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Insect Communication

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Communication is the exchange of information between individuals. Adapted for symbolic communication, but most of insect's "language" skills are acquired through learning. For members of the insect species, it is an essential part of all social interactions.

Process tends to be an inborn mechanism:

Each newborn individual has a specific vocabulary shared only with organisms of its own species. The majority of insect species live a solitary life, with few contacts between conspecific individuals. Social insects, however, are characterized by communities in which they live in permanent contact with their nestmates. Bees and bumble bees, wasps, ants and termites since long have fascinated man because of their well organized and often impressive colonies

Why do insects communicate?

Insects communicate both with organisms of the same species (intraspecific communication) and directly or indirectly with organisms of other species (interspecific communication) for many reasons: reproduction: to look for a mate, courtship, to identify members of the same species or even to warn other organisms of its own presence, to localize sources of recourses food, nidification places, as an alert signal towards potential hazards, to defend territory, as a way to camouflage or to mimic other organism, locating or identifying a member of the opposite sex, giving directions for location of food, warning of danger; setting off an alarm.

Types of Biocommunication:

There are four types of biocommunication i.e., Visual communication, Chemical communication, Tactile communication and Acoustic communication

Visual Communication: Visual communication in insects takes place by two main systems:

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- **Body color patterns and light signals (bioluminescence).** Each species has specific color patterns, which can be useful for identifying members of the same species, also to attract a mate o even to alert other organisms about its dangerousness, or to drive away predators. On the other hand, there are also species that emit light signals to attract other specimens (e.g., fireflies or beetle from Lampyridae family). Most visual communicate are effective during daylight, but some insects can generate their own light and use visual signals that can be seen at night. Also, for partner location, prior to mating, the males' big compound eyes can help in finding the females. Male dragonflies recognize female dragonflies. Fireflies: The male *Photinus comsumilis* during a rising flight movement emit a series of 3.5 short flashes and a female respond after a double flash.

Light producing mechanism in fireflies

Bioluminescence

When oxygen combines with calcium, adenosine triphosphate (ATP) and the chemical luciferin in the presence of luciferase, a bioluminescent enzyme, light is produced. Unlike a light bulb, which produces a lot of heat in addition to light, a firefly's light is cold light, without a lot of energy being lost as heat.

- In order for this reaction to occur, a chemical named "Luciferin", which emits light, is required.
- First, luciferin bind with an enzyme "luciferase". This enzyme acts as a catalyst to speed up the reaction.
- Then, oxygen is needed to oxidize the reaction.
- As a result of this chemical reaction, energy is released in a form of light due to energy from the excitation of the electrons in the ions. The photons of visible light produced is about 50 kcal.In alfalfa butterflies, males have U.V. reflective scales and missing scales is a sign for male ageing

Chemical communication

A semiochemical, from the Greek word *semeion* meaning "signal", is a chemical substance or mixture that carries a message for purpose of communication. It is classified as Pheromone (Intraspecific signals) and Allelochemicals (interspecific signals). Pheromone

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comes from Greek word pherein (to transfer) and hormone (to excite): semiochemical exchanged between individuals of the same species. Induces specific reaction such as special behaviour or developmental process.

- **Primer pheromone**: The most famous example of a primer pheromone is the honey bee queen mandibular pheromone (a mixture of two fatty acids: 9-ODA and 9-HAD which suppresses ovary development in worker bees.
- **Releaser pheromone**: The most commonly known are sex pheromones, which are highly species specific and serve to attract mates for reproduction. The first sex pheromone was identified in 1959 from the silk moth *Bombyx mori*. Many further insect sex pheromones have been identified to date and a number are commercially used in pheromone traps for pest control. Flutter dance: Male silkmoth (right) gets excited by the female (left). She is releasing bombykol from her gland.
- **Pheromone dispersal**: Pheromone gland exposed to outside bydepressing the tip of the abdomen, extension of the abdomen, gland is inverted by haemolymph pressure, exposure of the gland is accompanied by wing vibration which facilitate dispersal.

Trail pheromone

Trail pheromones, employed by social insects for orientation and to recruit nest mates to a suitable food source. They are produced by a variety of glands and can be composed of numerous different, mostly volatile compounds. When navigating their territory, ants and termites deposit these pheromones on the ground thus developing an extensive net ofchemical routes and can be composed of numerous different, mostly volatile compounds. It lays trails and lead to feed.Chemical nature of trail pheromones are hexanoic, heptanoic, decenoic acids (in formicine ants).Trail pheromones can be used to kill ants.Trail pheromones mixed with baits can attract ants which when transported by ants to their nest it will kills all young ones.

Alarm pheromone

Alarm pheromones are chemical substances released by insects to warn members of the same species about the presence of or attack by an enemy (mostly a predator). This warning elicits different behaviour in different insects as listed: dispersion or escape in aphids and bugs, aggression in ants and soldier termites, attraction in wasps and worker bees. The chemical nature of alarm pheromones are terpenes (aphids), aldehydes (hemiptera) andformic acid (ants). Aphid alarm signaling was first characterized in the 1970s. In response to predation and other

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disturbances, the cornicles of aphids emit an odor repellent to conspecifics (Kislowand Edwards, 1972). This pheromone induces *Myzus persicae* to stop feeding and move away from the signaler or to drop from the host plant during these aversive behaviours. A vital role of honeybee colony defense is played by so-called guard bees, which patrol the nest entrance and represent the first line of colony defense. These guards are also specialized for the production of alarm pheromone which they release to recruit nest mates from the interior of the colony in case of danger (Boch et al., 1962; Collins et al., 1982).

Aggregation pheromone

The perception of the pheromone increases workers movement and promotes attraction. Pheromones which induce aggregation or congregation of insects for protection, reproduction and feeding or combinations are called aggregation pheromones. For example, Bark beetles start to bore into the bark and release a long-range aggregation pheromone. Males of phloem beetle *Ips confusus* incorporate their pheromone in faecal matter whichattract both male and female to the infested tree.

Allelochemicals

Semiochemical exchanged between individuals of the different species of organisms or insects. It classified into allomones, kairomones, synamones,apneumones.

- **Allomones:** From Greek word (allos + hormone = excite others) allomone is a chemical ormixture of chemicals released by one organism that induces a response in another organism which is advantageous to the releaser. Example: The defensive secretions of insects and plants that are poisonous to attacking predators or herbivores. Bombardier beetles (*Brachinus* spp.) and vinegaroons (*Mastigoproctus* spp.) spray corrosive quinones/ hydroquinones and concentrated acetic acid solutions, at approaching predators thereby creating a defence. Ants release a defensive allomone called citral from its mandibular glands promotes attraction.
- **Kairomone** is a chemical or mixture of chemicals released by one organism that induces response in another organism. Helpful to recipient. Heptanoic acid released by larva of potato tuber moth Phthorimaea *operculella* increases searching by its parasitoid alpha – farnesene secreted by codling moth larva attracts its parasitoid Chemical released by one organism that induce a response in another species.

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- **Synamone:** Helpful to emitter and receiver. It encourages mutualistic relation between organisms. For example, Termites and protozoans. The flowers depend on the bees to pollinate them so they can reproduce and, in return, the bees get fragrance compounds they use during courtship displays (rather like cologne to attract the lady bees).
- **Apneumone:** Chemical substances emitted by a non- living material that evoke a behavioural or physiological reaction adoptively favourable to a receiving organism, but detrimental to another species, which may be found in or on the non- living material. For example, an ichneumonid parasite of *Venturia canescens* is attracted by the smell of the oatmeal, which is the food of its host. Here it is advantageous to the recipient which is the parasitoid but detrimental to host insect living on the oat meal (non- living material)
- **Tactile communication:** "Keep in touch!" For you, it's probably just a metaphor, but for some insects it's really a channel of Communication. Since many insects have poor vision and sound perception, physical contact provides an important avenue of communication. In blister beetles (family:Meloidae), courtship begins with a series of antennal taps by the male on eachside of the female's body. She signals her receptivity by lifting her wing covers (elytra) and allowing him to climb on her back. But to complete his quest, the male must continue tapping, alternating from side to side at just the right frequency until the female is stimulated to extend her genitalia and begin mating. Antennal tapping is also an essential component of communication in both ants and termites.
- **Acoustic communication:** Acoustic communication can be made to vary in frequency, amplitude and periodicity. Together, these three variables can create an extremely wide and complex range of signals from an insect's mating call to human speech and vocal music. Since sound waves move rapidly through air (about 331 m/sec), acoustic signals can be quickly started, stopped, or modified to send a time-sensitive message. Insect can emit and detect sounds above 20 Hz. Some crickets produce ultrasounds above 80 Hz. "Whispering" moths exemplify another antidetection strategy (Nakano et al., 2008). *Ostrinia furnicalis*, male Asian corn borer moths, use specialized very low intensity courtship songs produced by sex-specific scales on the forewings and mesothorax. In order to protect the pair from conspecific competitors and predators,

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this male moth produces the sounds in the female's ear, which provide a private communication channel between them (Conner, 2014). Aposematic sounds often converge structurally, having broad frequency ranges, low pattern

- complexity. Such signals are readily detected by a wide range of predators. Toxic tiger moths
- (Arctiidae) send loud return sounds to approaching insectivorous bats. These sounds warn the bat that the moth is unpalatable and potentially harmful, and may also interfere with the echolocation capabilities of bats.

A. Vibration (including Tremulation): The oscillatory movement of the wings of an insect sets up regions of compression and rarefaction and a vibrational sound is produced. For example, the flight sound, made by the wings, in swarming mosquitoes is considered to be used for species-specific recognition.

B. Percussion: Striking one part of the body against another as a communication system for pair formation. For example, The Australian moth (Lepidoptera); males produce ultrasonic acoustical long-distance signals to attract sexually receptive females and to establish territorial residency in competition with other males.

C. Stridulation: Stridulation consists of sounds produced by frictional mechanisms, involving the movements of two specialized body parts against each other in a systematic patterned manner. In orthopteran insects' response stridulation from the receptive female orientation towards and locomotion to the male. The female arrived near the male, stridulating in response to mate song; the male, once noticing the female, sings the courtship song, engages the genitalia and copulation occurs.

D. Click mechanisms: These sounds depend on the deformation of a modified area of cuticle,

E. Generally, by contraction and relaxation of specialized musculature within the insect body. This acoustic signal constitutes the first step in pair formation, attracting females at long distances, and is involved in male-male interactions. For example, the males of Tibicina (Hemiptera) cicada species produce a sustained and monotonous calling song by tymbal activity.

F. Air expulsion: This sound is described as an exhalatory sound, frequently expelled via the tracheal spiracles, however little is known about its function. The

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Madagascar hissing cockroach *Gromphadorhina portentosa*, is able to produce audible hisses from a pair of modified spiracles.

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