily of ants, which includes species such as the Argentine ant (*Linepithema humile*), the erratic ant, the odorous house ant, and the cone ant. This subfamily is distinguished by having a single petiole (no post-petiole) and a slit-like orifice, rather than the round acidopore encircled by hairs that typifies the subfamily Formicinae. Dolichoderine ants do not possess a sting, unlike ants in some other subfamilies, such as Ponerinae and Myrmicinae.

This subfamily is not currently divided into tribes, but there are 24 genera.

Genera

- *Amyrmex*
- *Anillidris*
- *Anonychomyrma*
- *Axinidris*
- *Azteca*
- *Bothriomyrmex*
- *Doleromyrma*
- *Dolichoderus*
- *Dorymyrmex*
- *Ecphorella*
- *Forelius*
- *Froggattella*
- *Gracilidris*
- *Iridomyrmex*
- *Leptomyrmex*
- *Linepithema*
- *Liometopum*
- *Loweriella*
- *Ochetellus*
- *Papyrius*
- *Philidris*
- *Tapinoma*
- *Technomyrmex*
- *Turneria*

Chapter- 4

Ecitoninae and Formicinae

Ecitoninae

Ecitoninae



Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Subphylum:	Hexapoda
Class:	Insecta
Order:	Hymenoptera
Suborder:	Apocrita
Superfamily:	Vespoidea
Family:	Formicidae
Subfamily:	Ecitoninae

Tribes

Cheliomyrmecini
Dorylini (incl. Aenictini)
Ecitonini

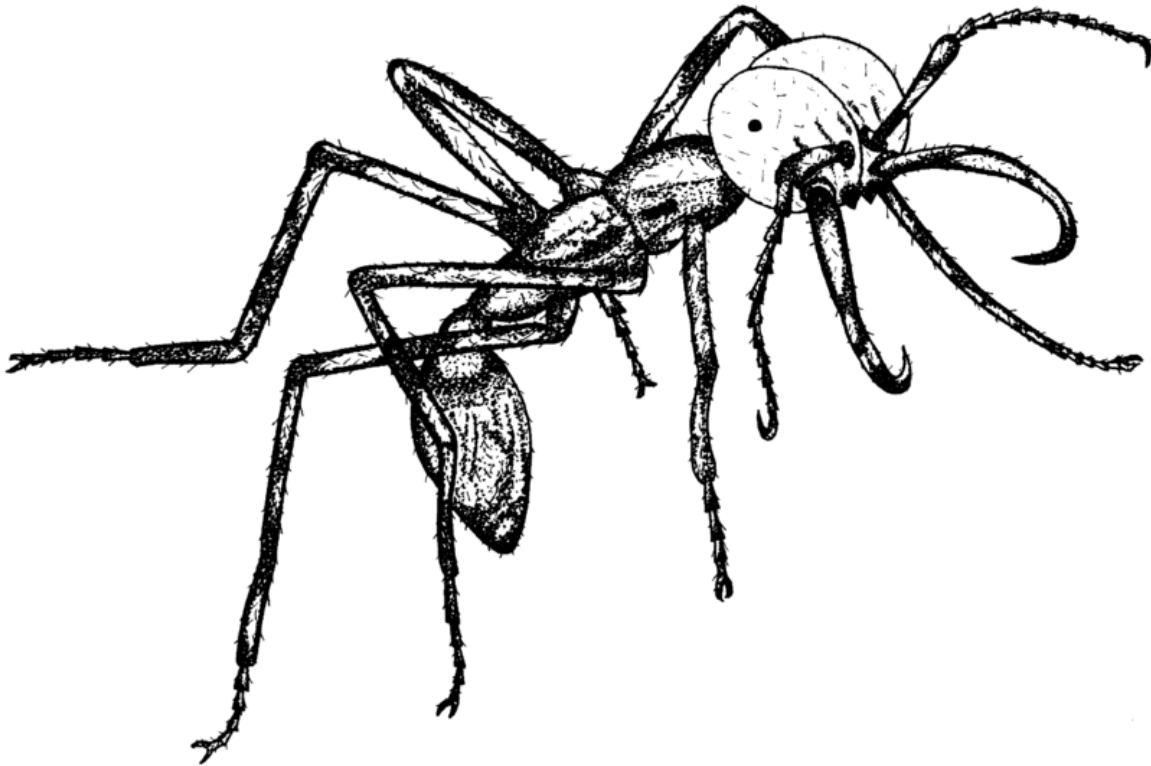
Most New World army ants belong to the subfamily **Ecitoninae**. This subfamily is further broken into two groups in the New World, the tribes Cheliomyrmecini and Ecitonini. The former contains only the genus *Cheliomyrmex*, and the tribe Ecitonini contains four genera, *Neivamyrmex*, *Nomamyrmex*, *Labidus*, and *Eciton*, the genus after

which the group is named. The genus *Neivamyrmex* is the largest of all army ant genera, containing some 120 species, all in the United States. The most predominant species of *Eciton* is *E. burchellii*, whose common name is "army ant" and which is considered to be the archetypal species.

The Old World army ants are divided between the two tribes Aenictini and Dorylini (often treated as Dorylini alone), each of which is made up of a single genus; in the former case, *Aenictus*, that contains over 100 species of army ant, while the Dorylini contains the aggressive "driver ants" in the genus *Dorylus*, of which there are some 70 species known.

Army ant taxonomy remains ever-changing, and genetic analysis will continue to provide more information about the relatedness of the various species; many genera contain large numbers of taxa at the rank of subspecies (e.g., *Dorylus*, in which some 60 of roughly 130 named taxa are only considered subspecies at present).

New World Army Ants



Soldier of the New World Army Ant Species *Eciton burchellii* with characteristically shaped mandibles.

There are about 150 species of army ants in the New World (that is, North, South, and Central America), all in the tribe Ecitonini. Although these army ant species are found from Kansas to Argentina, few people in North America realize that there are plenty of army ants living in the United States, in part because the colonies are rarely very

abundant, and because the United States species (mostly genus *Neivamyrmex*) are quite small (~5 mm), with small and generally unobtrusive raiding columns, most often active at night, and easily overlooked.

E. burchellii and *E. hamatum* are the most visible and best studied of the New World army ants because they forage above ground and during the day, in enormous raiding swarms. Their range stretches from southern Mexico to the northern part of South America.

Old World Army Ants

There are over 100 species of army ants in the Old World, all in the tribe Dorylini (in some older classifications, also the tribe Aenictini), approximately equal numbers in the genera *Aenictus* and *Dorylus*. The latter group is by far the better-known, including the infamous "driver ants" (or "safari ants").

Formicinae

Formicinae



Camponotus sp.

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Family:	Formicidae
Subfamily:	Formicinae Lepeletier, 1836

Formicinae is a subfamily within the Formicidae containing ants of moderate evolutionary development.

Formicines retain some primitive features such as the presence of cocoons around pupae, the presence of ocelli in workers, and little tendency toward reduction of palp or antennal segmentation in most species, except subterranean groups. Extreme modification of mandibles is rare, except in the genera *Myrmoteras* and *Polyergus*. On the other hand, some members show considerable evolutionary advancement in behaviors such as slave-making and symbiosis with root-feeding homopterans. Finally, all formicines have a very reduced sting and enlarged venom reservoir, with the venom gland, specialized (uniquely among ants) for the production of formic acid.

Classification



Carpenter ant

The tribal structure of Formicinae is not completely understood. This list follows the scheme at antbase.org, but there are other schemes and names.

- Camponotini
 - *Calomyrmex*
 - *Camponotus* – Carpenter ants (Global)
 - *Chaemeromyrma*
 - *Echinopla*
 - *Forelophilus*
 - *Opisthopsis*
 - *Overbeckia*
 - *Phasmomyrmex*

- *Polyrhachis* (Asian, African tropics)
 - *Pseudocamponotus*
- Formicini
 - *Alloformica*
 - *Bajcaridris*
 - *Cataglyphis*
 - *Formica*
 - *Polyergus* – Amazon ants
 - *Proformica*
 - *Protoformica*
 - *Rossomyrmex*
- Gesomyrmecini
 - *Gesomyrmex*
 - *Prodimorphomyrmex*
 - *Santschiella*
 - *Sicilomyrmex*
- Gigantopini
 - *Gigantiops* (Neotropical)
- Lasiini
 - *Acanthomyops*
 - *Acropyga*
 - *Anoplolepis*
 - *Cladomyrma*
 - *Lasiophanes*
 - *Lasius*
 - *Myrmecocystus*
 - *Prolasius*
 - *Stigmacros*
 - *Teratomyrmex*
- Melophorini
 - *Melophorus* (Australian)
- Myrmecorhynchini
 - *Myrmecorhynchus*
 - *Notoncus*
 - *Pseudonotoncus*
- Myrmoteranini
 - *Myrmoteras*
- Notostigmatini
 - *Notostigma*
- Oecophyllini
 - *Oecophylla* – Weaver ants
- Plagiolepidini
 - *Agraulomyrmex*
 - *Aphomyrmex*
 - *Brachyomyrmex*
 - *Bregmatomyrma*

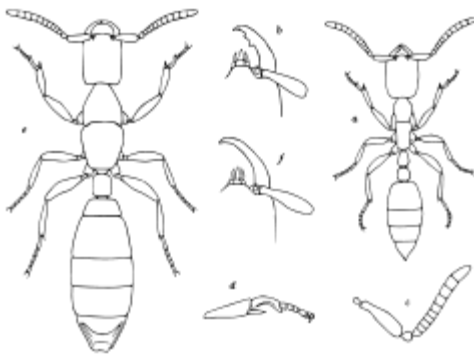
- *Euprenolepsis*
- *Myrmelachista*
- *Nylanderia*
- *Paraparatrechina*
- *Paratrechina* – Crazy ants
- *Petalomyrmex*
- *Plagiolepis*
- *Pseudaphomomyrmex*
- *Pseudolasius*
- *Tapinolepis*
- *Incertae sedis*
 - *Eucharis*
 - *Imhoffia*
 - *Kyromyrmex* (fossil: Cretaceous)
 - *Leucotaphus*
 - *Protrechina*
 - *Tylolasius*

Chapter- 5

Leptanillinae and Martialis Heureka

Leptanillinae

Leptanillinae



Leptanilla swani female and worker

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Family:	Formicidae
Subfamily:	Leptanillinae

Genera

Anomalomyrma
Leptanilla
Phaulomyrma
Protanilla
Yavnella

Leptanillinae is a subfamily of ants. They are further divided into the tribes Anomalomyrmini and Leptanillini.

In all Leptanillini the larva feed their hemolymph to the queen through specialized processes on their prothorax and third abdominal segment. This behavior resembles that of the unrelated *Adetomyrma*, also called Dracula ants, which actually pierce their larvae to get at the body fluids.

At least *Leptanilla* and *Phaulomyrma* are minute, yellow, blind ants living below the surface.

Systematics

- Anomalomyrmini
 - *Anomalomyrma* Taylor, 1990
 - *Anomalomyrma taylori* Bolton, 1990
 - *Protanilla* Taylor, 1990
 - *Protanilla bicolor*
 - *Protanilla concolor*
 - *Protanilla furcomandibula*
 - *Protanilla rafflesii* Taylor, 1990
- Leptanillini
 - *Leptanilla* Emery, 1870
 - *Leptanilla africana* Baroni Urbani, 1977
 - *Leptanilla swani* Wheeler, 1932
 - *Leptanilla kubotai* Baroni Urbani, 1977
 - *Leptanilla palauensis* (Smith, 1953)
 - *Leptanilla santschii* Wheeler & Wheeler, 1930
 - *Leptanilla vaucheri* Emery, 1899
 - *Leptanilla theryi* Forel, 1903
 - *Leptanilla tenuis* Santschi, 1907
 - > 30 more species
 - *Phaulomyrma* G.C. Wheeler & E.W. Wheeler, 1930
 - *Phaulomyrma javana* Wheeler & Wheeler, 1930 — Java
 - *Yavnella* Kugler, 1987

- *Yavnella argamani* Kugler, 1987
- *Yavnella indica* Kugler, 1987

Martialis heureka

Martialis heureka



Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Family:	Formicidae
Subfamily:	Martialinae
	<i>Martialis</i>
Genus:	Rabeling & Verhaagh, 2008
Species:	<i>M. heureka</i>

Binomial name

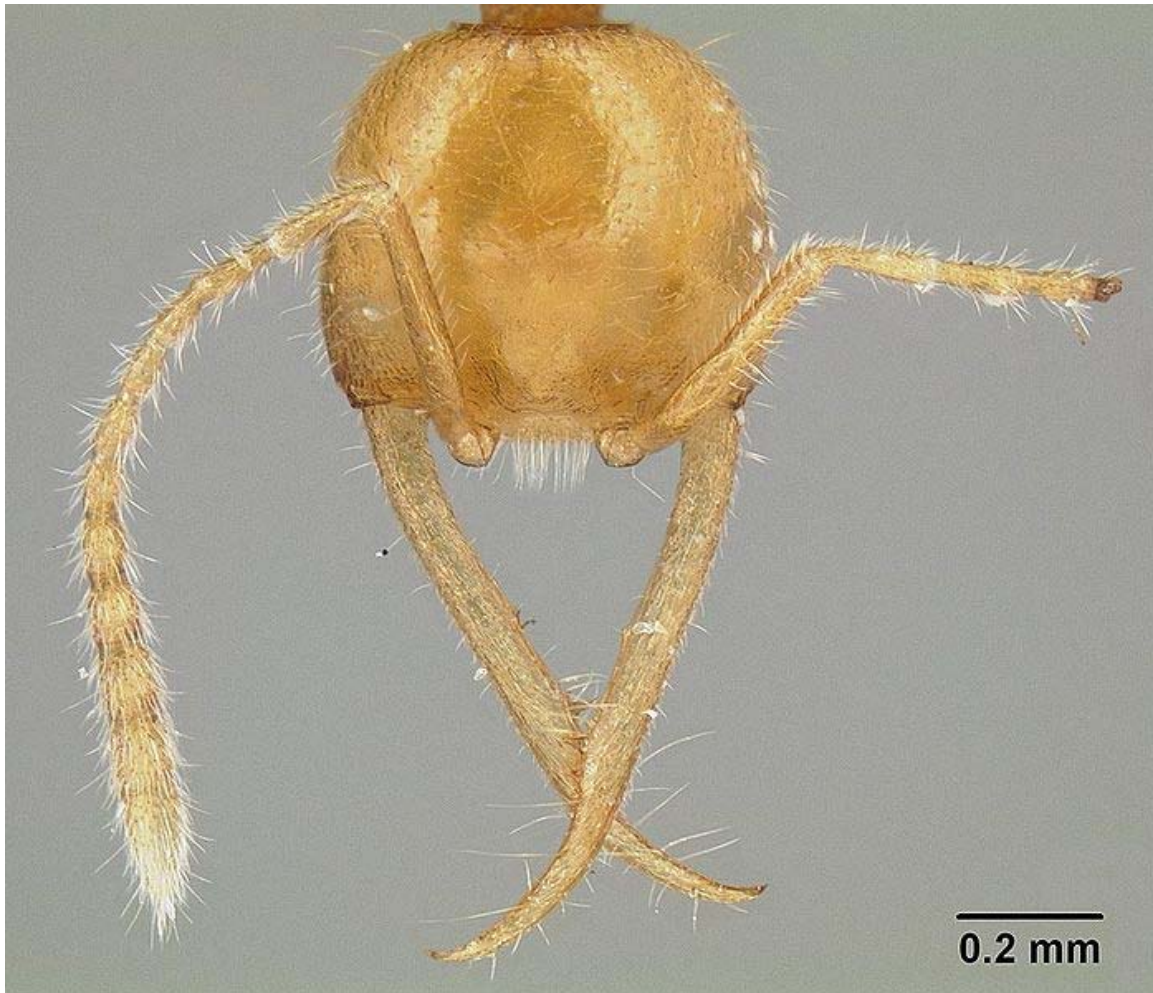
Martialis heureka
Rabeling & Verhaagh, 2008

Diversity

Sole species in subfamily

Martialis heureka is a species of ant that was discovered in 2000 from the Amazon rainforest near Manaus, Brazil. It was described as a new species and placed as the sole member of a new subfamily (**Martialinae**). The generic name means "**from Mars**" and was given due to its unusual morphology, and the species epithet *heureka* indicates the surprising discovery.

Description



Worker

Like all members of the family Formicidae these ants have the distinctive elbowed antennae, prominent metapleural glands and a distinctive petiole. The ants however lack compound eyes, are pale in colour, and lead a subterranean life preying on small litter organisms. The workers have unusual, elongated mandibles that are distinctly basal in their features.

Based on the morphology the authors suggest that the ants lead an underground life, possibly foraging on the surface during the night. The first two specimens were found in soil core samples while another was found in leaf litter. They probably make use of pre-existing underground cavities as the legs do not show adaptations for digging.

Discovery

Two specimens were first discovered by Manfred Verhaagh of the Staatliches Museum für Naturkunde in Karlsruhe, Germany in 2000, but they were damaged and it was only

in 2003 that a new specimen was collected by Christian Rabeling, a graduate student of the University of Texas at Austin.

Name

The aberrant features of this ant led Stefan P. Cover and Edward O. Wilson to comment that it was ant that had to be from Mars. The genus name therefore refers to the planet Mars, alluding to the strange characteristics that seem to come out of nowhere, the species epithet is from Ancient Greek ηΰρηκα "I found it", echoing Archimedes' famous exclamation was meant to epitomize the troubles involved in the rediscovery of the species after the first specimen discovered in a soil sample was lost.

Chapter- 6

Myrmicinae and Paraponera

Myrmicinae



Atta cephalotes worker

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Suborder:	Apocrita
Superfamily:	Vespoidea
Family:	Formicidae
Subfamily:	Myrmicinae

Myrmicinae is a subfamily of ants. There are about 140 genera within the group, with the family being cosmopolitan. The pupae lack cocoons. Some species retain a functional

Paraponera

Bullet ant



Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Family:	Formicidae
Subfamily:	Paraponerinae
Genus:	<i>Paraponera</i> F. Smith, 1858
Species:	<i>P. clavata</i>

Binomial name

Paraponera clavata
(Fabricius, 1775)

Paraponera is a genus of ant consisting of a single species, commonly known as the **lesser giant hunting ant**, **conga ant**, or **bullet ant** (*Paraponera clavata*), named on account of its powerful and potent sting, which is said to be as painful as being shot with a bullet. It inhabits humid lowland rainforests from Nicaragua south to Paraguay. The bullet ant is called by the locals "**Hormiga Veinticuatro**" or "24 (hour) ant", from the 24 hours of pain that follow a stinging.

Description

Workers are 20–30 mm long and resemble stout, reddish-black, wingless wasps. *Paraponera* is predaceous and like all primitive poneromorphs, does not display polymorphism in the worker caste. The queen is not much larger than the workers.



Photograph demonstrating the size of bullet ants, with a 2 cm scale bar

Sting

The pain caused by this insect's sting is purported to be greater than that of any other Hymenopteran, and is ranked as the most painful according to the Schmidt Sting Pain Index, given a 4+ rating, above the tarantula hawk wasp. It is described as causing "waves of burning, throbbing, all-consuming pain that continues unabated for up to 24 hours". It is thought that the ant has evolved this way to ward off any predators who would normally unearth them. In some indigenous communities, to enter manhood, a boy has to endure being stung by the ant 20 times without screaming. A paralyzing neurotoxic peptide isolated from the venom is called **poneratoxin**. It affects voltage-dependent sodium ion channels and blocks the synaptic transmission in the insect central nervous system. It is being investigated for possible medical applications.

Initiation rites

The Satere-Mawe people of Brazil use intentional bullet ant stings as part of their initiation rites to become a warrior. The ants are first rendered unconscious by submerging them in a natural sedative and then hundreds of them are woven into a glove made out of leaves (which resembles a large oven mitt), stinger facing inward. When the ants regain consciousness, a boy slips the glove onto his hand. The goal of this initiation rite is to keep the glove on for a full ten minutes. When finished, the boy's hand and part of his arm are temporarily paralyzed because of the ant venom, and he may shake uncontrollably for days. The only "protection" provided is a coating of charcoal on the hands, supposedly to confuse the ants and inhibit their stinging. To fully complete the initiation, however, the boys must go through the ordeal a total of 20 times over the course of several months or even years.

Nest distribution

Colonies consist of several hundred individuals and are usually situated at the bases of trees. Workers forage arboreally in the area directly above the nest for small arthropods and nectar, often as far as the upper canopy; little foraging occurs on the forest floor. Nectar, carried between the mandibles is the most common food that is taken back to the nest by foragers. Two studies in Costa Rica and on Barro Colorado Island (BCI), Panama, found that there are approximately four bullet ant nests per hectare of forest. On BCI the nests were found under 70 species of tree, 6 species of shrub, 2 species of liana and 1 species of palm. Nests were most common beneath the canopies of *Faramea occidentalis* and *Trichilia tuberculata* but these trees are also the most abundant in the forest. Nests were present more frequently than would be expected based on the abundance of the trees under *Alseis blackiana*, *Tabernaemontana arborea*, *Virola sebifera*, *Guaria guidonia* and *Oecocarpus mapoura*. The large number of nest plants suggests that there is little active selection of nest sites by bullet ants. Small shrubs however are under utilised, probably because they do not provide access to the forest canopy. The study on BCI concluded that trees with buttresses and extrafloral nectaries may be selected for by bullet ants.

Parasites

The small (1.5–2 mm long) phorid fly, *Apocephalus paraponerae*, is a parasite of injured workers of *P. clavata*, of which there is a constant supply because there are frequent aggressive encounters between neighbouring colonies resulting in maimed workers. They are able to parasitise healthy ants if they are artificially restrained, but this is thought to be rare in practice as healthy ants are agile and able to repel the flies. Both male and female flies are attracted by the scent of injured ants, the females to lay eggs as well as feed and the males to feed and possibly to mate with the females. The flies are attracted to a crushed ant within two to three minutes and ten or more flies may be attracted to each ant. Each ant can harbour 20 fly larvae. Carl Rettenmeyer observed *P. clavata* actively trying to attack *A. paraponerae* when they approached the entrance to their nest, but other authors have not observed similar behaviour.

Chapter- 7

Ponerinae and Ant-Fungus Mutualism

Ponerinae

Ponerinae



fighting *Harpegnathos saltator*

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Family:	Formicidae
Subfamily:	Ponerinae Lepeletier, 1835



Plectroctena sp fighting

Ponerinae is a subfamily of ants in the Poneromorph subfamilies group, with about 1,600 species in 28 extant genera, including *Dinoponera gigantea* - one of the world's largest species of ant.

They are most easily identified from other sub-families by a constricted gaster (abdomen).

Tribes

- Platythyreini - only one genus *Platythyrea*
- Ponerini
- Thaumatomyrmecini - *Thaumatomyrmex*

Genera

- *Afropone* (extinct)
- *Anochetus* (115 species)
- *Asphinctopone* (3 species)
- *Belonopelta* (3 species)
- *Boloponera* (1 species)
- *Centromyrmex* (18 species)
- *Cryptopone* (25 species)

- *Diacamma* (51 species)
- *Dinoponera* (9 species)
- *Dolioponera* (1 species)
- *Emeryopone* (5 species)
- *Eogorgites* (extinct)
- *Eoponerites* (extinct)
- *Feroponera* (1 species)
- *Furcisutura* (extinct)
- *Harpegnathos* (12 species)
- *Hypoponera* (343 species)
- *Leptoponera* (339 species)
- *Loboponera* (11 species)
- *Longicapitia* (extinct)
- *Myopias* (38 species)
- *Odontomachus* (66 species)
- *Odontoponera* (7 species)
- *Pachycondyla* (335 species)
- *Phrynoponera* (6 species)
- *Platythyrea* (50 species)
- *Plectroctena* (17 species)
- *Ponera* (57 species)
- *Promyopias* (1 species)
- *Psalidomyrmex* (6 species)
- *Simopelta* (29 species)
- *Streblognathus* (2 species)
- *Thaumatomyrmex* (19 species)

Genera previously classified in Ponerinae subfamily but reclassified

- *Rhytidoponera* - subfamily Ectatomminae
- *Discothyrea* - subfamily Proceratinae
- *Probolomyrmex* - subfamily Proceratinae
- *Proceratium* - subfamily Proceratinae
- *Amblyopone* - subfamily Amblyoponinae
- *Onychomyrmex* - subfamily Amblyoponinae

Ant-fungus mutualism



Atta colombica queen

Ant-fungus mutualism is a symbiosis seen in certain ant and fungal species, where ants actively cultivate fungus much like humans farm crops as a food source. Interestingly, in some species, the ants and fungi are dependent on each other for survival. The leafcutter ant is a well known example of this symbiosis. A mutualism with fungi is also noted in some species of termites in Africa.

General overview

Given the exclusive New World distribution of the >230 attine ant species, this mutualism is thought to have originated in the basin of the Amazon rainforest some 50–65 million years ago. There are five main types of agriculture that the attine ants practice include: lower, coral-fungus, yeast, generalized higher, and leafcutter agricultural systems. Lower agriculture was the first type of attine agricultural system and is currently practiced by 80 attini species in 10 genera. Coral-fungus agriculture is practiced by 34 species by a single derived clade within the attine genus *Apterostigma*. The coral fungus farmers underwent a switch of cultivars between 10 and 20 million years ago to a nonleucocoprineaceous fungus, which makes its choice of cultivar different from all other attines. Yeast agriculture is practiced by 18 species of *Cyphomyrmex rimosus*. The *C. rimosus* group is hypothesized to have evolved growing fungus in a yeast form between 5 and 25 million years ago. Generalized higher agriculture is practiced by 63 species in two genera and refers to the condition of highly domesticated fungus. The

fungi used in higher agriculture cannot survive without its agriculturalists to tend it and has phenotypic changes that allow for increased ease of ant harvesting. Leafcutter agriculture, which is a more highly derived form of higher agriculture, is practiced by 40 species in two genera and has the most recent evolution, originating between 8 and 12 million years ago. Leaf cutters use living biomass as the substrate to feed their fungi, whereas in all other types of agriculture, the fungus requires dead biomass.

In all of these types of agriculture, the attine ants actively propagate, nurture and defend the basidiomycete cultivar. In return, the fungus provides nutrients for the ants, which may accumulate in specialized hyphal-tips known as "gongylidia". In some advanced genera the queen ant may take a pellet of the fungus with her when she leaves to start a new colony. While this vertical transmission of fungal cultivars and strong host-symbiont specificity might suggest a tight coevolutionary relationship, recent phylogenetic analyses suggest this is not the case. Multiple domestications of the same fungus, fungal escape from domestication, or cultivar switching could lead to the observed diffuse coevolutionary pattern.

This mutualism is further complicated by the introduction of two other organisms, a fungal parasite *Escovopsis* and *Pseudonocardia* bacterial species residing on the ants' integuments that assist in defending the fungus from this parasite through the production of secondary metabolites. In fact, some species of ants have evolved exocrine glands that apparently nourish the antibiotic-producing bacteria inside them. A black yeast has been recorded as a partner in the mutualism. The yeast has a negative effect on the bacteria that normally produce antibiotics to kill the parasitic fungus and so may affect the ants' health by allowing the parasite to spread.

Whereas the ants are monophyletic, their symbionts are not. They fall roughly into three major groups, only G1 having evolved gongylidia. Some G2 species grow long hyphae that form a protective cover over the nest. Those in G3 are paraphyletic, the most heterogeneous, and form the most loose relationships with their cultivators. Studies now show that the fungi themselves may not be completely dependent on the ants. The fungi were earlier thought to be propagated by ants purely through clonal (vegetative) means. However considerable genetic variation in the fungi suggests that this may not be the case.

Chapter- 8

Ant Mimicry



Cricket nymph, *Macroxiphus* sp.

Ant mimicry is mimicry of ants by other organisms. Ants are abundant all over the world, and insect predators that rely on vision to identify their prey such as birds and wasps normally avoid them, either because they are unpalatable, or aggressive. Thus some other arthropods mimic ants to escape predation (protective mimicry). Conversely, some species (e.g. Zodariidae spiders) use their anatomical and behavioral ant mimicry to hunt ants (aggressive mimicry). Other cases are also known. The term **myrmecomorphy** is also used to describe ant mimicry.

By taxa

Spiders



A female *Myrmarachne plataleoides* in Thailand mimics an Asian weaver ant (*Oecophylla smaragdina*) worker



A male *Myrmarachne plataleoides* spider in Thailand mimics a weaver ant worker carrying another worker

80% of spiders with Batesian mimicry imitate ants, comprising more than 100 species. Ant-mimicking spiders can be found in the following spider families:

- Araneidae (e.g. *Micrathena*)
- Corinnidae (e.g. *Apochinoma*, *Castianeira*, *Myrmecium*, *Corinna vertebrata*, *Mazax pax*, *M. spinosa*, *Myrmecotypus*, *Sphecotypus*, *Otacilia*, *Phrurolithus*)
- Dysderidae (*Harpactea hombergi* preys on ants, behavioral mimic, not morphological)
- Eresidae (*Seothyra schreineri* males mimic small *Camponotus* castes)
- Gnaphosidae (e.g. *Micaria*, *Callilepis nocturna*)
- Prodidomidae (*Myandra*)
- Linyphiidae (*Linyphia furtiva*, *Meioneta beata*)
- Oonopidae (*Diblemma donisthorpei* mimics *Wasmannia auropunctata*)
- Salticidae (e.g. *Agorius*, *Augustaea*, *Belippo*, *Bocus*, *Chalcolecta*, *Consingis*, *Corcovetella*, *Cosmophasis*, *Depreissia*, *Eburneana*, *Enoplomischus*, *Judalana*, *Kima*, *Leptorchestes*, *Martella*, *Marengo*, *Mexcala*, *Myrmarachne*, *Paradamoetas cara*, *Peckhamia picata*, *Philates*, *Sadies*, *Sarinda*, *Synageles*, *Synagelides*, *Synemosyna*, *Tutelina*, *Ugandinella*, *Uluella*, *Zuniga*)
- Theridiidae (e.g. *Anatea formicaria*, *Cerocida strigosa*, *Coleosoma floridanum* (only males), *Coleosoma acutiventer*, *Helvibis brasiliana*, *H. chilensis*, *Heleosoma floridanum*, *Melychiopharis cynips*, *Cerocida strigosa*)
- Thomisidae (e.g. *Amyciaea*, *Aphantochilus*, *Bucranium*, *Strophius nigricans*)
- Zodariidae (e.g. *Storena*, *Zodarion*)

Some spiders (e.g. Zodariidae or some *Myrmarachne*) use their ant disguise to hunt ants, although most use their disguise to escape predators. In salticids, the latter can be discerned from the ants from the movements they make in order to keep the ants at an acceptable distance. Ant hunters often do not resemble ants as much.

Myrmarachne assimilis is the only *Myrmarachne* species that resembles the aggressive weaver ant *Oecophylla smaragdina*, with which it lives in close contact. *Cosmophasis bitaeniata* uses chemical mimicry to be accepted by the same ant species. It is suggested that *M. assimilis* uses a similar technique. Thus, its ant mimicry is twofold: in visual appearance to trick predators, but also evading to be hunted by the ants themselves.

Several spiders (eg., most *Myrmarachne*) undergo *transformational mimicry*: because the spiderlings are too minute to convincingly mimic the much bigger ant species that the adult copies, they use other smaller ant species as a model.

The overall body of spider myrmecomorphs is much narrower than non-mimics, which reduces the number of eggs per eggsac, compared to non-mimetic spiders of similar size. They seem to compensate by laying more eggsacs in their lifetime. Ant-mimics usually use their first or second pair of legs to fake ant antennae, such reducing the number of functional legs to six.

Sometimes, the sexes each mimic a different model. There are also spiders where several morphs occur, each mimicking a different morph of the model ant species, or different ant species. For example, light yellow to brown morphs of *Synemosyna aurantiaca* mimic *Pseudomyrmex flavidulus* and *P. oculatus*, while black morphs mimic *P. gracilis* and *P. sericeus*.

In *Micrathena*, only males and juveniles resemble ants. This may be mimesis rather than mimicry.

Even within a closely related group of taxa ant mimicry might have originated several times independently. This is demonstrated in the Salticidae subfamily Ballinae.

Mites

The phoretic mite *Planodiscus* attaches itself to the tibia of its host *Eciton hamatum*. The cuticula sculpturing of the mite's body is nearly identical to that of the ant's leg.

Hemiptera



Male *Myrmecoris gracilis*



Pilophorus perplexus from Cologne, Germany

Among the bugs, the wingless *Myrmecoris gracilis* looks like an ant and feeds on ant larvae. *Pithanus maerkeli* is also ant-like. *Systellonotus triguttatus*, in which nymphs and females strongly resemble ants, is often found in the vicinity of ants. *Dulichius inflatus* (Alydidae) closely resembles ants of the genus *Polyrhachis*.



Dulichius inflatus an Alydid bug

Pithanus maerkeli roughly resembles an ant, as does the lively *Pilophorus perplexus*.

The nymph of *Himacerus mirmicoides* looks like an ant.

Thrips

Franklinothrips is a genus of thrips that is predatory. Especially the females mimic ants in appearance and behavior. Ant mimicry also occurs in other genera of Aeolothripidae, where it has arisen independently, for example *Aeolothrips albicinctus* in Europe and *A. bicolor* in North America, the Australian species *Desmothrips reedi*, *Allelothrips* with seven species from Africa and India, *Stomatothrips* with eight species from the Americas. This kind of mimicry probably evolved as a response to the presence of ants.

Phasmids



freshly hatched *E. tiaratum*

Extatosoma tiaratum, while resembling dried thorny leaves as an adult, hatches from the egg as a replica of a *Leptomyrmex* ant, with a red head and black body. The long end is curled to make the body shape appear ant-like, and the movement is erratic, while the adults move differently, if at all. In some species the eggs resemble plant seeds, complete with a mimic elaiosome (called a "capitulum") as in plants that are associated with ants in myrmecochory. These eggs are collected by the ants and taken to their nests. The capitulum is removed and eaten and the eggs continue to be viable.

Mantids

While praying mantids are carnivorous insects, they also are in danger of being eaten by larger animals. The nymphs of the Ghost mantis, *Phyllocrania paradoxa*, looks like a black ant to repel predators. In later instars, it gets a brownish color and looks like a leaf. Mantids of the genus *Creobroter* use ant mimicry when young as well.

Diptera



Unidentified fly (Sepsidae) ant mimic from Germany

There are several fly species that look like an ant.

At least one species from the little studied Richardiidae genus *Sepsisoma* mimic ants, particularly the formicine ant *Camponotus crassus*.

Several species of Micropezidae (stilt-legged flies) resemble ants (especially the wingless, haltere-less *Badisis ambulans*), as do species in the genus *Strongylophthalmyia* and *Syringogaster*.

Beetles



Thanasimus formicarius

Many parasitic Staphylinidae that march with army ants strikingly resemble their hosts. An outstanding example is *Ecitomorpha nevermanni*, whose color varies to match the color variation of its host *Eciton burchellii*. Since *Eciton* army ants have poor vision, this is probably an example of Batesian mimicry to escape predation by vertebrates.

The Anthicidae are also ant-like in appearance.

Members of the cerambycid genus *Euderces* are ant mimics. *E. velutinus* mimics *Camponotus sericeiventris*. Several other cerambycids also resemble ants. The Central American *Mallocera spinicollis* Bates, 1872, *Neoclytus* and *Diphyrama singularis* Bates,

1872 all closely resemble stinging ants. *Pseudomyrmecion ramalium* Bedel, 1885 closely resembles *Crematogaster scutellaris* in size and coloration and lives in close vicinity to it. In North America certain *Anthoboscus*, *Cyrtophorus* and *Tillomorpha* are ant mimics. *Cyrtinus pygmaeus* resembles *Lasius niger americanus*, and *Michthisoma heterodoxum* mimics small workers of *Camponotus pennsylvanicus*. The ant beetle *Thanasimus formicarius* (Cleridae) mimics ants of the genus *Formica*.

Coatonachthodes ovambolandicus is a termite-mimicking beetle which lives as a parasite in their nests.

Collemboles

Several species of springtails look like ants, with white lines acting as pseudo-incisions.

Chapter- 9

Fire Ant



Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Subphylum:	Uniramia
Class:	Insecta
Order:	Hymenoptera

Suborder: Apocrita
Family: Formicidae
Subfamily: Myrmicinae
Tribe: Solenopsidini
Genus: *Solenopsis*
Westwood, 1840

Species

S. conjurata
S. daguerrei
S. fugax
S. invicta
S. molesta
S. richteri
S. solenopsidis
S. wagneri
S. xyloni

Fire ants are a variety of stinging ants with over 280 species worldwide. They have several common names including **ginger ants** and **tropical fire ants** (English), hormigas bravas or hormigas coloradas (Spanish), fourmis de feu (French), Feuerameisen (German), mod-kun-fai (Thai), Pulang Langgam (Filipino), and aka-hi-ari or aka-kami-ari (Japanese).

Appearance



Fire Ant Mound

The bodies of fire ants, like all insects' bodies, are divided into three sections: the head, the thorax, and the abdomen, with three pairs of legs and a pair of antennae. Fire ants can be distinguished from other ants by their copper brown head and body with a darker abdomen. The worker ants are blackish to reddish, and their size varies from 2mm to 6 mm (0.12 in to 0.24 in). These different sizes of the ants can all exist in the same nest.

Solenopsis sp. ants can be identified with three body features — a pedicel with two nodes, an unarmed propodeum, and antennae with 10 segments and a two segmented club.

Behavior



A fire ant worker, queen, and male

A typical fire ant colony produces large mounds in open areas, and feeds mostly on young plants, seeds, and sometimes crickets. Fire ants often attack small animals and can kill them. Unlike many other ants, which bite and then spray acid on the wound, fire ants bite only to get a grip and then sting (from the abdomen) and inject a toxic alkaloid venom called solenopsin, a compound from the class of piperidines. For humans, this is a painful sting, a sensation similar to what one feels when burned by fire—hence the name fire ant—and the after effects of the sting can be deadly to sensitive individuals. The venom is both insecticidal and antibiotic. Researchers have proposed that ant nurse workers will spray their brood to protect them from microorganisms.

Fire ants nest in the soil, often near moist areas, such as river banks, pond edges, watered lawns and highway edges. Usually the nest will not be visible as it will be built under objects such as timber, logs, rocks, pavers, bricks, etc. If there is no cover for nesting, dome-shaped mounds will be constructed, but this is usually only found in open spaces such as fields, parks and lawns. These mounds can reach heights of 40 cm (15.7 in). The mounds that the fire ants live in can also be as deep as five feet.

Colonies are founded by small groups of queens or single queens. Even if only one queen survives, within a month or so the colony can expand to thousands of individuals. Some colonies may be polygynous (having multiple queens per nest).

Roles



Solenopsis queens and workers



Fire ants with a dead *Romalea Guttata* grasshopper

Queen

A queen is generally the largest individual in the colony. The primary function of the queen is reproduction; she may live for 6 to 7 years and produce up to 1,500 eggs per day. Many fire ant colonies will have more than one queen.

An established nest can have up to 8 inactive sub-queens that will flee the nest if threatened, which is why poisoning a nest may not completely rid a property of the ants.

Males / Drones

Males mate with the queen for the sole purpose of producing offspring. Their lifespan is approximately four days.

Workers

The workers are sterile females who build and repair the nest, care for the young, defend the nest, and feed both young and adult ants. The worker ants also go find supplies to build up the colony.

Introduced species

Although most fire ant species do not bother people and are not invasive due to biological factors, *Solenopsis invicta*, known in the United States as the red imported fire ant (or RIFA) is an invasive pest in many areas of the world, notably the United States, Australia, the Philippines, China and Taiwan. The RIFA was accidentally introduced into the United States aboard a South American cargo ship that docked at the port of Mobile, Alabama, in the 1930s, but now infests the majority of the Southern and Southwestern United States.

In the US, the FDA estimates that more than US\$5 billion is spent annually on medical treatment, damage, and control in RIFA-infested areas. Furthermore, the ants cause approximately US\$750 million in damage annually to agricultural assets, including veterinarian bills and livestock loss as well as crop loss. Over 40 million people live in RIFA-infested areas in the southeastern United States. Between 30 and 60% of the people living in fire ant-infested areas are stung each year. Since September 2004, Taiwan has been seriously affected by the red fire ant. The US, Taiwan and Australia all have ongoing national efforts to control or eradicate the species, but, other than Australia, none have been especially effective. In Australia an intensive program costing A\$175 million has, at February 2007, eradicated 99% of fire ants from the sole infestation occurring in South East Queensland.

In just 70 years, according to a new study, lizards in parts of the United States have developed longer legs and new behaviors to escape the ants, which can kill the lizard in under a minute.

Symptoms and first aid



A human leg three days after coming in brief contact with a fire ant colony

The venom of fire ants is composed of alkaloids such as piperidine and the sting swells into a bump. This can cause much pain and irritation at times, especially when stung repeatedly by several ants. The bump often forms into a white pustule, which is at risk of becoming infected if scratched; however, if left alone, it will usually flatten within a few days. The pustules are obtrusive and uncomfortable while active and, if the sting sites become infected, can turn into scars. Additionally, some people are allergic to the venom and as with many allergies, may experience anaphylaxis, which requires emergency treatment. An antihistamine or topical corticosteroids may help reduce the itching.

First aid for fire ant bites includes external treatments and oral medicines.

- External treatments: a topical steroid cream (hydrocortisone), or one containing aloe vera.
- Oral medicines: antihistamines.

Victims who experience severe or life threatening allergic reactions to fire ant insect stings should visit a doctor or hospital immediately upon contact as these reactions can result in death. These more severe reactions include severe chest pain, nausea, severe sweating, loss of breath, serious swelling, or slurred speech.

Other names

In Spanish, fire ants are known as *hormiga colorada/roja* (red ant) or *hormiga brava* (fierce ant). In the Dominican Republic they are known as *Hormiga Caribe*. In Portuguese, they are called *formiga de fogo* (fire ant) and *formiga lava-pé* (wash foot ant).

Natural predators

Phorid flies, or Phoridae, are a family of small, hump-backed flies resembling fruit flies; two species in this family (*Pseudacteon tricuspis* and *Pseudacteon curvatus*) are parasitoids of the red imported fire ant in its native range in South America. Some 110 species of the genus *Pseudacteon*, or ant-decapitating flies, have been described. Members of *Pseudacteon* reproduce by laying eggs in the thorax of the ant. The first instar larvae migrates to the head, then develops by feeding on the hemolymph, muscle tissue, and nervous tissue. After about two weeks, they cause the ant's head to fall off by releasing an enzyme that dissolves the membrane attaching the ant's head to its body. The fly pupates in the detached head capsule, requiring a further two weeks before emerging.

Pseudacteon flies have been widely introduced throughout the southern United States, starting with Travis, Brazos, and Dallas counties in Texas, as well as Mobile, Alabama, where the ants first entered North America.

Chapter- 10

Formica and Gliding Ant

Formica

Formica



Formica rufa collecting

Scientific classification

Kingdom:	Animalia
Phylum:	Arthropoda
Class:	Insecta
Order:	Hymenoptera
Family:	Formicidae
Subfamily:	Formicinae
Tribe:	Formicini
Genus:	<i>Formica</i> Linnaeus, 1758

Type species

Formica rufa

Species

Formica aquilonia
Formica cunicularia
Formica exsecta

Formica exsectoides
Formica fusca
Formica lugubris
Formica polyctena
Formica pratensis
Formica rufa
Formica rufibarbis
Formica sanguinea

Formica is a genus of ants. It is the type genus of the family Formicidae and the subfamily Formicinae, and in turn *Formica*'s own type species is the European red wood ant *Formica rufa*. Common names for this group are wood ant, mound ant, and field ant. Many of the better known forest species have common names that include the words "wood ant", although *F.rufa* is also known as the "horse ant". (However in German, the equivalent term *Rossameise* refers to the carpenter ants of the genus *Camponotus*.)

As the name wood ant implies, many *Formica* species live in wooded areas where there exists no shortage of material with which they can thatch their mounds. The most shade tolerant species are *F. lugubris* in Eurasia and *F. subaenescens (fusca)* in North America. However, sunlight is important to most *Formica* species, and colonies rarely survive for any considerable period in deeply shaded, dense woodland. The majority of species, especially outside the *rufa* species group, are inhabitants of more open woodlands or treeless grassland or shrubland. In North America, at least, these habitats had a long history of frequent landscape-scale fires that kept them open before European settlement. Conversion to agriculture and fire suppression have reduced the abundance of most American *Formica*, while the cessation of traditional haycutting seems to have had the same effect in Europe. However, at least a few *Formica* species may be found in a wide range of habitats from cities to seashores to grasslands to swamps to forests of the temperate Northern Hemisphere.



A worker ant in the *Formica pallidefulva* group

Mound building, forest dwelling *Formica* like *F. rufa* often have a considerable effect on their environment. They maintain large populations of aphids on whose secretions they feed, and the ants defend them from other predators. They also prey on other insects. In fact in many countries they are introduced in forests to control tree pests, such as swains jack pine sawfly and eastern tent caterpillars in North America. The effects of mound-building grassland species such as *F. montana* are not well-studied but their local abundance, conspicuous mound-building and very frequent association with aphids and membracids points to a comparably important ecological role.



A Formica obscuripes mound

Formica nests are of many different types from simple shaft-and-chamber excavations in soil with a small crater or turret of soil above to large mounds, under stones or logs, or in stumps. None are arboreal. The genus is abundant in both the Nearctic and Palearctic Regions. Due to their relatively large size and diurnal activity, they are among the more commonly seen ants in northern North America.

There are many species of *Formica* (ITIS records nearly 200). Some species, including *Formica rufa*, which is common in Southern England, make large visible nests of dry plant stems, leaves, or conifer needles, usually based around a rotting stump. Wood ants typically secrete formic acid; *F. rufa* can squirt the acid from its acidopore several feet if alarmed, a habit which may have given rise to the archaic term for ant pismire, and by analogy its American equivalent piss-ant. They can be relatively large: *F. rufa* workers can reach a maximum length of around 10 mm. The eastern US species *F. dolosa* and the western *F. ravidula* (= *haemorrhoidalis*) may reach slightly greater lengths.

Formica are notable for their parasitic and slave making behaviors. There are three categories.

In the *exsecta* and *rufa-microgyna* groups, virgin queens cannot start colonies on their own, but invade colonies of other groups and by various processes eventually oust the

host queen and have the host workers help them raise their own brood. Eventually the colony consists of only the invading queen's offspring. This is called temporary social parasitism.

In the *sanguinea* group, colonies are started as above, but then in some species of the group workers go out and raid colonies of other groups for new workers to act as a work force, so-called slaves (but this is a poor analogy). Some species of this group need to do this to survive, for others it is optional.

The *pallidefulva*, *neogagates*, and *fusca* groups are those most often parasitized by the above groups. They are also enslaved by ants of the genus *Polyergus*. The evolution of this behavior is believed ultimately to have been derived from the common habit of many *Formica* species of adopting recently mated queens into established colonies. Indeed, in many of the parasitic species outside the "slave-makers", this "secondary polygyny" is common.

Species

- *Formica aquilonia* Yarrow
- *Formica cunicularia* Latreille
- *Formica dirksi*
- *Formica exsecta* Nylander
- *Formica exsectoides*
- *Formica fusca* Linnaeus (F. (Serviformica) fusca)
- *Formica gagatoides* Ruzsky, 1904
- *Formica lemani* Bondroit
- *Formica lugubris* Zetterstedt
- *Formica obscuripes* Forel, 1886
- *Formica polycтена*
- *Formica pratensis* Retzius
- *Formica rufa* Linnaeus
- *Formica rufibarbis* F.
- *Formica sanguinea* Latreille Fabricius - enslaves other ant species
- *Formica talbotae*
- *Formica transkaukasica* Nasonov
- *Formica uralensis*

Gliding ant



Cephalotes depressus, one of the several species that display this ability.

Gliding ants are arboreal ants of several different genera that are able to control the direction of their descent when falling from a tree. Living in the rainforest canopy like many other gliders, gliding ants use their gliding to return to the trunk of the tree they live on should they fall or be knocked off a branch. Gliding was first discovered for *Cephalotes atreus* in the Peruvian rainforest.

At least five genera in the subfamilies Myrmicinae, Pseudomyrmecinae, and Formicinae display gliding of various degrees. All species in the genus *Cephalotes* (within Myrmicinae) tested to date show this ability, as do many species within Pseudomyrmecinae.

Gliding ants have been shown to have an 85% chance of landing successfully on the same tree, as opposed to 5% if they were simply parachuting like normal ants. This adaptation helps to keep ants from getting lost or killed on the forest floor, away from their treetop nests.

During a fall, gliding ants use visual cues to locate tree trunks. Specifically, they orient to light-colored columnar objects that sharply contrast the darker background of foliage in the forest. Tropical trees often have light-colored bark and frequently are covered with white lichens, thus they provide the most conspicuous targets.

In a typical fall a descent by a gliding ant is "J-shaped". The ant will first randomly descend three or four meters in free fall then visually lock on to the tree trunk it wishes to land on. The glide ant then while exhibiting a sort of parachuting behavior to slow its fall uses its flattened head, hind legs and abdomen like wings or a parachute to make a rapid adjustment to point its abdomen (or head) towards the tree trunk. The ant then turns upside down and lands on the trunk, head facing the earth. The period of free fall is thought to be used by the ants to slow down to a minimum viable glide velocity, to allow them to successfully direct their descent towards the tree. This explains why smaller ants have been observed to reach their trees sooner than do larger. A smaller body mass makes it easier to slow to the minimum viable glide velocity, allowing smaller ants to gain control of their falls more quickly. Many ants use long, flattened legs and wide, flanged heads to act as parachutes to control the direction of their descent, although controlled descent has also been observed in species of Pseudomyrmecinae that have more cylindrical bodies.

Gliding is not observed in all arboreal ants. Some characteristics that may be evolutionarily correlated with gliding are:

- Arboreal nesting
- Frequent foraging at branch tips
- Heavily armored individuals
- Wide range of abdominal movement
- Good vision
- Diurnal activity
- Evolutionary origins in flooded forests

This kind of gliding has evolved independently in a number of species from the groups Cephalotini, Pseudomyrmecinae, and Formicinae (mostly *Camponotus*) in an example of parallel evolution. Unique among gliding animals, Cephalotini and Pseudomyrmecinae ants glide abdomen first. Formicinae ants glide in the more conventional head first manner, though.

Chapter- 11

Leafcutter Ant



Atta colombica workers transporting leaves

Leafcutter ants, a non-generic name, are any of 47 species of leaf-chewing ants belonging to the two genera *Atta* and *Acromyrmex*. These species of tropical, fungus-growing ants are all endemic to South and Central America and parts of the southern United States.

The *Acromyrmex* and *Atta* ants have much in common anatomically; however, the two can be identified by their external differences. *Atta* ants have 3 pairs of spines and a smooth exoskeleton on the upper surface of the thorax while *Acromyrmex* have 4 pairs and a rough exoskeleton.

Next to humans, leafcutter ants form the largest and most complex animal societies on Earth. In a few years, the central mound of their underground nests can grow to more than 30 metres (98 ft) across with smaller, radiating mounds extending out to a radius of 80 metres (260 ft), taking up 30 to 600 square metres (320 to 6,500 sq ft) and containing eight million individuals.

Colony life cycle

Reproduction and colony founding



Atta colombica, queen with larvae and workers on substrate

Winged females and males leave their respective nests en masse and engage in a nuptial flight known as the *revoada*. Each female mates with multiple males to collect the 300 million sperm she needs to set up a colony.

Once on the ground the female loses her wings and searches for a suitable underground lair in which to found her colony. The success rate of these young queens is very low and only 2.5% will go on to establish a long-lived colony. In order to start her own fungus garden, the queen stores bits of the parental fungus garden mycelium in her infrabuccal pocket, which is located within her oral cavity.

Colony hierarchy

In a mature leafcutter colony, ants are divided into castes, based mostly on size, that perform different functions. *Acromyrmex* and *Atta* exhibit a high degree of biological polymorphism, four castes being present in established colonies - minims, minors, mediae and majors. Majors are also known as soldiers or dinergates. *Atta* ants are more polymorphic than *Acromyrmex*, meaning that there is comparatively less difference in size from the smallest to largest types of *Acromyrmex*.



Leaf cutter ant *Atta cephalotes*

- Minims are the smallest workers, and tend to the growing brood or care for the fungus gardens. Head width is less than 1 mm.
- Minors are slightly larger minima workers and are present in large numbers in and around foraging columns. These ants are the first line of defense and continuously patrol the surrounding terrain and vigorously attack any enemies that threaten the foraging lines. Headwidth are around 1.8-2.2 mm

- Mediae are the generalized foragers, who cut leaves and bring the leaf fragments back to the nest.
- Majors are the largest worker ants and act as soldiers, defending the nest from intruders, although there is recent evidence that majors participate in other activities, such as clearing the main foraging trails of large debris and carrying bulky items back to the nest. The largest soldiers (*Atta laevigata*) may have total body lengths up to 16 mm and head widths of 7 mm.

Ant-fungus mutualism

Their societies are based on an ant-fungus mutualism and different species use different species of fungus, but all of the fungi the ants use are members of the Lepiotaceae family. The ants actively cultivate their fungus, feeding it with freshly-cut plant material and keeping it free from pests and molds. This mutualistic relationship is further augmented by another symbiotic partner; a bacterium that grows on the ants and secretes chemicals, - essentially the ants use portable antimicrobials. Leaf cutter ants are sensitive enough to adapt to the fungi's reaction to different plant material, apparently detecting chemical signals from the fungus. If a particular type of leaf is toxic to the fungus the colony will no longer collect it. The only two other groups of insects that have evolved fungus-based agriculture are ambrosia beetles and termites. The fungus that is cultivated by the adults is used to feed the ants larvae and the adult ants feed off the leaf sap. The fungus needs the ants to stay alive, and the larvae need the fungus to stay alive.

Waste management



Workers of *Atta colombica* at work



Two leafcutter ants



Leafcutter ants in Costa Rica

Leaf-cutter ants have very specific roles when it comes to taking care of the fungal garden and dumping the refuse. Waste management is a key role for each colony's longevity. The necrotrophic parasite *Escovopsis* of the fungal cultivar threatens the ants' food source, and is of course a constant danger to the ants. The waste-transporters and waste heap workers are the older, more dispensable leaf-cutter ants, ensuring that the healthier and younger leaf-cutter ants can work on the fungal garden. The *Atta colombica* species, unusually for the *Attine* tribe, have an external waste heap. Waste-transporters take the waste, which consists of used substrate and discarded fungus, to the waste heap. Once dropped off at the refuse dump, heap-workers organise the waste and constantly shuffle it around to aid decomposition. A compelling observation of *Atta colombica* was that the dead ants were placed around the perimeter of the waste heap.

In addition to feeding the fungal garden with foraged food, mainly consisting of leaves, it is protected from *Escovopsis* by the antibiotic secretions of *Actinobacteria* (genus *Pseudonocardia*). This mutualistic microorganism lives in the metapleural glands of the ant. *Actinobacteria* are responsible for producing the majority of the world's antibiotics today.

Parasitism



Collecting leaves

When the ants are out collecting leaves, they are at risk of being attacked by the phorid fly, a parasitic pest which lay eggs into the crevices of the worker ants head. Often a minim will sit on the worker ant and ward off any attack. Also, *Escovopsis* is highly virulent and has the potential to devastate an ant garden. *Escovopsis* is horizontally transmitted. Currie *et al.* (1999) found that *Escovopsis* was cultured, during colony foundation, in 6.6% of colonies. However, in 1 to 2 year old colonies almost 60% had *Escovopsis* growing in the fungal garden.

Interactions with humans

In some parts of their range, leafcutter ants can be quite a nuisance to humans, defoliating crops and damaging roads and farmland with their nest-making activities. For example, some *Atta* species are capable of defoliating an entire citrus tree in less than 24 hours. In Central America, leafcutter ants are referred to as "Wee Wee" ants, though not based on their size. They are one of the largest ants in Central America. Deterring the leafcutter ant *Acromyrmex lobicornis* from defoliating crops has been found simpler than first expected. Collecting the refuse from the nest and placing it over seedlings or around crops resulted in a deterrent effect over a period of 30 days.