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*In this human dominated biosphere, ants share a place unparalleled by any form of life, which our human species have now started to reckon with.*



# Ants Superorganisms of the World!

**H**UMANS recklessly crush these tiny, elegant creatures under their feet. Children often take pride in squashing these defenceless creatures. And, of course, none of us gives even a fleeting thought to their existence at all and think of them as irritating pests that should be got rid of.

Most of us are unaware of the fact that ants are an important and indispensable part of our ecosystem. These tiny creatures have existed on earth much before the arrival of the human race, originated 145 million years ago

and were witness to the extinction of dinosaurs!

The fascinating world of ants has received much attention during the last decade or so and they have been given the status of 'Superorganism', much superior to human species in terms of development, intricacies and evolution. Due to their great adaptability, ants have occupied every possible niche or habitat found on land, forest canopies, rotten logs, crevices, and braved the freezing temperatures of high altitudes. Almost 30,000 species of ants are estimated on

earth, out of which more than 12,000 have been discovered, of these about 660 from our country.

## Friends of Humans

Ants play an important role in our survival. They are the major soil turners, channelers of energy, pollinators, scavengers, biological control agents, indicator organisms monitoring ecosystem health and are important components of our food chain. Ants constitute one-tenth of the total biomass on earth, roughly equal to the total biomass of all the people on earth. If ants perish human species may not be able to generate resources and clear debris from earth. Unfortunately, with growing penetration of anthropogenic activities in natural ecosystems, about a dozen ant species have turned pests. *Monomorium pharaonis* (Pharaoh's ant) is a common example of this.

## World of Ants

An ant colony is built up by the queen ant. After its nuptial flight, a fertile queen finds a suitable nesting site for laying eggs. The eggs hatch into tiny larvae. The first batch of larvae is tended by the queen itself. The larvae change into pupal stage and finally



The Queen Ant



Food shared by ants

FEATURE ARTICLE



Army Ant



Leafcutter Ant



Ant with brood



Harvester Ant



Redfire Ant



High Altitude Ant



Weaver Ant



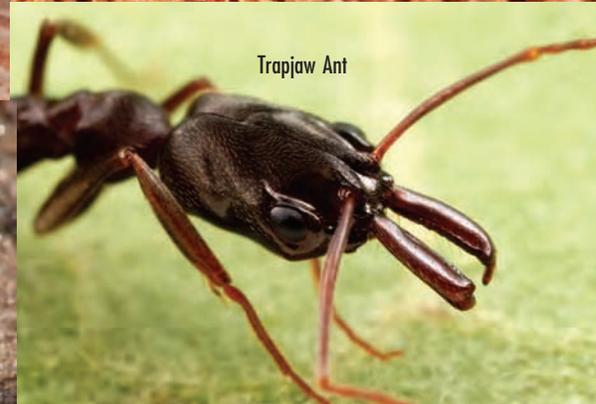
Ant frightens death



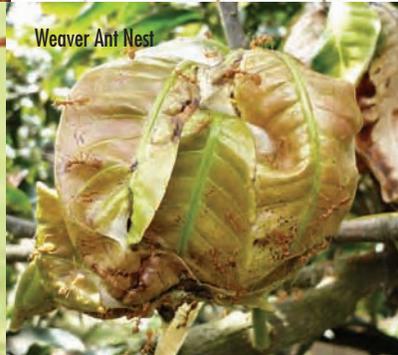
Jumping Ant



Ant with Larva



Trapjaw Ant



Weaver Ant Nest

*“The neglect of ants in science and natural history is a shortcoming that should be remedied...”*

*Bert Holldobler*

*The workers exhibit a variety of behaviour – cooperation with nest mates, defending the nest from robbers, organizing food raids, looking for the best food, tending to the immature ants in the nest etc. All their efforts are targeted at ensuring the survival of the colony.*

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the first batch of workers emerges. These workers then take up the responsibility of feeding the young ones – the larvae as well as the queen. The worker caste differentiates into soldier caste, foragers, feeders etc. and works on the principle of division of labour.

Thus, a single ant colony with a set of workers performing different tasks can be compared to the human body where organ systems perform different functions. In this way, an ant colony is established with one colony containing up to 20 million workers. During the reproductive phase of the colony, the queen produces future queens and males. The queen ant may live up to 20-30 years, worker ants up to 60 days and males for few days, their main task is to inseminate the female.

The workers exhibit a variety of behaviour – cooperation with nest mates, defending the nest from robbers, organizing food raids, looking for the best food, tending to the immature ants in the nest etc. All their efforts are targeted at ensuring the survival of the colony. They are a unique example of unbinding co-operation and high degree of unselfishness.

While performing all these tasks thousands of workers communicate for smooth functioning of the colony. The ants do not communicate verbally, or visually, but use the language of chemical cues to communicate. Ants release specific chemicals called pheromones along with tactile cues (tapping each other's antennae) to elicit a specific response from fellow workers. They use a blend of chemicals for recruitment of nest mates for collecting food; or to alert the entire colony when attacked by intruders. Moreover, a unique colony odour is present in each ant's nest, which is released by the queen ant. Thus, each colony has a specific odour by which its members recognize nest mates from non-nest mates.

Many of the ants have been grouped on the basis of specific tasks performed by them. These include: a) Harvester ants, b) Weaver ants, c) Leaf-cutter ants, d) Army ants and e) Fire ants.

**a. Harvester ants:** The harvester ants have been named so as they harvest seeds of different types of grasses and mainly belong to *Messor*, *Pogonomyrmex* and *Pheidole* genera. These can be easily spotted in a garden, park or lawn where they create corridors or passages on land which look like passages created by repeated movements of humans. The ants collect grass seeds, remove their plumule, so that they don't germinate and store them in well-kept nest godowns. After consumption, the hard seed coats are thrown out of the nests and can be noticed in abundance outside their nests.

**b. Weaver ants:** As the name suggests they weave nest with leaves. One of the prominent groups in this category is *Oecophylla*. These can be spotted on mango, citrus and guava trees and are quite ferocious in nature. These ants exhibit marvelous architecture and intelligence to build their nest with leaves. The workers capture their larvae quite delicately in their jaws and move them to and fro on the edges of young tender leaves, in response to this movement or tingling feeling, the larvae release sticky material from their glands. Then the other workers fold these leaves and join them with the secreted glue. To join the two leaves (which are quite apart), ants form chains by holding each other's waists and thus pull the leaves together.

Weaver ants are used in biological control to increase fruit yield and their brood is used in Chinese soups, drugs, as food and as aphrodisiac in many parts of the world.

**c. Leaf-cutter ants:** This group contains about 47 species belonging to the genera *Atta* and *Acromyrmex*. These are endemic to Central, South America, Mexico and United States. Leaf-cutter ants initiated agriculture much earlier as compared to the human species. These ants bring fresh leaves and plant cuttings into their nests; which are further cut into smaller pieces and are treated with ants' faecal liquid. Then these are dumped into that part of

the nest where fungus is cultivated to digest leaf cellulose. The most interesting part of the story is that if even the most advanced human species is forced to live with fungus culture, it may not be able to bear the brunt of pathogens, but these superorganisms are least susceptible to such infections. The resistance developed is unparalleled in any form of life.

**d. Army ants:** This group contains more than 200 ant species. In our part of the world these belong to *Aenictus* and *Dorylus* genera. These carry raids in groups attacking prey *en masse*. Army ants can consume up to 100,000 prey animals each day and thus have a significant influence on the population, diversity, and behaviour of their prey. Army ants on the march are known to kill tethered horses, human babies, lizards, snakes, chickens, and small mammals. They also climb trees and attack birds in nests and have even been used to execute criminals. These don't make permanent nests like other ants, instead build a living nest with their bodies, known as a bivouac and keep moving like nomads. It is a treat to watch a moving column of these ants in tandem and rhythm without exchanging a single word. It can make the most efficient army of the world envious.

**e. Fire ants:** Fire ants include a variety of stinging ants with more than 285 species worldwide. They have several common names, including ginger ants, tropical fire ants and red ants. The most commonly heard fire ant is *Solenopsis invicta*, known in the United States as the red imported fire ant (RIFA). It 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, and came to infest the majority of the Southern and Southwestern United States. In our country a similar species *Solenopsis geminata* exists.

Unlike many other ants, which bite and then spray acid on the wound, fire ants only bite 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, it hurts, a sensation similar to what one feels when burned by fire—hence the name fire ant.

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### Unraveling Ants

The wonderful world of ants has been explored by researchers to unravel marvelous pieces of scientific information. The genome of six ant species has already been worked out, which include *Harpegnathos saltator* (jumping ant, common in India as well), *Camponotus floridans* (Florida carpenter ant), *Atta cephalotes* (leaf cutter ant), *Linepithema humile* (Argentine ant), *Pogonomyrmex barbatus* (Red harvester ant) and *Solenopsis invicta* (Red Fire ant).

Ants of the same species but in different social castes have the same DNA sequence but assume radically different characteristics as a result of 'epigenetic changes' — DNA modifications that affect the expression of genes rather than the genes themselves. By examining the sequences from jumping ant and Florida carpenter ant, researchers have been able to identify how these epigenetic changes affect the ants' characteristics. The results provide a tantalizing link between ageing mechanisms in ants and other organisms. Two genes in case of jumping ant, one encoding the enzyme telomerase and the other encoding the protein SIRT1, are also associated with longevity in humans.

In the case of Argentine ant, 367 genes are meant for odour receptors (twice in number as compared to honey bee), which help to distinguish between their friends and enemies. In fire ant genomics, G C content in DNA has been found to be 34.8% similar to most of eukaryotes and the genome is much larger and complex than most insects. Since both fire ant and Argentine ant are invasive species, disrupt ecosystems, and harm crops, the genomes would help ascertain how to use the ants' reliance on its own odours against them without using environmentally toxic pesticides.

The next step in this direction is the comparison of various ant genomes to study how the invasive species have diverged from their native counterparts and whether pesticides like DDT could have accelerated ant evolution. The genome of red harvester ant (which is a model for studying reproductive division of labour, phenotypic plasticity, and sociogenomics) revealed that gene networks involved in generating key differences between the queen and worker castes (e.g., wings and ovaries) show signatures of increased methylation. These findings indicate that ants and bees may have independently co-opted the same gene regulatory mechanisms for reproductive division of labour.

The leaf-cutter ant, which cannot survive without its fungus food, has slimmed its genome to get rid of those genes it no longer requires due to its symbiotic life style. Thus the evolutionary trades of one of the most successful association in nature between leaf-cutter ant and its fungus can be read through DNA.

Such is the importance of these world's premier social organisms that "An Ant Tree of Life Project (Ant AToL)" is being carried to understand their evolutionary patterns. Besides, a big Barcode initiative of life has also been initiated for ants as well, where DNA barcodes of all the ant species present on earth are being generated with active participation from India also.

### Communication in Ants

Ants communicate by biological molecules; of much interest in recent times among these molecules are cuticular hydrocarbons (CHC) which provide important cues for nest mate and caste recognition. Scientists have already elucidated CHC profiles for about 80 ant species. Such 1000 different CHCs have been recognized, which act due to switching on or off of particular biosynthetic pathways.

A very interesting piece of information which appeared online recently in the journal *BMC Ecology* reveals that a newly described species of silver fish (*Malayatelura ponerophila*) spends its entire life among a colony of army ants (*Leptogenys distinguenda*). To avoid being spotted, it rubs against baby ants to pick up their scents i.e. CHC profile, so that the smart silver fish gets free food and shelter and is considered part of family until it has the scent.

### Adapting Ants

Ants have adapted to high altitudes well and such ant species are termed as cold hardy species, since they can survive in subzero temperatures of winter. Himalayan ants belong to this category and recent discoveries of new species from Himalaya by the author and his team has revealed that these ants are quite distinct in their features and have diversified in this region after the formation of the Himalayas.

The most significant discovery is a potentially redlist socially parasitic species named as *Myrmica nefaria* (nefaria means robber). This species has very unique features, and has been reported with males and workers along with host species and exemplifies the concept of sympatric speciation (the formation of species with in the same region without geographical isolation contrary to the widely accepted view that new species are formed due to some geographical barrier like mountains etc.).

Queens of socially parasitic ants invade the nests of other ants by using various means (by killing the host queen, picking up scents of the colony or mimicking CHCs of that particular colony so that they are not noticed) and capitalize on the host resources without using their energy. Thus they don't produce the worker caste and are termed as inquillines. Moreover, 94% of the Himalayan ant fauna has been found to be endemic to this region and due to its exceptional features or adaptive strategies needs conservation.

Ants of leaf litter are mostly specialized predators and are of interest to researchers. In the last decade more focus has been to look for leaf litter ants and one of the remarkable discoveries is the ant *Martialis heureka* (*Martialis* means from Mars and *heureka* means surprising discovery) from the Amazon rain forest, which has shed light on the evolutionary patterns in ants. In our country, Western Ghats also harbour a number of leaf litter ant species.

Due to a great deal of anthropogenic activities invading in to natural ecosystems the world over, these ecosystems are getting disturbed. To measure such disturbances indicator organisms that are supposed to encapsulate all information about the ecosystem or which act as surrogate organisms for that ecosystem are used and ants have been found to be most effective indicator organisms. Researchers in developed nations have

AMAZING FACTS ABOUT ANTS

- The first comprehensive book on ants entitled "The Ants" written by Bert Holldobler and Edward Wilson was awarded the prestigious "Pulitzer Prize" for General Non-Fiction in 1991.
- Ant specialist and biologist Edward Wilson was awarded Crafoord Prize, 1990, a prize awarded by the Royal Swedish Academy of Sciences in certain sciences not covered by the Nobel Prize, and therefore considered the highest award given in the field of ecology.
- Ant brain contains 250,000 neurons, the largest brain among insects and the largest in proportion to body size among all animals on earth. The processing power is almost similar to Macintosh II computer.
- Ants which do not have a sting squirt a spray of formic acid in defense.
- In some ants jaws are held open from 180° to 270° and snap shut on a hair trigger to capture the prey.
- More than 40 chemicals are used by ants for communication.
- In some species, workers vibrate their heads or bodies against some wood or nest structure, when the queen ant is passing by to inform other members of the nest about the location of the queen.
- Ants also domesticate cows like humans; these cows are aphids, mealybugs and other insects. These plant sap-sucking insects excrete material rich in nutrients called honeydew, ants feed on this

- honeydew and in turn protect their cows from predators.
- Many plant species have developed special structures to harbour ants, ants make their nests in these structures and the plant gets protection in return.
- Ants remove dead bodies of fellow mates and debris to maintain hygiene of the nest, on the contrary some species keep fragmented body parts of their colleagues as remembrance in their nests.
- Infected or diseased ants perform less social interactions, so that others are not infected and spend most of their time outside the nest before their death.
- Some ants show jumping behaviour, some feign death when captured, some show aggressive postures.
- In the deserts of Arizona, Harvester ants collect seeds in the day time, but during night a different species of ants covers up the nest holes of Harvester ants in order to block the entrances. So that the other species could collect seeds during night and the next day, when harvester ants waste most of their time to unplug entrances.
- The leaf cutter ants are of immense importance in tropical and sub-tropical ecosystems and are also major pests in cultivated fields of Central and South America and harvest about 85-470 kg (dry weight) total plant biomass per colony per year.
- Ants are also smuggled and colonies are kept, the trade known as ant farming growing day by day.

- Ant colonies can cross river by combining themselves in to water tight balls and floating until the ball finds dry land.
- The Slave-Maker ants raid the nest of other ants, steal their pupae and once the pupae hatch, they are used as slaves in the colony.
- Some ants don't produce workers, the queen enters another queen's nest, kills the host queen and dictates terms to the host workers.
- Fire Ants cause the most bites and deaths among other ant species, about 20 deaths in the world per year.
- In United States \$5 billion is spent annually on medical treatment, damage, and control in Red Imported Fire Ant infested areas. Furthermore, the ants cause damage annually of about \$750 million to agricultural assets, veterinarian bills, livestock loss and crop loss.
- Red imported fire ant (*Solenopsis invicta*), tropical fire ant (*Solenopsis geminata*) the big-headed ant (*Pheidole megacephala*), the little fire ant (*Wasmannia auropunctata*), the Argentine ant (*Linepithema humile*), the yellow crazy ant (*Anoplolepis gracilipes*), Pharaoh's ant (*Monomorium pharaonis*), Singapore ant (*Monomorium destructor*) and black crazy ant (*Paratrechina longicornis*) are the major species of tramp/invasive ants, known to cause devastating ecological effects. Out of these, five (tropical fire ant, big headed ant, yellow crazy ant, Pharaoh's ant and Black crazy ant) have already spread in our country as well.

successfully used ants as indicator organisms to assess the health of deteriorating ecosystems.

Interestingly, the same mechanism has also been used in our country to assess the health of the Shivalik range of Himalaya (which is currently under stress due to human activities) by the author and his team. It has been found that this range of Himalaya has been invaded by alien species of ants that displace native species and imbalance the ecosystem. To understand bio-geographical patterns of ants on earth various studies have been

conducted, so that the dispersal of organisms after the formation of continents could be better worked out.

In this era of technological revolution, ants are far more superior to advancing technology, because scientists have even studied the behaviour of ants to develop a new generation of antivirus software for computers. So, in this human dominated biosphere (noosphere) ants share a place unparalleled by any form of life, which our human species have started to reckon with.

To put in the words of great biologists Edward Wilson and ant specialist Bert

Holldobler, "The neglect of ants in science and natural history is a shortcoming that should be remedied, for they represent the culmination of insect evolution, in the same sense that human beings represent the summit of vertebrate evolution". Dr. Himender Bharti is with the Department of Zoology and Environmental Sciences, Punjabi University Patiala, Punjab-147002; Web: [www.antdiversityindia.com](http://www.antdiversityindia.com); Email: [himender\\_bharti@yahoo.com](mailto:himender_bharti@yahoo.com) / [himenderbharti@antdiversityindia.com](mailto:himenderbharti@antdiversityindia.com) / "Images © Alex Wild, used by permission" (The Queen ant, Food shared ant, Red fire ant, Harvester ant, Jumping ant, Trapjawed ant, Leaf cutter ant).