Insect Communication

a. Chemical communication in insects through pheromones

- Pheromones are chemical signals secreted by exocrine glands of insects and released into the atmosphere to communicate with other individuals of the same species.
- Pheromones are useful to attract mates, mark trails, warn of danger, or coordinate group behaviour.
- The chemical signals released are detected by antennae or other sensory organs and can act over long or short distances.
- It is highly species-specific: only recognised by the same or closely related species

Types of insect pheromones

Type	End result
Sex pheromones	Attract mates: Female moths release them to attract males over long distances
Trail pheromones	Seen in social insects such as ants and helps to guide other colony members to a food source or to the home/ shelter
Alarm pheromones	Seen in social insects or insects that are found in groups. The signal warns the other members of danger. Bees and termites release when attacked. β-farnesene is a chemical released by aphids when attacked and warns other aphids nearby
Aggregation pheromones	Bring individuals together bark beetles gather on trees to mass-attack
Territorial pheromones	Mark territory:Male insects may mark mating areas
Caste-regulating pheromones	Control roles in social insects: Queen honeybee releases pheromones to suppress worker reproduction

Importance of pheromones in Agriculture

- Pest control using synthetic pheromones:
- Monitoring pest populations (e.g., moth traps)
- Mating disruption to reduce reproduction
- Attract-and-kill strategies

b. Non-chemical forms of communication

Signal form	Description
Tapping	Ants, termites drum in their subterranean nests to call for help
Drumming/vibrational signals	Many leafhoppers, bugs, and even mayflies drum with either their abdomen or legs to attract mate
Stridulation	Crickets and katydids generate noise by rubbing body parts for defence or to attract mates
Tremulation	Some leafhoppers and planthoppers and termites, the insect shakes its whole body, causing vibrations in the surface it's standing on.

Stridulation refers to the production of sound in insects by rubbing specialized body parts together, also called. This is used for communication during courtship, mating, or to signal the presence of resources. Stridulatory organs generally involve two specialized parts - a "file" (a ridged surface) and a "scraper" (a structure that rubs against the file).

In case of crickets and katydids one wing/ tegmina acts as a file and the other a scraper.

Some beetles have a small ridge (plegmatium) on the dorsal surface of the abdomen which is rubbed across ridges (files) on the underside of the elytra while others have specialized parts on their legs or mandibles to produce sound.

The sounds produced can vary in pitch, frequency, and duration depending on the species, their environment, and the temperature.

Noble Prize-winning discovery of the bee dance

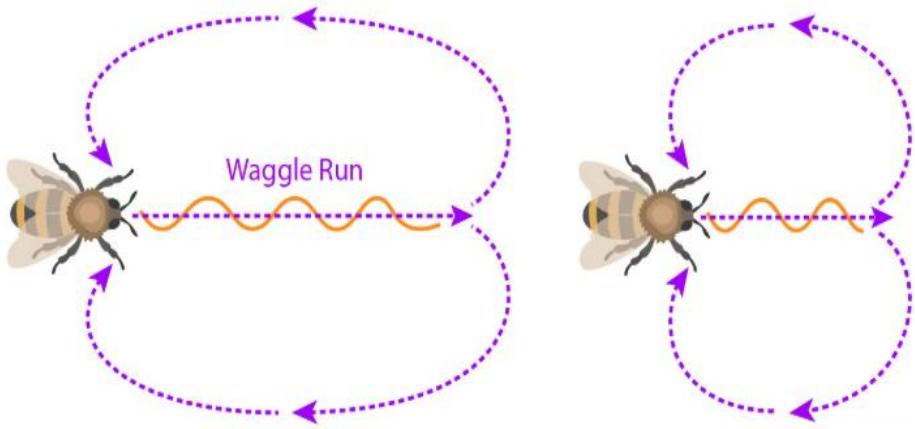
Honeybees use a sophisticated form of dance to communicate the location of food sources (flowers), nest sites, and even water to other bees in the hive. This was famously decoded by Karl von Frisch, who won a Nobel Prize for this discovery.

Waggle dance is the key communicating form and is used to convey how far and in what direction to fly towards food source. The bee vibrates its abdomen while running in a straight line and then loops back to the starting point, forming a figure-eight pattern. This pattern is repeated several times.

The angle of waggle run relative to vertical indicates the direction of food relative to the sun and the duration of the waggle run indicates the distance to the food source, while the vigour indicates quality of the resource.

If the bee waggles straight up, the food is in the direction of the sun. If the bee waggles at a 60° angle to the left of vertical, the food is 60° to the left of the sun.

Dance Type	**When Used**	**What It Communicates**
Round dance	When the food source is **near** (within ~50 meters)	Food is close by, but no direction is given
Waggle dance	When the food source is **farther** (over ~50 meters)	Both **distance** and **direction** of the food
Tremble dance	When there's **too much nectar** to process	Signals need for more nectar receivers in the hive
Shaking signal (or jerking dance)	General alert or recruitment signal	Stimulates other bees to become more active



Source: https://askabiologist.asu.edu/games-sims/bee-dance-game/introduction.html

Social Insects – Ants, bees, termites, and wasps

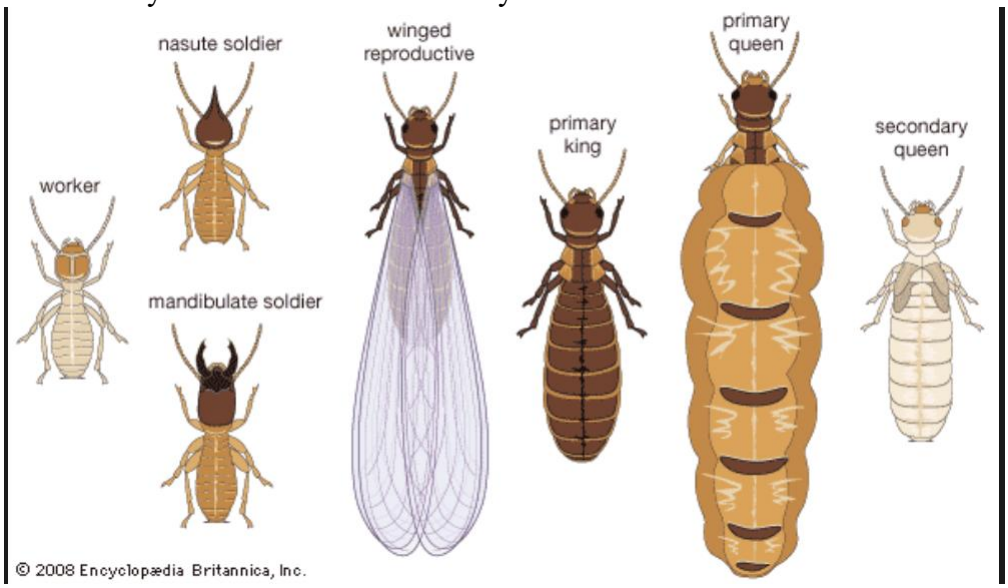
While most insects are solitary, some species have developed some sort of group living that could be as simple as sharing a nest (quasi-social as in tent caterpillars living together), to sharing of chores in one generation (semi-social as in some sweat bees), to the highly evolved eusocial insects with a complex colony structure as seen in some ants, termites and honeybees.

Eusocial insects

Key Characteristics of Social Insects (Eusociality)

- Cooperative care of offspring
- Reproductive division of labour
- Overlap of generations in a colony

Each colony has a well-defined caste system in some form.



Castes in a termite colony

They consist of
1. Queen(s) which are the reproductive female(s). It is generally larger than workers
2. King (in termites only) which mates with the queen for life
3. Workers which are all sterile females (ants, bees, wasps) or sterile individuals (termite males and females). Roles include foraging, brood care, nest maintenance, defence
4. Soldiers caste - In termites and some ant species individuals that specialise in defence, with large mandibles or chemical defence are seen.
5. Drones (bees & wasps) are male insects whose only job is to mate with the queen and die after mating

Communication in colonies are maintained by pheromones. The queen pheromones spread in the colony by trophallaxis maintains social order and prevent worker reproduction. Trail pheromones are used for marking the paths and alarm pheromones to warn.

Trophallaxis is the direct transfer of **food or fluids** from one individual to another, typically through **mouth-to-mouth** (stomodeal) or **anus-to-mouth** (proctodeal) contact. It's most common in **social insects** like ants, bees, termites, and wasps. It helps in chemical communication, to transfer pheromones, colony identity cues, symbiont transfer especially in termites and others.

Trophallaxis in weaver ant *Oecophylla smaragdina*