GATE ECOLOGY AND EVOLUTION

QUICK ACHIEVER COURSE

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INTERACTIONS

Types of interactions

Intraspecific	Interspecific
• Reproduction • Care of offspring • Social behaviour • Competition	• Competition • Commensalism • Amensalism • Parasitism • Predation • Mutualism

Intraspecific interactions

- **Reproduction:**
  - The first phase in the reproduction is the selection and location of the mate
  - It occurs by advertisement by one sex using scent (pheromones), sound (call, song, croak) or sight (light in glow worm)
  - The process of mate selection usually involves competition between individuals of same sex. For example:
    - In case of deer, monkey, lion etc., males fight for harems of females
    - In case of many birds, the female choose most attractive and colourful male (peacock, bird of paradise)
    - Females competes for males in case of jacanas.

Intraspecific interactions

- **Care of offspring:**
  - This includes feeding, guarding, keeping them warmth and transporting immature individuals.
  - This can be further of 3 types:
    - Maternal care [most mammals]
    - Paternal care [sea horse and some other fishes, some insects]
    - Biparental care [most birds]
    - Alloparental care [honeybee, Bee-eaters, Jungle Babbler]




Intraspecific interactions

- **Social behaviour:**
  - It can be found in a wide variety of animals from small invertebrates (honeybees) to large mammals (elephants).
  - Social behaviour involves altruistic (+/+) behaviour between individuals and centers around finding food, vigilance, defending common territories, caring of young etc.



Intraspecific interactions

- **Competition:**
  - Usually intense competition observed between individuals of same species due to sharing of similar kind of resources: food, space, light, water, nutrient, shelter, mate etc.
  - Competition can occur between individuals at any time during life cycle.
  - It is a major evolutionary force in ecology, affecting natality, mortality and behaviour of animals.
  - *Scramble competition:* When resource distribution within the competitor is fairly even. In this case, under high population density, no individuals will have enough resource to survive resulting in population crashes.
  - *Contest competition:* In this case, resources are distributed unevenly between the competitors. So, some individual will grow and reproduce, while other will die.

Effect of intraspecific interactions

- **Density dependence:**
  - The relationship between fitness and population size is described as density dependence
  - Usually, fitness decreases as the population increases due to intraspecific competition for limited resources.
  - As the population increases, it results in higher mortality and lower fecundity.

Effect of intraspecific interactions

- **Dispersal:**
  - To avoid intense competition organisms disperse from the patch with high density to patch with low density.
  - Even sessile organisms have modes of dispersal like via wind, water currents, fur of animals etc.
  - Many sessile marine organisms have motile larval stages
  - In some animals, there are sex biasness in dispersal: male lions leave their family groups where sisters remain with their mothers
  - Dispersal accounts for:
    - Permits possible escape
    - A mechanisms to avoiding inbreeding
    - It is often a risky activity, as it involves locations of suitable habitat
    - Tendency to disperse depends upon the competitive ability of the species

Effect of intraspecific interactions

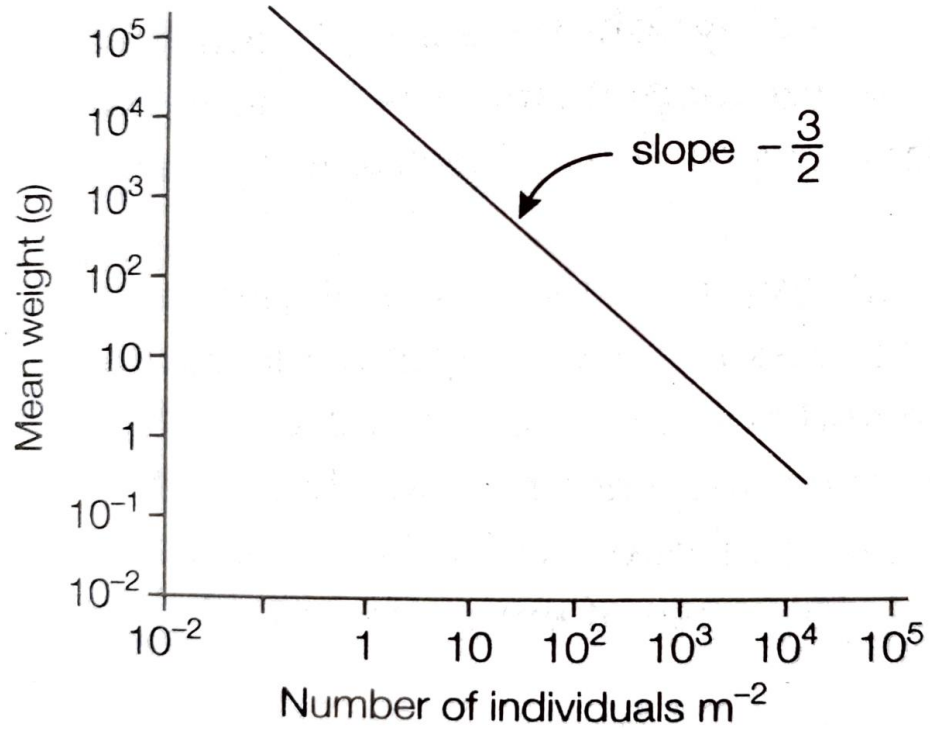
- **Territoriality:**
  - *Territory* is an area competed by individuals or by groups of animals.
  - *Territoriality* is the defense of territory-a social behaviour.
  - The territory boundary is maintained by active interference by individuals.
  - Territory size is determined by the balance of costs and benefits.
  - Territory can be of 2 kinds:
    - *General purpose territories:* Usually established by many songbirds. Almost all kinds of activities like feeding, mating and rearing of young occur in this kind of territory.
    - *Specialized territories/lek:* This is formed by closely aggregated male territories for the purpose of breeding. This kind of territory is short lived.

Greater sand-grouse lek

Effect of intraspecific interactions

- **Self thinning:**
  - It is found in plants and sessile organisms
  - This progressive decline in density and increase in biomass (growth) of remaining individuals caused by the combined effects of density-dependent mortality and growth within a population is known as self-thinning.
  - *Yoda's 3/2 law*: Plant ecologist Kyoji Yoda with his experiments with horseweed found the relationship between decrease in number of individuals and increase in average individual biomass follows a relationship:

$$\log m = \log c - 3/2 \log N$$



Interspecific association

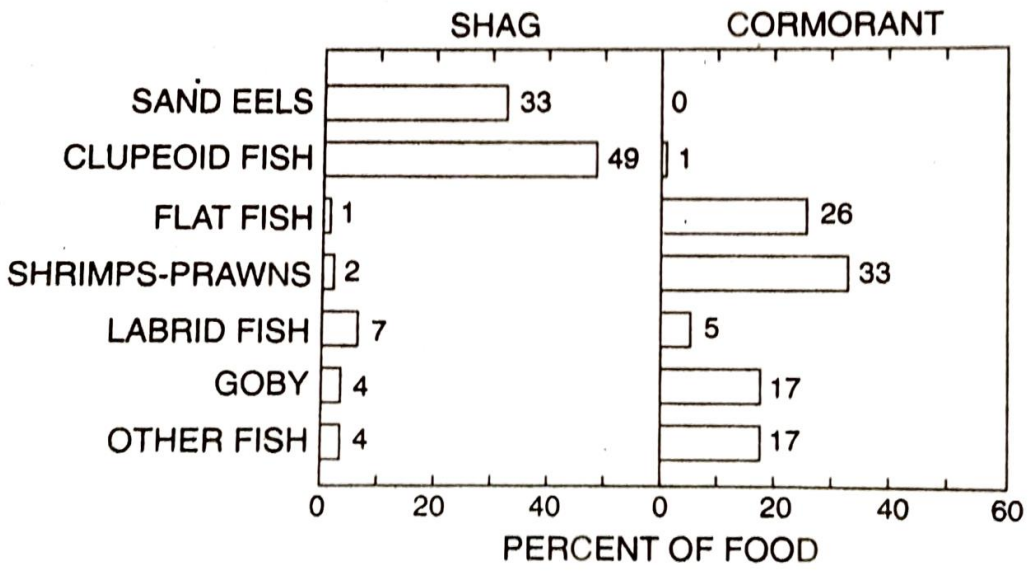
Type of interaction	Species 1	Species 2	General nature of interaction
1. Neutralism	0	0	Neither population affects the other
2. Competition	-	-	Inhibition of each species by the other
3. Amensalism	-	0	One population negatively affected, while other remains unaffected
4. Commensalism	+	0	Population 1, the commensal benefitted, while the host remains unaffected
5. Parasitism	+	-	Parasite, species 1, is much smaller than host
6. Predation	+	-	Predator, species 1, usually larger than prey
7. Protocooperation	+	+	Interaction is favourable to both, but not obligatory
8. Mutualism	+	+	Interaction is favourable to both and obligatory

Interspecific association: Neutralism (0/0)

- When two different species population are not affected by the association with one another, called *Neutralism*.
- Example:
  - Grass carp and Catla residing on the pond surface. While, former feeds on microvegetation and later feeds on zooplankton.
  - In England, European Shag (*Phalacrocorax aristotelis*) and Great Cormorant (*P. carbo*) found together during breeding season. Though both are piscivorous bird, but have entirely different feeding preference.

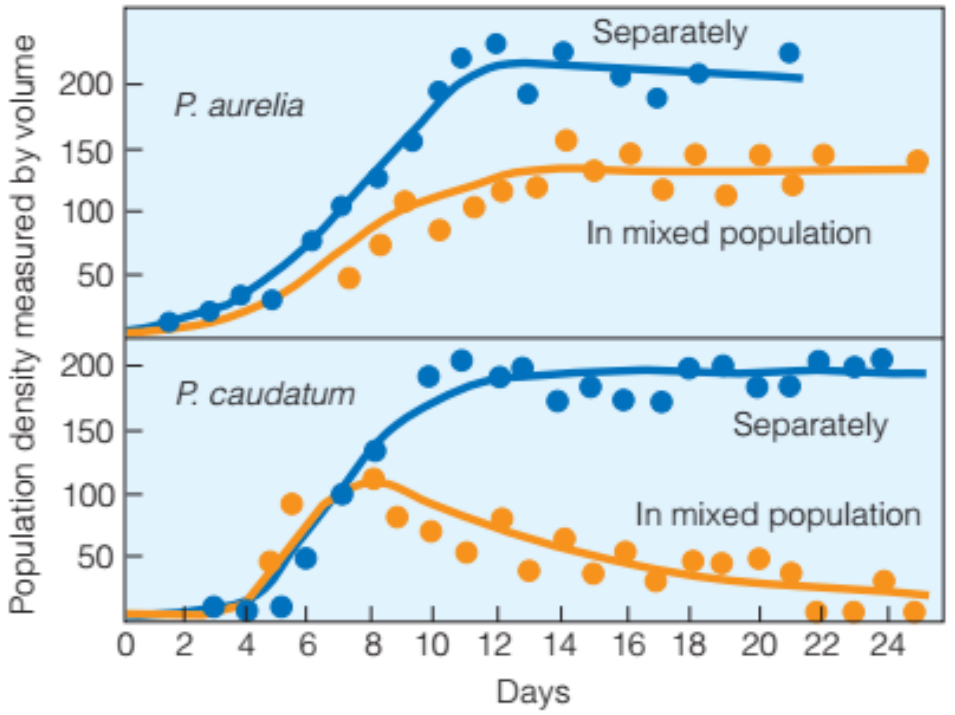
EUROPEAN SHAG

GREAT CORMORANT



Interspecific association: Competition (-/-)

- It occurs when two or more species utilises same limited resource.
- It is of two kinds:
  - *Direct or interference competition:* It occurs when competing species interact directly. Example: Lion may arrive at the kill of smaller carnivore and displace it.
  - *Indirect or exploitation competition:* It occurs when one species exploits resource in common with another species, but without coming in direct contact. This kind of competition may provide competitive advantage to one species against another. Example: Gause's original experiment with ciliate *Paramecium caudatum* and *P. aurelia*.



Interspecific association: Amensalism (-/0)

- In this kind of interaction, one species is harmed, while other remain unaffected.
- The term was coined by Haskell (1949)
- This is also called **antibiosis**
- Example:
  - Bees die when health department sprays insecticides to kill mosquitoes.
  - Lichen dies due to air pollution by human
  - Guano deposition of bird colonies of Great Egret and Great Blue herons resulting in death of vegetation below it, including the seedlings of the nest trees.
  - Fungi produces different antibiotics that kills many bacteria and viruses.

Interspecific association: Allelopathy (+/-)

- When one population produces a substance harmful to a competing population, called allelopathy.
- The term was coined by Australian Botanist Hans Molisch in 1937
- Example:
  - The algae *Chlorella vulgaris* produces a toxin called *chlorellin*, which is toxic to other algal species
  - Sponges contain a variety of chemicals, which inhibit the settling and growth of other potentially competitive invertebrates
  - *Juglone* secreted from the root of walnut destroys its surrounding vegetation.
- Allelochemicals recognized so far belong to terpenoids and phenolics.
- Allelochemicals can be used in agriculture as natural herbicides.

Interspecific association: Predation (+/-)

- **Predation** can be defined as consumption of all or part of another individuals (**prey**).
- **True predators** killed their prey soon after attacking. It is of 3 types:
  - Carnivore (feeds on animal tissue)
  - Herbivore (feeds on plant tissue)
  - Omnivore (feed both)
- **Grazers** are not true predator, they move from one prey to another, consume a part of it, but never kill its prey.
- A predator can be **specialist** (feeds upon a narrow ranges of prey) or **generalist** (feeds on a wide varieties of prey).
- **Monophagous** predator feeds on only one kind of prey, **oligophagous** predator predates on a few but more than one type of prey. While, **polyphagous** predators are generalist.

Interspecific association: Predation (+/-)

- **Escaping Predation:**
  - Animal:
    - Mutual vigilance
    - Confusing predator
    - Physical defense
    - Mobbing
    - Geometrical effects
  - Plant:
    - Toxicity and unpalatability
    - Defensive structure

MOBBING

Interspecific association: Predation (+/-)

- **Impact of predators on prey population size:**
  - If the role of the predator towards total prey mortality is very small, removing that predator will exert a minor effect on prey population.
  - Predation usually removes excess of animals above the number that an environment can support.
  - When a new predator introduced in a ecosystem, it may exert drastic effect on prey population, often extinction. Because the predator have no evolutionary history of predation on that prey and prey also did not evolved any escaping response against that predator.

Interspecific association: Parasitism (+/-)

- **Parasites** are organisms that *live* and *feed* on another organism, usually without killing it.
- The organisms on which the parasites lives is called the **host**.
- Parasites are much smaller than their host and have rapid growth rate.
- A heavy injection of parasites – the **parasite load** – eventually cause death of the host, either weakening it or causing disease.

Interspecific association: Parasitism (+/-)

- Parasites can be classified in various ways:
  - **Ectoparasites and endoparasites:**
    - *Ectoparasites* lives on the **surface** of their host. Ex. Mosquitoes, bed bug, ticks, lice etc.
    - *Endoparasites* lives **inside** the host's body. Ex. Viruses, malarian parasites etc.
  - **Micro- and macro-parasites:**
    - *Microparasites* **multiply** within or on the hosts. Ex. Viruses, bacteria, fungi etc.
    - *Macroparasites* grow within or on the host, but **do not multiply**. Ex. Tapeworms, ticks, nematodes etc.
    - It is important to note that size of the parasite is not indicator of whether it will behave as macro- or microparasite
  - **Biotrophs and necrotrophs:**
    - *Biotrophs* are parasites that survive only on the **living** tissue.
    - *Necrotrophs* are the parasites that continue to live on the host even after causing **its death**. Ex. Sheep blowfly (*Lucilia cuprina*)
  - **Temporary and permanent parasite:**
    - *Temporary parasites* come in contact with their hosts **for a brief periods**. Ex. Mosquitoes, sandfly
    - *Permanent parasites* remain in contact with their host **throughout their life**. Ex. *Ascaris lumbricoides*, *Taenia solium* etc.

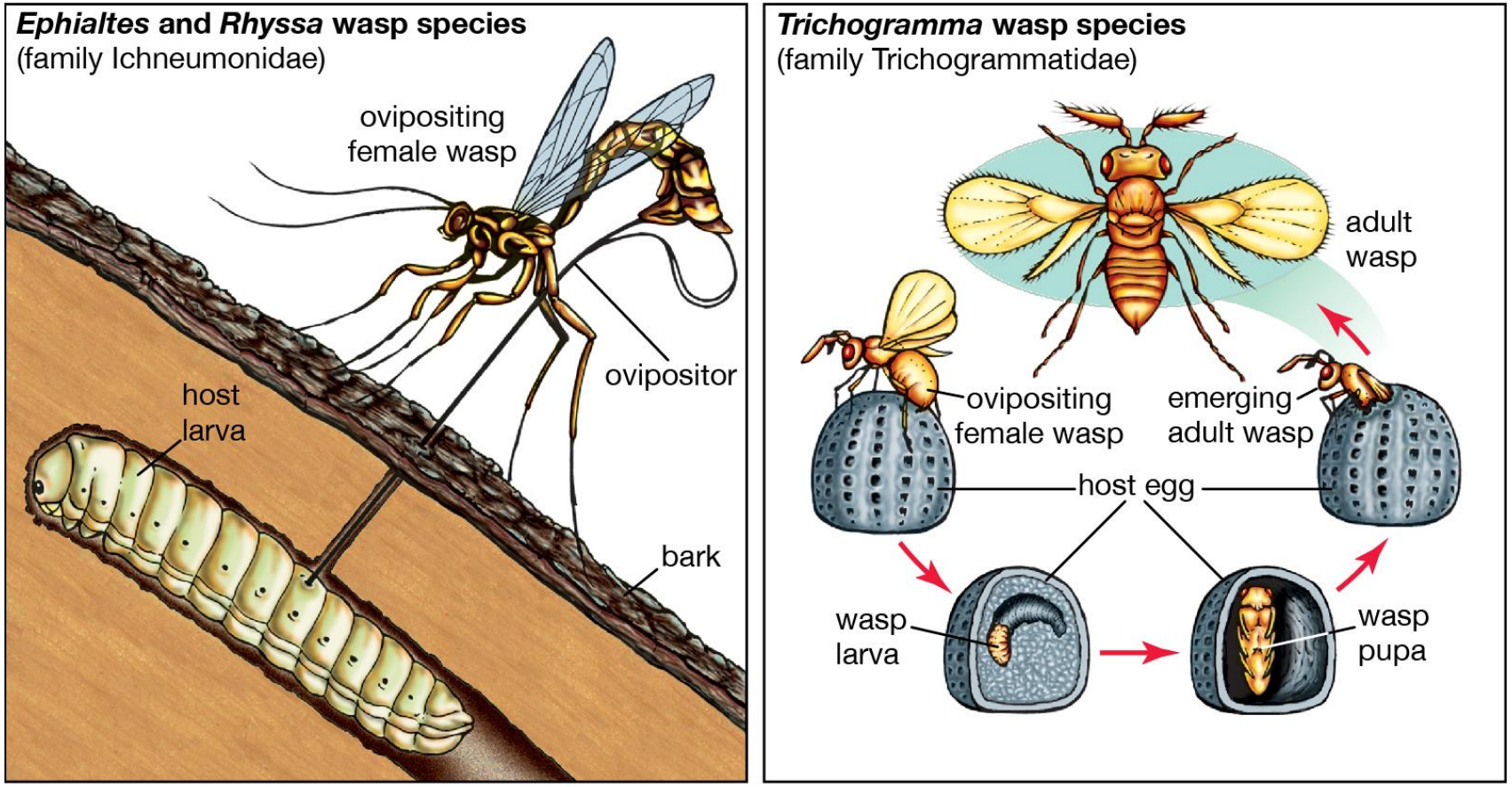
Interspecific association: Parasitism (+/-)

- **Parasitoids:**
  - These are a large group of insects, which lay eggs on another animals, the larvae grows within the host and consume the host during their growth.
  - The life cycle of parasitoid includes both parasitism and predation.
  - **Ecto- and endoparasitoids:**
    - In case of *ectoparasitoids* female adult deposits eggs on the outside of the host.
    - In case of *endoparasitoids* female lays eggs inside the host body with the help of a long ovipositor.

A tobacco hornworm that has been killed by *Cotesia* larvae which have pupated outside the host.

A parasitoid wasp parasitising a caterpillar.

Interspecific association: Parasitism (+/-)



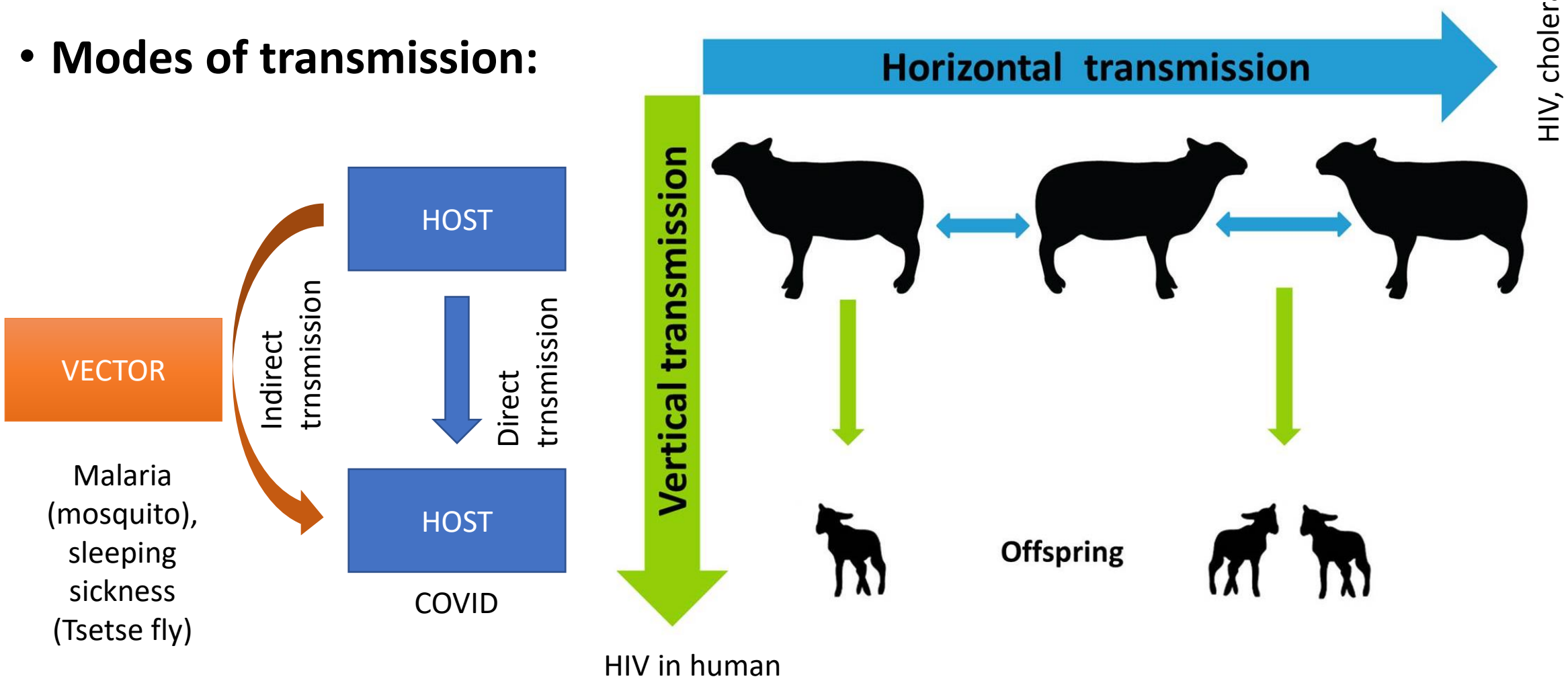
Interspecific association: Parasitism (+/-)

- **Social parasite:**
  - This kind of parasites do not feed on host tissues like true parasites, but gain benefits from their animal hosts by coercing them to provide food or other benefits.
  - Example: Brood parasitism

CROW AND KOEL

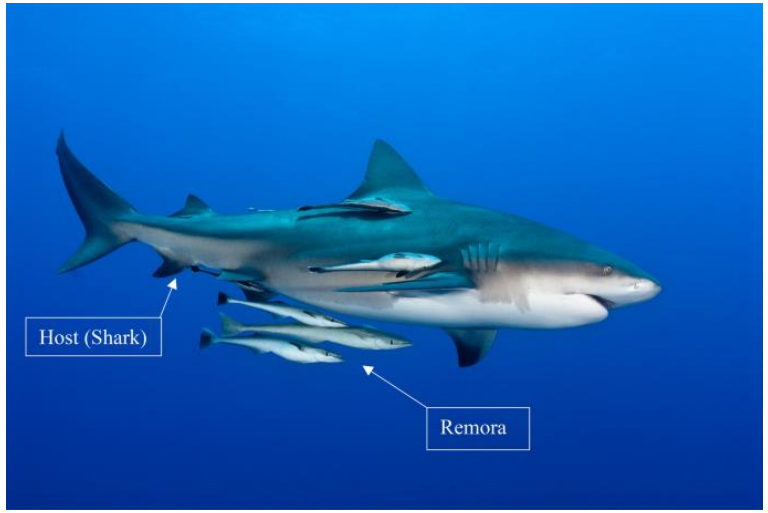
Interspecific association: Parasitism (+/-)

- **Modes of transmission:**



Interspecific association: Commensalism (+/0)

- The term was coined by PJ Van Beneden (1876).
- In this kind of relationship, one species benefited, while another species neither benefited nor harmed.
- The host species provides home/modes or transportation of other species.
- Example:
  - Remora fish has a suction cup on the top of their head. With its, it attached to the body of sharks and travels with it. It eats on the leftover of the bigger fishes meals.
  - Vulture feeds on the leftover of kills of a large carnivores.
  - Deer mouse use old bird's nest for their own.
  - Epiphytic plants like orchids, uses trees or branches of trees for support without harming/benefiting them.
- Commensalism may or may not be host specific.



Interspecific association: Protocooperation (+/+)

- In this kind of association, both species are benefited, but the relationship is not obligatory. This kind of relationship also called **facultative mutualism**.
- WC Allee (1951) first put light on this kind of associations.
- Example:
  - The coelenterates grow on the backs of the crabs (also sometime planted by the crabs), which provide camouflage and protection (as coelenterates have stinging cells) to the crab. In turn, coelenterates are transported by the crabs, and they obtain food when crabs capture and eat another animal. Though the crab and coelenterate also can live independently.
  - Another example is Cattle and Cattle Egret

CATTLE AND CATTLE EGRETS

Interspecific association: Mutualism (+/+)

- It is a positive reciprocal relationship between two individual of different species population, where both the parties are benefited, and neither can survive in natural condition without the other.
- The mutualism can be of three types:
  - **Trophic mutualism:** In this cases both species depends on one another for energy and nutrients. Ex. Lichens between algae and fungi, nitrogen fixing root nodules between *Rhizobium* and plant roots, cow and its rumen bacteria.
  - **Defensive mutualism:** In this kind of relationship one partner receives food and shelter, while another receives defence. Ex. Interdependence between a certain kind of ant (*Pseudomyrmex ferruginea*) and the bull's thorn acacia (*Acacia cornigera*).
  - **Dispersive mutualism:** This kind of mutualism involves animals that helps in pollination or seed transport in expense of food.

LICHEN

Pseudomyrmex ferruginea on *Accacia cornigera*