Unit - 11

Social life of insects

Structure of the Unit:

11.1 Objectives

After completing the unit, you will be able to understand about-

- Social life, behaviour and different caste system of termites of order Isoptera.
- Social life, behaviour and different caste system of bees of order Hymenoptera.
- Bee communication
- Social life, behaviour and different caste system of Wasps of order Hymenoptera.
- Social life, behaviour and different caste system of Ants of order Hymenoptera.
- Role of various factors like pheromones and nutrition in caste determination of different social insects.
- General introduction about aphids and its life cycle.

11.2 Introduction

Insects show a variety of social behaviours. Some of the social insects lives together in large groups, communicates, shares food, feed and protect the young ones and the eggs. The social behaviours are usually found in bees, ants, wasps and termites. The permanent living together of the insects is known as the colonies. They also work together for the survival.

In insects, females are mainly responsible for the foundation of the social colonies. The single female insect which is usually the founder of the social colony is termed as gyne the queen. It is termed the queen because after mating is the one which builds the nests where it will start with the laying of the eggs. After the young insects have been raised, they take the responsibilities of the queen, so that the queen may continue with her concentration on the reproduction.

One of the most significance of the social behaviour of the insects is communication. Insects communicate with each other in different patterns and modes. It is said that during darkness and in the crowd while they are in the nest, touch and smell are the most usefully used in conveying the messages. The queen as the mother of the nest release pheromones which is a chemical used to stimulate other members of the colony to act as unit among themselves.

11.3 Order – Isoptera

Social Life of Termites

In order Isoptera only one member 'Termite' exhibit social habit very similar to ants, bees and wasps. Termites are commonly known as “Deemak" or "White ants". Termites are found throughout India and are usually detected in natural habitats by their conspicuous earthen mounds, which may be as high as 3 or 4 metres in some areas depending on the species. Some termites build smaller earthen nests in trees while others construct a complex network of subterranean tunnels connecting larger galleries. Wood dwelling species do not build nests but live within the galleries they have excavated in the wood they feed on.

Characteristics of Termites

Termites are small to medium sized insects ranging form 3-20 millimetres in body length. These insects are not often seen although evidence of their presence is observable in the large mounds they construct or the damage they do to wood products and structures.

Termites consists of the following characteristic features:

- Pale, elongate body
- 2 pairs of membranous wings of equal length. Wings are present in reproductive castes only and they are shed after mating
- Mandibulate (chewing) mouthparts
- Antennae about the same length as the head

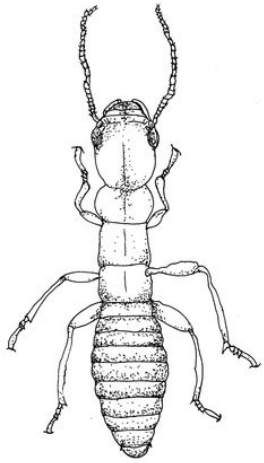

Figure - Termite (Worker)

Termites survives exclusively on cellulose and carry cellulose-digesting flagellates(Protozoa) inside their intestines. They make underground nests called **termatorium**, in which they maintain constant temperature and humidity, even when outside ground temperature rises to above 60 degrees, by constructing intricate overground natural air conditioners called termite-hills. As the wind passes through the ventilation galleries of the termite hill, the temperature of the nest drops fast. They never venture out in the open and construct earthen passageways on the trees, walls or on ground and move in the darkness of these tunnels. No wonder their eyes are rudimentary and they communicate almost exclusively in the chemical language. This peculiar underground habitat and shy nature has evolved in them due to a large number of predatory animals like giant anteaters, scaly anteaters, spiny anteaters etc. which exclusively live on termite diet and are always looking for them.

Difference between Ants and Termites

Although. Termites are termed as white ants but they are not ants. They are distinguished from ants by the absence of a constriction or peduncle between the thorax and the abdomen. Ants have unequal wings, their anterior pair of wing is larger, whereas the termites have equal wings. Termites live on wood and are nocturnal, whereas the ants live on sweet chemicals and organic matter and are diurnal. *Microtermes obesi* and O*dontotermes obsus* are two common species of termites found in India.

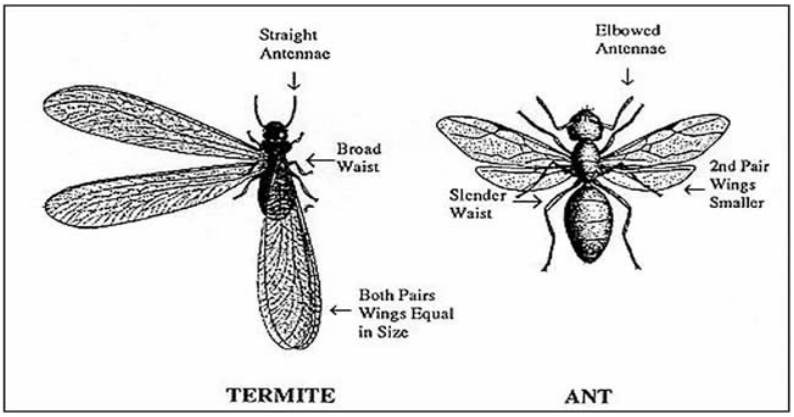

Figure – Comparison Of Termite And Ant

Termites were the first animals which started living in colonies and developed a well organised social system about 300 million years ago, much earlier than honey bees and ants. Although termites do not exceed 3-4 mm in size, their **queen** is a 4 inch long giant that lies in the royal chamber motionless since its legs are too small to move its enormous body. This phenomenon of enormous enlargement of abdomen in termite queen is called **physogastry**. Workers have to take care of all its daily chores. Termite queen is an egg-laying machine that reproduces at the astonishing rate of one egg per second, 24 hours a day and for about 20 years of life. Some Australian species are known to lay up to 60,000 eggs per day. Producing eggs is the only mission in the life of a termite queen. The other castes, **workers** and soldiers are highly devoted to the colony, working incessantly and tirelessly, demanding nothing in return from the society. **Soldiers** have long dagger-like mandibles (Mandibulate type)with which they defend their nest and workers chew the wood to feed to the queen and larvae and grow fungus gardens for lean periods. **Nasutes** are specialized soldiers having produced head that emits chemicals which help in further proliferation of tunnels in wood or soil .They are also specialized in chemical warfare. They are bulldozers of the colony.

Caste Differentiation

The colony of termites is managed by division of labour by caste differentiation. Termites exhibit polymorphism. Colony comprises two major castes (A) Fertile caste (B) Sterile Caste.

(A) **Fertile castes**: The fertile caste is of the following three forms:

a. Long winged adults or colonizing Adults: winged adults are produced in good number in rainy season and are actually winged males and female. Male and female individuals go on nuptial flight and copulate in the sky. After fertilization the female may have a

new colony separately. Males have well developed eyes and wings. Long winged adults are of two types.

i. Queen: The queen of *M. abesi* is 5 to 7.5 cm. in length. The sole function of the queen is egg laying. She lays about 70,000 to 80,000 eggs in 24 hours. The life span of a queen is recorded to be 5 to 10 years. The queen lives n royal chamber of the nest and feeds royal jelly. The queen is well served by the workers.

ii. King: The king is father of the colony living with the queen in the royal chamber. It is developed from an unfertilized egg by feeding on nutritive diet. It fertilizes the queen repeatedly to produce fertilized eggs for the hatching of the winged male, female and workers. Life of the king is shorter than the queen. So the king is replaced by a new one.

Both true kings and queen have two pairs of wings in the beginning but wings are ultimately discarded and only their truncated base remains present.

b. Short-winged adults (Brachypterous): These are supplementary or substitute or neotenic king and queen. Body is less pigmented. The two pairs of wing are short, vestigial and pad-like.

c. Wingless form (Apterous): There are worker-like substitute kings and queens which occurs in the more primitive species. The body is without pigmentation. There are no traces of wings.

(B) **Sterile castes**: These are form with rudimentary reproductive organs. This is of three types:

a. Workers: The workers are numerous and they perform all the duties of the colony except reproduction. The body has little or no pigmentation. The workers are commonly dimorphic, but sometimes trim orphic comprising small, intermediates and large individuals.

b. Soldiers: The soldiers are highly specialized. They are concerned with the defense of the colony against predictors. They are pigmented and large handed individuals with projected prominent mandibles. In some species three grades of soldiers-small, medium and large are present.

c. Nasutes: In higher genera (*Edutermes*) the mandibulate soldiers are replaced by other form called the nasutes. Their head is prolonged into a rostrum, bearing the opening of a large frontal gland at its

apex. The sticky secretion of the gland is inflicted upon their enemies in warfare and is used to dissolve hard substances, like concrete which fall in the way of the workers when building nest.

In breeding season which usually coincides with the rains, newly produced **males** and **females** grow wings and have nuptial flight to disperse to long distances. They make pairs and find a new place to start a colony by digging a shallow gallery and laying eggs that all hatch into workers to expand the nest.

Termite **nymphs** are diploid males as well as females that develop into sterile adults except those growing into nuptials in rainy season. There are 7 instars of nymphs and the last three instar nymphs function as workers. Unlike honey bees, termite adults are diploid in both sexes as they develop from fertilized eggs. Queen secretes inhibiting hormones that do not allow nymphs to develop into new queens. Differentiation of different castes in termites takes place by feeding the larvae with saliva of workers. Larvae that are fed on more saliva develop into sexual forms while nymphs that are fed on wood and fungus develop into workers and soldiers.

Swarming and mating

During rainy season, the winged forms of termites i.e. queen and king take a nuptial flight known as swarming. After a brief flight, these winged forms land on the ground and shed their wings. The flight is not a true nuptial flight, but only a dispersal flight since mating does not take place in the air. Mating takes place after they have descended to the ground, but before shedding their wings. unlike honeybee, mating is further repeated at irregular intervals. The generation of kings lives with the queen for whole life however have quite short life span and replaced by another male.

Founding new colonies

Each colony is founded by a royal couple. Together they excavate a small burrow or cavity in the ground called the nuptial chamber. The first laid eggs, by the young couple develop into workers. The Workers performs all the major duties of nest.

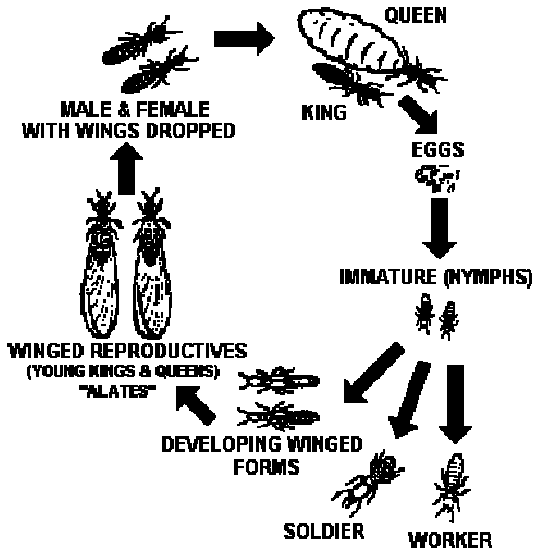

Figure – Life cycle of Termites

11.4 Order - Hymenoptera

Social Life of Honeybee

Honey bees are social or colonial insects that visit flowers, collect nectar and convert it into a golden-yellow aromatic viscous fluid called honey, which is also called the liquid gold of nature. Nearly 17,000 species of bees are found all over world out of which only 100 species are honey bees and some are stingless social bees which makes a permanent house , made up of sheets of wax. In the spring, a honeybee colony that has grown sufficiently large will split in two, with the old queen and half her worker along with a daughter who will become a new queen make chambers in the ground in cliff, and in hollow tree. There are often many such sites within range of the waiting swarm, but only some motivate a worker to perform a dance back at the swarm a dance that communication information about the distance and quality of the potential new home. Other workers attend to a dancing scout and may be sufficiently stimulated to fully out to the spot themselves. If it is attractive to them they too will dance and send still more workers to the area then the swarm leaves its temporary perch and flies to the most popular nest site.

The worker bees produce wax for the formation of the new hive and are known as builders. New hive is made hanging vertically from rock buildings or branches of trees consist of thousands of hexagonal chambers of cells made up of wax secreted by the builder's abdomen. The resins and gums secreted by plants are also used for construction and repair of the hive.

The larvae are kept in the lower and central cells in the hive which are the "Brood cells" In *Apis dorsata* a brood cells are similar in shape and size but in other species brood cells are of three types viz worker cell for workers drone cells for drones and queen cell for the queen cell is used once only while rest are used a number of times there are no cells for lodging the adults. They generally keep moving about on the surface of the hive. The cells are mainly intended for the storage of honey and pollen especially in the upper portion of the comb. Colony of honeybees consists of three castes Queen Drone and workers.

A bee colony has about 20,000 workers, one queen and about two dozen drones. If there is more than one queen in a hive, as happens in breeding season, then the phenomenon is known as **pleometrosis**.

Caste Differentiation

1. QUEEN(Gyne)

Queen is the fertile female only that can lay up to 3000 eggs per day, which is twice the weight of her body but normal fecundity is about 600 eggs per day. The size of the queen is largest among other castes of bees Queen can be easily identified by its long abdomen strong legs and short wings. The queen has ovipositor on the tip of the abdomen It is the egg laying organ. The contribution of queen for its scullery is to lay eggs.

Queen can produce male or female offspring . Unfertilized eggs develop into males and fertilized ones into females. Growing larvae, both of which are genetically females, can be developed into queens or workers by feeding them with royal jelly or pollen and honey by the workers.

Queen produces a number of pheromones which attract workers and keeps the colony together. The secretions of **mandibularglands**, **tergal** and **tarsal glands** of queen are licked by the workers and passed to other members of the colony and larvae through food exchanges called **trophallaxis**. If a queen is killed, workers in the absence of queen pheromones, rear a new queen from the developing female larvae. Queen pheromone also inhibits development of ovaries in workers. Queen pheromone has stimulating effect on the activities of workers, such as comb building, brood rearing, foraging and honey making. If a queen dies or disappears, workers rear a new queen by selecting a larva and modifying its cell to make a queen cell and feed it exclusively with royal jelly.

2. DRONE (Aners)

Males members are called as **drones**, which are darker, robust and hairy and larger than workers. Drones are haploid fertile males the size of drone is smaller than queen but larger than sterile females' i.e. workers.. They are developed from unfertilised eggs. There are about two dozen of them in a hive and chase the queen in air every time she ventures on nuptial flight. The secretions of **mandibular glands** and that of sting apparatus of queen attract drones during nuptial flight. They copulate with the queen and fertilize her eggs. Drones are not tolerated in the hive once the queen is fertilized and are generally driven out of hive, where they eventually die of starvation.

3. WORKERS(Ergates)

These are diploid sterile females and are smallest in size. They are sterile because of diet effect, queen substance and the pheromone. Their number in colony is the highest

The **workers** are genetically females but sterile as they are not fed on royal jelly in the larval stage. They have a lifespan of 6 weeks, the first half of which is spent in the hive attending to household chores, secreting wax and building hive, producing a highly nutritious royal-jelly and converting nectar into honey. They become foragers in the later part of life and tirelessly collect nectar and pollen throughout life. They eventually die during performing their duties, an excellent example of honest and selfless service for the society. An amazing phenomenon that has been observed in honeybees is their capacity to reverse their age should a catastrophe struck the colony. In case of a crisis, such as destruction of the hive, the 4-5 week old foragers start reversing their age and become younger to secrete **royal jelly** and wax, repair their hive, rear a new queen from the larvae and rebuild their colony. Members of a colony are heavily dependent on one another and cannot survive in isolation, even if kept in the best of conditions. They communicate by ultrasound signals, pheromones, dancing and gestures.

Workers possess numerous morphological adaptations to carry out their duties effeciently. Their **mandibular glands** secrete wax softening substance, **pharyngeal glands** secrete a gelatinous highly nutritious substance called Royal Jelly and stomach contains several glands that help in converting nectar into honey. There are **wax glands** on abdominal segments 4-7 which open by several ducts on to the sternites 4-7. Hind legs have tibia and basitarus modified to form a **pollen basket** . Mouth parts of workers bees are of chewing

and lapping type. Workers are sterile females and hence their ovipositors are modified in **sting** and accessory reproductive glands get modified to form alkaline and poison glands. A worker in its entire lifespan makes about a spoonful of honey. To make 500 grams of honey, bees have to extract nectar from more than 4 million flowers, for which they have to make about 50,000 trips of the foraging area ranging between 5 km .

In bee body the legs are modified and are hairy. When workers visit a garden of flower and sit on a flower pollen grains adhere to these hairs and other parts of the body Worker clean off pollen with the help of a special structure (the cleaners) present on each fore legs. Pollen brushes are present on every leg and pollen grains are stored in the pollen basket present on the outer surface of metatarsi on hind legs Nectar and water is collected in crop by sucking through mouth parts.

Worker bees possess **Nabokov scent gland** in their abdominal region which acts as a defensive organ and is modified ovipositor having a large poisonous storage sac and a sting. Poison storage sac contains a poisonous chemical. This chemical is injected into the body of enemy through sting. Worker bees attack collectively to the intruder and sting the intruder collectively.However, the tip of sting usually breaks into the body of intruder and the remaining secretion of alkaline gland mixed with that of poison gland (active poison) gets injected in her body thus it is killed by her own venom. Alarm and aggression pheromones are released by the worker bees from the abdomen by raising the tip of abdomen and protruding the sting apparatus.

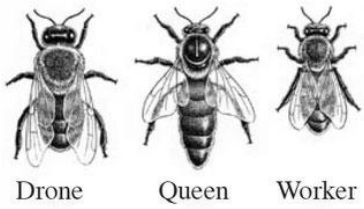

Figure – Caste differentiation of honey bee

Bees Terminology

Alates - the young winged reproductives of both sexes. From time to time about 100 to 1000 alates leave the colony for a mating and colonising flight. After mating a pair settles down at a suitable site like a rotting scar on a tree in order to establish a new colony.

De-alates, alates that cast their wings after the colonising flight and successively turn into queens and kings. Initially only a few eggs are laid and brought up by a female de-alate. As the number of individuals in the colony grows, the more workers are available to help the young queen to care for the brood. After three to five years the number of individuals is already so large, that the colony of a useful species can turn into a damaging stage.

Neotenics :assist the queen in laying eggs, once her productivity decreases. When the queen has died or deteriorated, one of the neotenics takes her place. That is the reason why the removal of a queen from her colony does not necessarily mean the end of the colony.

Attendants: Worker bees that are attending the queen. When used in the context of queens in cages, the workers that are added to the cage to care for the queen.

Abscond :When the entire colony of bees abandons the hive because of pests, disease or other adverse conditions.

Nasonov : A pheromone used given off by a gland under the tip of the abdomen of workers that serves primarily as an orientation pheromone. It is essential to swarming behavior and nasonoving is set off by disturbance of the colony. It is a mixture of seven terpenoids, the majority of which is Geranial and Neral, which are a pair of isomers usually mixed and called citral. Lemongrass (Cymbopogon) essential oil is mostly these scents and is useful in bait hives and to get newly hived bees or swarms to stay in a hive.

Colony collapse disorder (**CCD**) is the phenomenon that occurs when the majority of worker bees in a colony disappear and leave behind a queen, plenty of food and a few nurse bees to care for the remaining immature bees and the queen.

Nuptial Flight

Most interesting part in the life cycle of honeybee is its way of mating. Mating takes place during a flight called nuptial flight. Virgin queen takes a flight followed by males. A few males only succeed in mating. Queen and other males return to their comb. But now worker bees allow only the queen and all males are driven away and they die in nature. Polyandry is relatively rare in insects where a single female mates with several mates. But polyandry is common phenomenon in honeybee. Queen honey bee mates with several drones in succession during her nuptial flight.

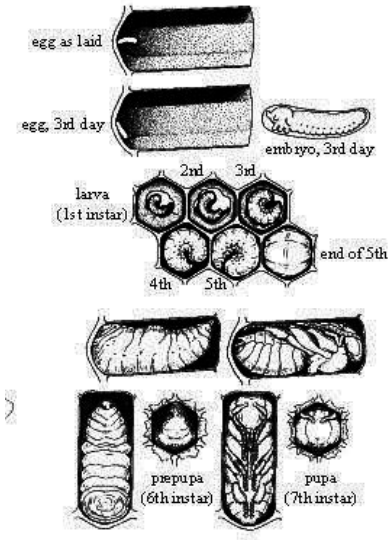

Figure – Developmental stages of honey bee inside hive cells

Bee Dance

Social behaviour in bees has a number of advantages. One of the most important of these is the ability to quickly mobilize a large number of foragers to gather floral resources that may only be available for a short period of time. The ability to communicate location with such precision is one of the most interesting behaviours of a very interesting insect honey bee.

The recruitment of foragers from a hive begins when a scout bee returns to the hive engorged with nectar from a newly found nectar source. She begins by spending 30-45 seconds regurgitating and distributing nectar to bees waiting in the hive. Once her generosity has garnered an audience, the dancing begins. There are 2 types of bee dances: the round dance and the tail-wagging or waggle dance, with a transitional form known as the sickle dance.

In all cases the quality and quantity of the food source determines the liveliness of the dances. If the nectar source is of excellent quality, nearly all foragers will dance enthusiastically and at length each time they return from foraging. Food sources of lower quality will produce fewer, shorter, and less vigorous dances; recruiting fewer new foragers.

Honeybee scouting means the individual bees which are searching for the environment without prior information about the possible location of food sources or nest sites. Although it is very difficult to study, the details of the bee communication or bee dance were worked out by Karl von Frisch and his colleagues and are detailed in his 1967 book *The Dance Language and Orientation of Bees.* Von Frisch was able to watch the bees perform dances by replacing one of the walls of the hive with glass.

1) The Round Dance

The round dance is used for food sources 25-100 meters away from the hive or closer. After distributing some of her new-found nectar to waiting bees the scout will begin running in a small circle, switching direction every so often. After the dance ends food is again distributed at this or some other place on the comb and the dance may be repeated three or rarely more times.

The round dance does not give directional information. Bees elicited into foraging after a round dance fly out of the hive in all directions searching for the food source they know must be there. Odour helps recruited bees find the new flowers in two ways. Bees watching the dance detect fragrance of the flower left on the dancing bee. Additionally, the scout bee leaves odour from its scent gland on the flower that helps guide the recruits.

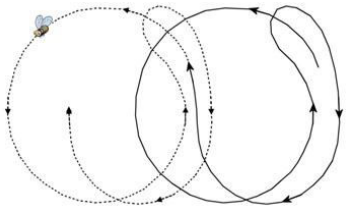

Figure – Round Dance

2) The Waggle Dance

As the food source becomes more distant the round dance is replaced by the waggle dance. There is a gradual transition between the round and waggle dance, taking place through either a figure eight or sickle shaped pattern.

The waggle dance includes information about the direction and energy required to fly to the goal. Energy expenditure or distance is indicated by the length of time it takes to make one circuit. For example a bee may dance 8-9 circuits in 15 seconds for a food source 200 meters away, 4-5 for a food source 1000 meters away, and 3 circuits in 15 seconds for a food source 2000 meters away.

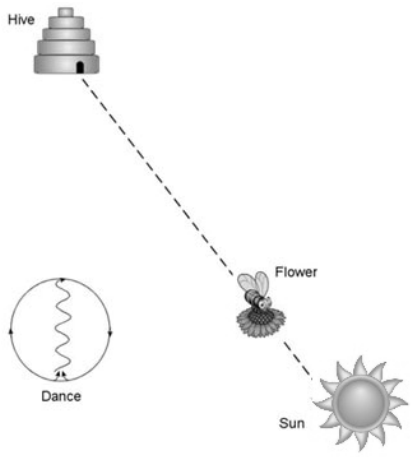

Figure -Direction of the food source is indicated by the direction the dancer faces during the straight portion of the dance when the bee is waggling. If she waggles while facing straight upward, than the food source may be found in the direction of the sun.

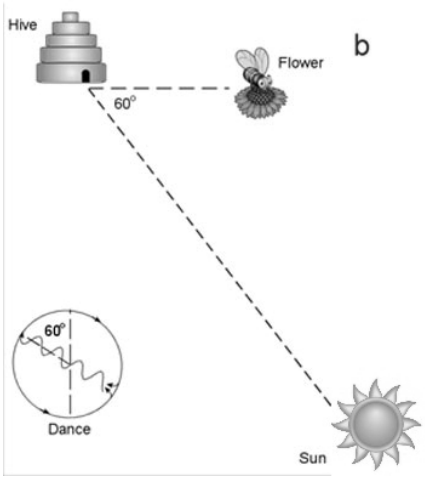

Figure - If she waggles at an angle 60 degrees to the left of upward the food source may be found 60 degrees to the left of the sun.

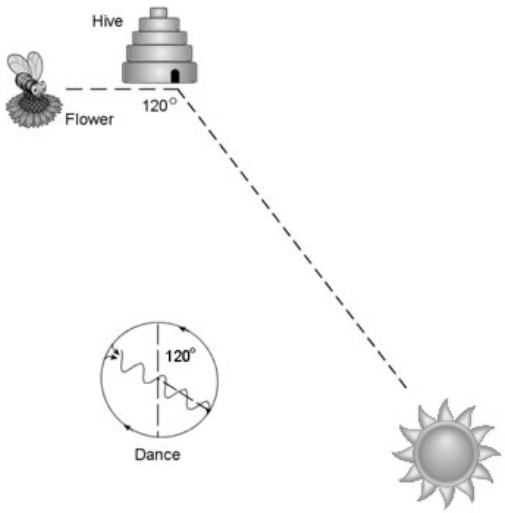

Figure -If the dancer waggles 120 degrees to the right of upward, the food source may be found 210 degrees to the right of the sun. The dancer emits sounds during the waggle run that help the recruits determine direction in the darkness of the hive.

Order – Hymenoptera

Social Life of Wasp

Eusocial behaviour among wasps is found only in certain members of the family Vespidae. These insects are commonly called paper wasps, hornets, and yellowjackets. They build communal nests by mixing wood fibres with saliva to form a paper-like material that can be moulded into brood cells and other nest components. The brood comb, where larvae are reared is always constructed like an inverted umbrella with open ends of the hexagonal cells facing downward. Workers usually cling to the underside of the comb as they guard the nest, feed the larvae, and perform other housekeeping chores. All social wasps are carnivores; their prey consists mostly of caterpillars and flies. The wasps chew up their victims' bodies into a paste that can be fed to their larvae and, in return, the larvae produce nutritional syrup that is consumed by the adults. A small colony of 200 yellowjackets may kill and eat about 5000 caterpillars over the course of a summer.

Wasps show transition from the solitary (non social) to the social life. During evolution transition from solitary to social life, species would have gone through different stages

1. Nesting together without much interaction

2. Nesting together with interaction and some division of labour

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3. Nesting together with one morphologically specialized queen or a small number of such queens, that can lonely reproduce.

Wasps cooperate together in nest building and brood care, and show some division of labour. But there is no morphologically differentiated queen. If workers get opportunity most, can become queens. Any female member of the colony can start a nest and bring up her offspring by herself without participating in social life. Thus wasps live in a primitive society. There are only two social aspects in context of social behaviour of wasps:

(i) The relationship between workers and grubs

(ii) The division of labour amongst their co-workers.

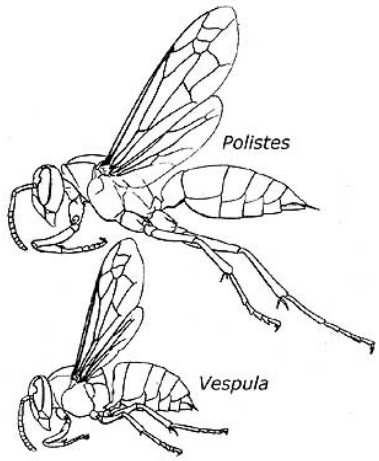

Figure – Common Indian Wasp species

One Indian species of wasps *Polistes herbreus* (Fabricius) shows social behaviour. The adults are smaller and yellowish in colour. The most prominent social wasp is *Vespa orientalis.* It is brownish and larger than yellow wasp. *Vespa niagnirica* is largest social wasp and it is dark brown in colour-

Wasps prepare their nests over walls, ceilings, and trees near human habitats. Nests of French wasps *(Polistes)* and Indian wasps *(Ropalidia)* have some hexagonal chambers in which embryos are reared. Wasps remain active in summer and hibernate in winter.

Through aggressive interactions the caste structure of the wasp's social system is maintained primarily among the colony members. If a queen fails to sustain

her dominant role, she will be replaced by another fertile female who assumes primary responsibility for egg production. Males develop only from unfertilized eggs which are usually laid by unmated workers.

In tropical climates, social wasps are active throughout the year. New colonies often form by fission or swarming in which a fertile queen and a group of workers leave a large parent nest and set up housekeeping for themselves. In temperate climates, wasp colonies are founded in early spring by one or more queens who mated the previous summer and hibernated throughout the winter. The foundress queen constructs a small nest containing just a few brood cells. After laying a small complement of eggs, she feeds and cares for her offspring until they emerge as adults. These individuals (all females) become her workers. They assume all brood care, foraging, and housekeeping duties.

The queen continues to lay eggs and the colony grows larger throughout the summer. In early fall, the colony structure begins to break down. Unfertilized eggs give rise to males who mate with newly emerging females that will overwinter and found new colonies the following year.

Types of social wasps. There are about 9700 species of wasps world-wide. They can be divided into three groups:

- **Yellowjackets.** Nests are usually built in underground cavities, such as old rodent burrows.
- **Hornets.** Nests are always located above ground. Some species colonize hollow trees while others hang brood comb from a tree branch and surround it with paper walls for protection against the weather and natural enemies.
- **Common paper wasps.** Nests are typically found under sheltered overhangs where they are protected from wind and rain.

Caste Differentiation

Wasps show different castes differentiation in comparison to bees. Generally wasp colonies do not have a well - differentiated queen. All wasps in a colony look alike. She may be queen for some time only because she is often challenged and driven away by one of the others, who then become the next queen. The individuals who are not queens at any given time act as workers. They do not reproduce but perform all the works of the nest such as to build the nest, forage for food, care for the brood and defend the colony.

New nest can be managed by one female or a group of females. If it is a single foundress colony, the foundress acts as queen and manages all by herself to

bring her eggs to adulthood.

In case of more than one or multiple foundress in the nest, one of the foundresses assumes the role of queen while the others assume the-role of-workers. In some wasp speciesqueens mate with a minimum of 3 males and simultaneously use sperm from different males and produce a mixture of full and half sisters among their daughters.

The queen lays eggs in the cells of the nest, when the eggs hatched out into larvae they are fed on a diet of hemipteran bugs, spiders, and caterpillars and occasionally some nectar, by the queen herself in single foundress nests and by workers in multiple foundress nests under normal conditions. Some of the workers or foragers search food and building material. Other members stays in home and working on the nest and on the brood. Among these, some are more aggressive toward other members of the colony, and these are called **fighters**. The remaining wasps work on the nest quietly and spend much time just sitting and grooming themselves, called as **sitters***,* Larvae pupate in the same cell. Pupa metamorphoses into an adult. The entire process of maturing from an egg into an adult wasp, may take about 2 months.

Generally if the wasp emerging from the pupa, it will stay on the nest for about a week and then leave to lead a wandering life, mate with some foraging female wasp, and die. But in some species males also spend their whole life in the colony except for brief periods when they leave the nest apparently to mate with wasps from the colonies. Mating never take place on the nest.

If the female wasp is emerging, she may leave to start a new nest all by herself or she may leave with a group of females to do so, or she may join females from other colonies to start a new nest. She may remain on the nest and assume the role of a worker in the colony of her birth. She may remain on the nest, work for some time, and eventually drive away the queen and take charge as the next queen in the colony of her birth. Such a power struggle may also take place between the co-foundresses in a new colony, so that one foundress may replace another even before producing any offspring.

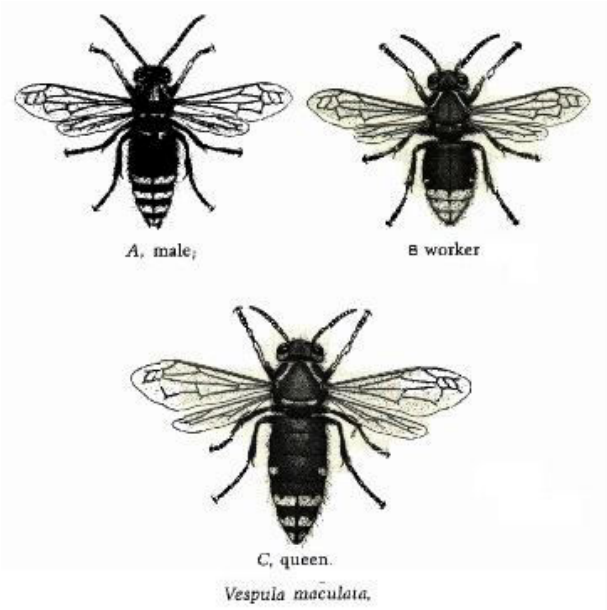

Figure – Caste differentiation of Wasp *Vespula maculata*

Nest of Wasp

Queens survive the winter by nesting in protected places such as under the bark of trees, or in cracks and crevices around structures. In the spring, several queens commonly get together to start a new nest. Eventually, one queen will dominate the others, making them serve as workers for the new colony.

By scraping and chewing wood into a pasty pulp, paper wasps make paper-like nests in the shape of an umbrella. These nests are built in protected locations including in shrubs, on tree branches, on porch ceilings, window and door frames, roof overhangs, attic rafters, and under decks, joists or railings. The queen deposits eggs in the brood cells on the underside of the nest. After the eggs hatch, the larvae are mostly fed other insects, such as caterpillars, that the worker wasps collect. Once the larvae have matured, they pupate in their cells and join the colony as an adult. Adult paper wasps mainly feed on nectar.

Southern Indian species of wasps *Ropalidia marginata* and *R. cyathiforrids,* are primitively social. These wasps build their nest from paper which they themselves manufacture from cellulose fibers scraped from plants. The size of the nest is very small, rarely exceeding 500 hexagonal cells.- Except for the brood, the wasps move on the surface of nest and not in it. The number of wasps in a colony rarely exceeds 100. This makes it easy to mark every individual wasp and make detailed observations on its behaviour, its interactions with other members of the colony, and its contribution to the

welfare of the colony.

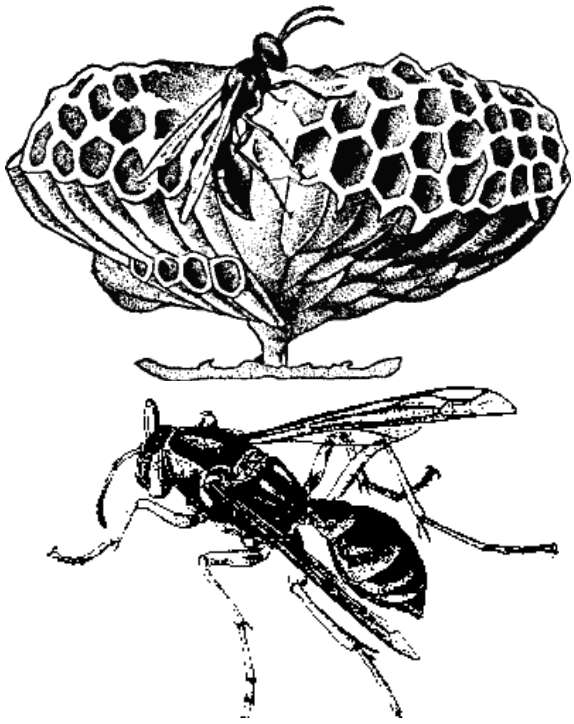

Figure- Paper Wasp Nest and Builder Social wasp

Order - Hymenoptera

Social Life of Ants

The ants are among the most highly evolved social insects. Like honeybee and termites they also have a very complex social organization. About 90% ant species are social. Ants live in colonies and a perfect division of labor exists amongst them. Ants are cousins of honeybees as they belong to the same order Hymenoptera, but the honeybees are diurnal and sleep in the night ants are busy working day and night. Ants have no wings, except in winged sexual forms that are produced in breeding season.

Ants have the highest developed social system, next only to man, with no apparent conflict seen in the society. A colony may have few thousand to over 500,000 individuals. The nests are built in various designs and are called **formicaria**. Like honeybees, they shows **polyethism**, which means castes are specialized to carry out specialized duties in the colony. For example, the queen has large abdomen to lay a lot of eggs approximately 2-3 million in a year, males fertilize her, workers have broad, sharp mandibles for cutting and chewing and the soldiers have large head that bears sharp dagger-like mandibles for fighting. Workers and soldiers are sterile females. Soldiers have

giant heads that they use it for blocking the entrance of the nest. They are extremely powerful creatures that can easily lift 20 times their own weight.

Ants have poorly developed senses of sight and hearing but have a highly sophisticated chemical language for communication. They possess glands that secrete pheromones or messengers of chemical language that is perceived by one of antennae or feelers located on head. They trade food, glandular secretions and enzymes, which is called **tropholaxis**.

The path of migrating ant columns is directed by the chemical trail of pheromones left by the scouts and constant body contacts among the following foragers. Sometimes if their chemical trail is washed away by rain, they are doomed to follow each other's trail in circular tracks with eccentrically high speed.

Most species constructs their nests in the ground or wood but some construct suspended nests on trees made of earth, carton, wax or silk, while some species of safari ants, do not build nests at all. Desert ants build crater-like nests or mounds in which they are able to maintain temperature much below the outside heat of deserts. However, workers of the colony are allowed entry after they gently tap on the head of doorkeeper soldier. The tropical ant *Oecophylla* makes nest by webbing the leaves together with silken thread that is produced by their larvae. While many workers hold the leaves close together, some workers hold the larvae in their mandibles and use them like living thread balls to spin web to attach the leaves together.

Almost all ants store food for the lean periods but in the Australian honey pot ants *(Myrmecocystus hortideorum* and *Camponotus inflatus),* some colony members are specially modified to store honey. Their bodies are sac-like and appendages modified as hooks. Their abdomen is enormously large to store honey and they remain hanged from the ceiling and perform no other apparent function. These casts are called **Repletes** which are specially adapted to store honey stolen by foragers from the bee hives.

Ants are also good gardeners like a man. They are known to cultivate grasses and harvest and store their seeds. Some species raid the nests of other species of ants and rob them of stored food and keep their members as slaves in their own nests.

Nest (formicaria) formation

SIMILARLY like other social insects, in ants also the new colony is founded by a single newly fertilized queen. Some species do not construct nests. They simply take abode in cervices, holes under stones, or logs. Some species temporarily occupy nests other ants, a relationship termed piesiobiosis. Most species make their own nest. The nests or formicaries are of different types located in different places. Ants make subterranean nests excavating galleries and c1am-ben in the-grounds, used as nurseries for brood, granaries for storing food. Many species make mound nests. Such mound nests are well exhibited by species of *Formica*. *Formica rufa* make mounds of 60-160cm. in diameter. Some species construct suspended nests made of earth cartoon (Saliva mixed with Vegetable matter) or silk hanging from trees in tropics and containing anastomosing galleries and chamber.

African weaver ants (*Oecophylla longinoda*) and Asian weaver ant (*Oecophylla smaragdina*) construct large conspicuous nests on tree by weaving together several leaves with silk. They obtain the silk from their own larvae. The colony of weaver ants consists of a single queen and two kinds of workers, the larger major workers who forage, construct the nest, and take care of the queen, and the smaller minor workers who care for the eggs and young larvae. The adult worker cannot product silk. The silk is produced by the larvae. It is well known to us that in most insect species the larvae use their silk to spin cocoon inside which the pupae undergo metamorphosis. The major weaver ant workers who need silk, hold larvae together during nest construction to obtain silk from these larvae. While some major workers maneuver and hold leaves together, other major workers hold larvae in their mandibles and weave them across the leaf. This makes the larvae release strands of silk from silk glands underneath their mouth. Male larvae have smaller silk gland and contribute less silk for nest construction or cocoon.

Castes Differentiation

According to Imms (1948) at least 29 distinct types of morphologically different individuals are known. The ants shows an extreme case of polymorphism. The main castes of ants are queens, workers and mates.

1. **Queen or Gynes**

   Queens are the fertile females. Queen is largest in size in comparison to other castes of their species. The antennae and legs are relatively shorter and stouter and the mandibles are well developed. Some species are winged

while some species are wingless. Usually large individuals are termed macrogynes, and dwarf ones, microgynes. Unlike honeybees, a colony of ants contains several queen.

An egg laying worker, gynaecoid, occurs in colony. She becomes normal queen if queen is lost due to any reason. Rarely there occur some peculiar individuals called gynandromorphy. They bear external secondary sexual characters of both male and female.

2. Workers of Ergates

Sterile female members of ant colony are called workers or ergates. Ergates are smallest in size and are characterized by a reduced thorax, and small eye. Workers shows mostly dimporphism i.e. large and dwarfs. The larger workers are called the macregates and dwarf individuals as micregates. Macregates are called the wrestlers of the colony for their ability to lift too many weights. They also have amazing sense of direction. Soldiers are modified workers (sterile female). They are without wings, with distinct heads and powerful. They protect the colony from enemies. Besides protection they serve to crush seeds and other hard food material.

In an ant colony number of army ants is very huge, it can be up to 22 million individuals. While on march they eat up everything edible in their path. Army ants (Eelton) have three types of workers. Small worker perform the task of feeding the developing broods. Intermediate size of workers works as foragers or scout ants. They search for the food site. Largest size of workers serves as soldiers who defends their colony. Some soldiers attack the colony of the insects and capture the young larvae and pupae of other ant colonies. Their captured larvae and pupae after hatching works as slaves in colony.

3. Males or Aners

These are small, fertile winged individuals. They bear proportionately smaller head, reduced mandibles, longer antennae, well developed reproductive organs and genitalia. The larger individuals arc called the macraners and the smaller one micraners.

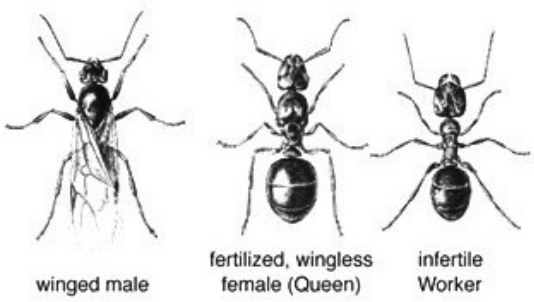

Figure – Caste differentiation of Ants

Life Cycle

Mating between male and queen occurs during nuptial fight. The queen lays eggs of about 0.5 mm size. The eggs hatch into larvae. The body of larva is legless and cylindrical. The queen feeds them with her saliva until the pupa stage. In a short time they change into the perfect insects. The earlier generations are of wingless worker which soon take over the charge of the colony, feeding and attending the queen and the brood. The winged males and females are produced later. Usually the ant colonies are perennial and continue to grow in size for many years. The population of nest of ant vary from a few thousand up to 5,00,000.

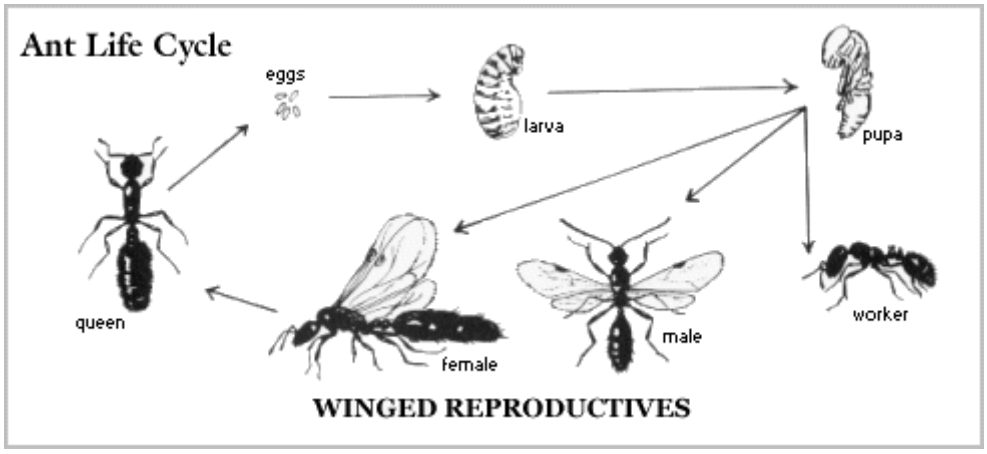

Figure – Life cycle of Ant

Caste Determination in Social Insects

Involvement of Pheromones

Pheromones are thought to play an important role in the physiological mechanisms underlying the development and maintenance of eusociality. In social insects very few members of a colony can become sexually matured because their reproductive development being inhibited by pheromones, so these individuals can perform other activities for the benefit of the colony as a whole by forming the worker caste. The regulation of caste differentiation in

social insects is a morphogenetic phenomenon, just as are the changes from larva to larva, larva to pupa, and pupa to adult. Such changes depend on the activity of the corpora allata which controls the level of juvenile hormone in the hemolymph for their manifestation.

BEES

The most well-studied queen pheromone system in social insects is that of the honey bee *Apis mellifera*. Queen mandibular glands were found to produce a mixture of five compounds, three aliphatic and two aromatic, which have been found to control workers. Mandibular gland extracts inhibit workers from constructing queen cells in which new queens are reared which can delay the hormonally based behavioral development of workers and can suppress ovarian development in workers. The levels of two of the aliphatic compounds increase rapidly in virgin queens within the first week after eclosion i.e. emergence from the pupal case, which is consistent with their roles as sex attractants during the mating flight. These behavioural effects are mediated by the nervous system often leading to recognition of queens as a releaser and physiological effects on the reproductive and endocrine system as primer are attributed to the same pheromones. It is only after a queen is mated and begins laying eggs, however, that the full blend of compounds is made. The physiological factors regulating reproductive development and pheromone production are unknown.

ANTS

In several ant species, reproductive activity has also been associated with pheromone production by queens. In general, mated egg laying queens are attractive to workers whereas young winged virgin queens, who are not yet mated, elicit little or no response. However, very little is known about when pheromone production begins during the initiation of reproductive activity or about the physiological factors regulating either reproductive development or queen pheromone production in ants.

Among ants, the queen pheromone system of the fire ant *Solenopsis invicta* has been well studied. Both releaser and primer pheromones have been demonstrated in this species. A queen recognizing releaser hormone is stored in the poison sac along with three other compounds. These compounds were reported to elicit a behavioral response from workers. Several primer effects have also been demonstrated. Pheromones initiate reproductive development in new winged females, called female sexuals. These chemicals also inhibit workers from rearing male and female sexuals, suppress egg production in

other queens of multiple queen colonies and cause workers to execute excess queens. The action of these pheromones together maintains the eusocial phenotype which includes one queen supported by sterile workers and sexually active males i.e. drones. In queenless colonies that lack such pheromones, winged females will quickly shed their wings, develop ovaries and lay eggs. These virgin replacement queens assume the role of the queen and even start to produce queen pheromones. There is also evidence that queen weaver ants *Oecophylla longinoda* have a variety of exocrine glands that produce pheromones, which prevent workers from laying reproductive eggs.

WASPS

Similar mechanisms are used for the eusocial wasp species *Vespula vulgaris*. In order for a *Vespula vulgaris* queen to dominate all the workers, usually numbering more than 3000 in a colony, she exerts pheromone to signal her dominance. The workers were discovered to regularly lick the queen while feeding her, and the air-borne pheromone from the queen's body alerts those workers of her dominance.

The mode of action of inhibitory pheromones which prevent the development of eggs in workers has been convincingly demonstrated in the bumble bee *Bombus terrestris*. In this species, pheromones suppress activity of the corpora allata and juvenile hormone secretion. The corpora allata is an endocrine gland that produces juvenile hormone, a group of hormones that regulate many aspects of insect physiology. With low juvenile hormone, eggs do not mature. Similar inhibitory effects of lowering juvenile hormone were seen in halictine bees and polistine wasps, but not in honey bees.

TERMITES

In addition to the worker caste, there exists in termites and ants a soldier caste. The number of soldiers present is proportional to the size of the colony, a feature suggesting that soldiers regulate the numbers in their ranks by production of a soldier inhibiting pheromone. However, the situation is made more complicated by a positive influence on soldier production by influence of pheromones on the part of the reproductives.

The pheromones regulating caste differentiation including the development of reproductives exert their effect, ultimately, via the corpora allata. In lower termites, for example, soldier formation can be induced in experimental colonies by administration of juvenile hormone through feeding, topical application, or as vapor. Thus, the soldier-inhibiting pheromone may act by

inhibiting the corpora allata or by competing with juvenile hormone at its site of action

INVOLVEMENT OF DIET

Caste determination in most social insects likely involves both nature and nurture. Diet and nutrition in addition to the pheromones plays an important role in caste differentiation. Diet had evolved the queens of different species of social insects a measure of reproductive control over their nest mates.

In highly eusocial wasps where castes are morphologically dissimilar, both the quantity and quality of food seem to be important for caste differentiation. Recent studies in wasps suggest that differential larval nourishment may be the environmental trigger for larval divergence into one of two developmental classes destined to become either a worker or a gyne.

All honey bee larvae are initially fed with **royal jelly**, which is secreted by workers, but normally they are switched over to a diet of pollen and honey as they mature; if their diet is exclusively royal jelly, however, they grow larger than normal and differentiate into queens. This jelly seems to contain a specific protein, designated as royalactin, which increases body size, promotes ovary development and shortens the developmental time period. Furthermore, the differential expression in *Polistes* of larval genes and proteins also differentially expressed during queen versus caste development in honey bees indicate that regulatory mechanisms may occur very early in development.

In a beehive, the larvae are destined to be sterile females in form of strong workers if they are given the heartiest meals, packed full of not only processed pollen, called 'beebread,' but also a substance known as 'royal jelly. This is believed that larvae destined to be queens are exclusively fed royal jelly not a beebread for royalty, it contains powerful nutrients.

Mysterious milky substance is largely just water and sugar, and contains only one key ingredient called **royalactin**, is also present which somehow influences queen growth. Royalactin is a trace amount of a protein commonly present. A recent study shows that royal jelly lacking royalactin cannot make a queen.

It was found that phytochemical p-coumaric acid is found in beebread and honey which interfere with the path to queen development. Specifically, about a third of the honeybee genome is upregulated to make a strong worker, while another third are downregulated, changing the landscape of proteins available to help fight disease or develop the bees' reproductive parts.

Larvae become modified into different castes like small workers, large workers, or new queens which are based largely on the nutrition they receive. Those fed more insects than seeds are more likely to become larger individuals (queen > large worker > small worker). However, genetic differences also contribute and bias the larva's developmental pathway. Even once caste is determined, nutritional, colony size, and genetic factors all contribute, but in different ways, to how big an individual grows.

Although genetic factors contribute to what caste an individual becomes, the environment of the larva is controlled by the workers. Quite generally, ant colonies are supreme examples of both conflict and cooperation each extreme of the nature-nurture continuum.

11.5 Order – Hemiptera

Aphids

Aphids are known as plant lice, greenflies, blackflies, or whiteflies, (not jumping plant lice or true whiteflies). These are small sap-sucking insects, and members of the superfamily Aphidoidea. Aphids are among the most destructive insect pests on cultivated plants in temperate regions. The damage they do to plants has made them enemies of farmers and gardeners the world over. From a zoological standpoint they are a highly successful group of organisms. Their success is due in part to the asexual reproductive capabilities of some species.

About 4,400 species are known, all included in the family Aphididae of order Hemiptera, the mouth parts of which are modified to form piercing and sucking tubes, the insects obtaining their food by sucking plant juices or the blood of other animals. There are over 400 species and varieties of aphids but around 250 species are serious pests for agriculture and forestry as well as an annoyance for gardeners. This group of insects has an incomplete metamorphosis, there being no pupal stage but a series of moults in which the nymph gradually becomes a mature adult.

Aphid are with a complex lifecycle found widespread throughout cold, temperate, and warm climates across Europe, Asia, Africa and the American continents. The species can cause economic damage to plant crops as a result of its direct feeding activity. In high enough densities it can remove plant nutrients which can potentially cause a reduction in the number of heads, the number of grains per head, and a reduced seed weight

It may cause yellowing to upper leaves and ears, symptoms which are common to many aphid species and plant pathogens. Indirect damage can be caused by excretion of honeydew, and as a vector for viruses. It is found on many widely cropped species throughout the world.

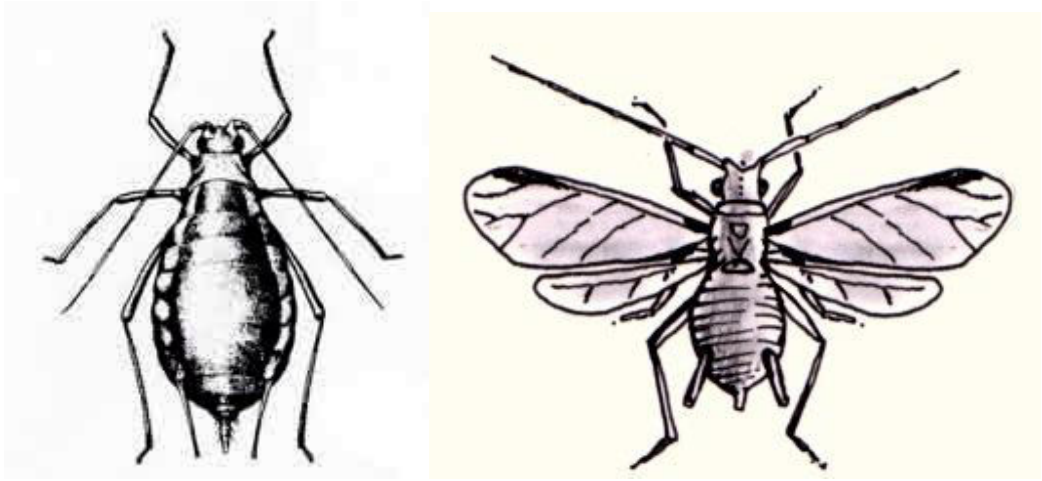

Figure – Aphids : Wingless and Winged form

Nymphs and adults feed in the similar way. Their mouth parts consist of a slender tube with two sharp stylets running down each side. All these are enclosed in the sheath-like labium and are held horizontally below the thorax when not in use. During feeding the labium is bent and shortened as the stylets and central tube are pushed through the epidermis of the leaf or stem until they reach the sieve tubes of the phloem in a vascular bundle. Saliva is injected through the puncture to begin the digestion of the sap and cytoplasm, and the fluids are then pumped up by muscular movements of the gullet into the alimentary canal. The fluid pressure existing in most plant cells probably assists the flow of liquid through the aphid's mouth parts. Most aphids seem to take in from the plant sap more sugar than they can assimilate, so that their faeces consist of a sweet syrup, honey dew, that is passed out of the anus. Some species of ant like to feed on this exudation and may be seen clambering over the colonies of aphids on nettles and other plants to collect it. Other species of ants ‘farm’ aphids by keeping them in the nest below ground where they suck fluids from roots, the ants then collect the honey dew as it is egested.

Life Cycle

Aphid species have unusual and complex reproductive adaptations, while some species have fairly simple reproduction. Adaptations include having both sexual and asexual reproduction, creation of eggs or live nymphs, and switches

between woody and herbaceous types of host plants at different times of the year.

When a sophisticated reproductive strategy is used, only females are present in the population at the beginning of the seasonal cycle (although a few species of aphids have been found to have both male and female sexes). The overwintering eggs that hatch in the spring result in females, called fundatrices. Reproduction is typically parthenogenetic and viviparous.

In October the females lay eggs usually on the stems of trees or shrubs. The eggs are black, with thick shells and can withstand extremes of temperature. It is in the egg form only that aphids pass the winter. In March the eggs hatch out into wingless female nymphs which are similar to the adults, with three pairs of legs, compound eyes, antennae, etc. There is no larval or pupal stage comparable to those of the butterfly, but with successive moults and continuous growth the nymphs become mature females. No males are hatched at all.

The female nymphs feed on the shoots and leaves of the tree on which they hatch, at the time when the buds are sprouting. After a series of ecdyses (moults) they become mature and give birth to daughter aphids without any fertilization. This kind of reproduction is called **parthenogenesis**. Eggs are parthenogenetically produced without meiosis and the offspring are clonal to their mother. The embryos develop within the mothers' ovarioles, which then give live birth to first-instar female nymphs (viviparous). The offspring resemble their parents in every way except size, and are called virginoparae. The daughters, moreover, are not produced from eggs but are born alive as nymphs though they are surrounded at first by a transparent capsule like an egg membrane.

The daughters grow quickly and themselves have offspring by parthenogenesis. Some of these develop wings which grow larger at each **ecdysis**. These winged daughters fly off to an herbaceous plant such as a rose tree or bean plant. The winged forms have two pairs of wings of which the hind pair are quite small. Both pairs are transparent with few veins. The aphids are not strong fliers but tend to be carried by chance air currents rather than make direct flights.

When the winged generation reach the new food plant they give birth to wingless daughters parthenogenetically. In warm weather these may mature in 8 to 10 days and begin to reproduce in the same way by bearing winged daughters which fly off and infest new plants. This process of parthenogenesis goes on all through the summer months, winged and wingless generations more

or less alternating. Enormous numbers of aphids are produced in this way, though a great many are killed by birds, ladybirds and their larvae, lace-wing larvae, and cold weather.

In October the first males appear. They have wings, and fly to a tree. Winged females fly to the same tree and there give birth to wingless daughters. The males mate with these when mature, and the wingless females subsequently lay eggs on the twigs of the tree. The eggs remain dormant until the following spring when the tree buds begin to sprout.

Some species produce winged females in the summer, sometimes in response to low food quality or quantity. The winged females migrate to start new colonies on a new plant, often of quite a different kind. For example, the apple aphid (*Aphis pomi*), after producing many generations of wingless females on its typical food plant, gives rise to winged forms which fly away and settle on grass or corn stalks.

Some aphids have telescoping generations, that is, the parthenogenetic, viviparous female has a daughter within her, who is already parthenogenetically producing her own daughter. Thus, a female's diet can affect the body size and birth rate of more than two generations (daughters and granddaughters).

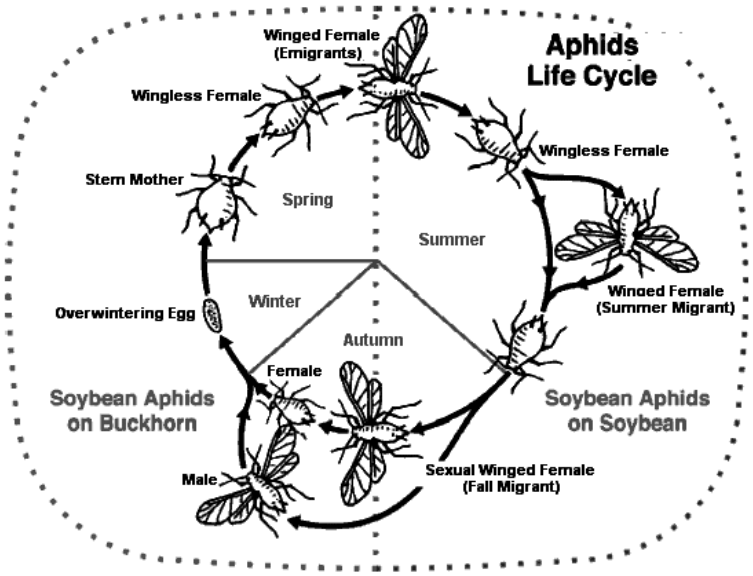

Figure – Generalized Life cycle of Aphid

Parthenogenesis

This is a natural form of asexual reproduction in which growth and development of embryos occur without fertilization. In animals, parthenogenesis means development of an embryo from an unfertilized egg cell

and is a component process of apomixis. Parthenogenesis occurs naturally in many social insects like aphids, some bees and parasitic wasps.

Normal egg cells form after meiosis and are haploid, with half as many chromosomes as their mother's body cells. Haploid individuals, however, are usually non-viable, and parthenogenetic offspring usually have the diploid chromosome number. Depending on the mechanism involved in restoring the diploid number of chromosomes, parthenogenetic offspring may have anywhere between all and half of the mother's alleles. The offspring having all of the mother's genetic material are called full clones and those having only half are called half clones. Full clones are usually formed without meiosis. If meiosis occurs, the offspring will get only a fraction of the mother's alleles.

Arrhenotoky

This is a form of parthenogenesis in which unfertilized eggs develop into males. Arrhenotoky may be restricted to the production of males that are haploid, or include diploid males that permanently inactivate one set of chromosomes (parahaploidy) or be used to cover all cases of males being produced by parthenogenesis (e.g. aphids). Arrhenotoky occurs in members of the insect order Hymenoptera (bees, ants, and wasps) and the Thysanoptera (thrips). This system also occurs sporadically in some spider mites, Hemiptera, Coleoptera (bark beetles), and rotifers.

Thelytoky

This is a type of parthenogenesis in which females are produced from unfertilized eggs, as for example in aphids. Thelytokous parthenogenesis is rare among animals, but it is more common in invertebrates, like arthropods. It can also occur in vertebrates, It can be induced in Hymenoptera by the bacteria *Wolbachia* and *Cardinium*, and has also been described in several groups of Hymenoptera, including Cynipidae, Tenthredinidae, Aphelinidae, Ichneumonidae, Apidae and Formicidae

Hymenopterans have a haplodiploid sex-determination system. They produce haploid males from unfertilized eggs through arrhenotokous parthenogenesis. However, in a few social hymenopterans, queens or workers are capable of producing diploid female offspring by thelytoky. The daughters produced may or may not be complete clones of their mother depending on the type of parthenogenesis that takes place. The offspring can develop into either queens or workers. Examples of such species include the Cape bee, *Apis mellifera capensis*, *Mycocepurus smithii* and clonal raider ant, *Cerapachys biroi*.

Pseudo-Arrhenotoky

It is the phenomenon where males develop from fertilized eggs but where the paternal genome is heterochromatinized or lost in the somatic cells and not passed on their offspring. This phenomenon occurs in certain mites, beetles and mealybugs and scale insects.

Deuterotoky

When both males and females develop from unfertilized eggs, the term "deuterotoky" is usually used .

11.6 Summary

Social insects are among the most dominant and prolific of all organisms on earth. Many insects exhibit "social" behaviours like feeding aggregations, parental care of the nest sites. In a broad sense, any insect that interacts with another member of its own species could be called a social insect. Insect society is more organized and functional in many ways in comparison to any other society. Most species of honeybees, ants and wasps of order Hymenoptera and termites of order isoptera of class Insecta are perfectly social . There are various advantages and disadvantages both for living in social groups. Large colonies are especially vulnerable to the spread of contagious pathogens, nest sites may be exploited by social parasites who steal food or attack the brood, and member individuals must compete with each other for space and resources. But on the other hand, cooperation among different members can help them to do activities like construction of huge nest sites, widespread foraging for food, and constant vigilance against predation or parasitism which is impossible for solitary insects. Social behavior is an adaptation that promotes survival and reproductive success of the species. Every social insect colony member ceaselessly keeps on contributing for the welfare of the society and race continuity without any personal greed, lust of jealousy.

11.7 Self-Assessment Questions

1. Define polymorphism with suitable examples of insects.
2. Describe the life cycle of termites.
3. What do you mean by pleometrosis?
4. Define trophallaxis
5. What is royal jelly ? explain its importance for social bees.
6. What is Nabokov scent gland**?**
7. Explain the social organization and caste differentiation in termites in

details.

8. Describe the role of pheromones in caste dertermination.
9. Write an essay on Social life of bees.
10. Write a note on different types of parthenogenesis.
11. Differentiate between ants and termites.
12. Explain the caste differentiation of termites.
13. Describe the Social life of ants in details with its different castes.
14. Explain the role of nutrition in caste determination of social insects.
15. Define neotenics
16. What is nuptial flight?
17. What do you mean by colony collapse disorder?
18. Write a note on "Bee dance"
19. Describe the caste differentiation of social wasps

11.8 References

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