UNIT-4 (ARTHROPODS OF VETERINARY IMPORTANCE)

Syllabus

Arthropods: Introduction, general account and classification, general life cycle of arthropods with morphological features of their developmental stages. Important morphological features, general bionomics, life cycle, vector potentiality, pathogenesis and control of following arthropods affecting animals and birds: Bugs (Cimex). Biting midges (Culicoides), black flies (Simulium), sandflies (Phlebotomus), mosquitoes (Culex, Anopheles and Aedes). Horse flies (Tabanus), Haematopota and Chrysops. Musca, Stomoxys, Haematobia and Sarcophaga. Warbles (Hypoderma), stomach bots (Gasterophilus,Cobboldia), nasal bots (Oestrus ovis,Cephalopina), Bottle flies (Calliphora, Lucilia, Chrysomya), myiasis. Hippobosca, Melophagus, Pseudolynchia. Lice (Haematopinus, Linognathus, Trichodectes, Damalinia, Menopon, Lipeurus, Menacanthus and Heterodoxus). Fleas (Ctenocephalides, Echidnophaga, Xenopsylla, Pulex). Arachnids : General account, soft ticks (Argas, Ornithodoros and Otobius). Hard ticks (Hyalomma, Haemaphysalis, Rhipicephalus(Boophilus), Dermacentor, Ixodes and Amblyomma). Mites (Dermanyssus, Ornithonyssus, Demodex, Notoedres, Sarcoptes, Psoroptes, Chorioptes, Cnemidocoptes and Otodectes). Pentasomida (Linguatula). Study of insecticide or acaricide resistance.

ETERINARY ENTOMOLOGY AND ACAROLOGY is the branch of parasitology which deals with insects (flies, lice, fleas, bugs) and acarines (ticks, mites) causing disease or act as vectors in animals.

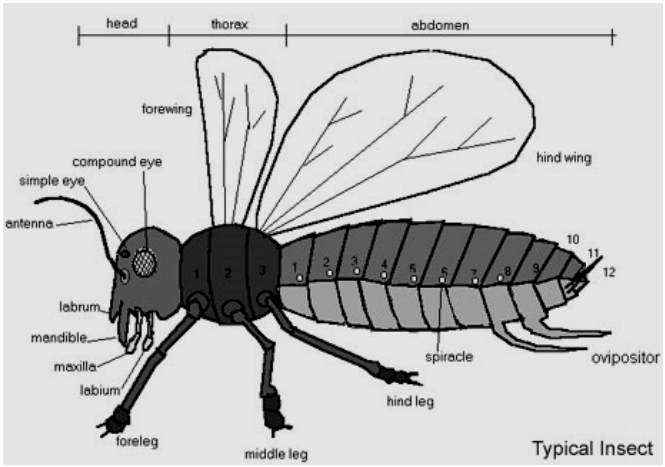
PHYLUM -ARTHROPODA

- Arthropoda is a greek word meaning ‘arthros’-joint; ‘podos’-leg which refers to the fact that members of Phylum Arthropoda have jointed legs.

GENERAL FEATURES OF ARTHROPOD

- **Bilaterally symmetrical**
- **Segmented body**
- **Compound eyes**
- **Chitinous exoskeleton**
- **Jointed legs**
- **Haemocoel**

- **Haemolymph**
- **Dorsal blood vessels**
- **Ventral nerve cord**



EXOSKELETON- INSECTS

- The hard outer covering of arthropod is made of chitin, it forms the ***Exoskeleton*** which covers the external surface of the body
- It passes through the mouth and lines the anterior part of the alimentary tract which is called ***Stomodaeum***
- It also goes through the anus into posterior part of alimentary canal which is called ***Proctodaeum***
- Exoskeleton is usually in the form of chitinous plates called ***Sclerites***
- The dorsal sclerite is called ***Tergum***
- Ventral sclerite is called ***Sternum***
- Lateral plate between tergum and sternum is called ***Pleuron***
- The tergum, sternum and pleuron of each segment are united by more flexible portions of exoskeleton which are termed ***sutures***
- Casting off the exoskeleton is called ***Ecdysis or moulting.***
- The main function of exoskeleton: **Protection to the internal organs**

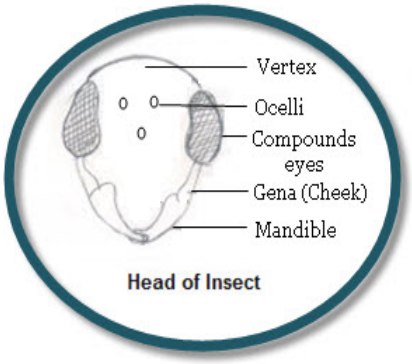
The **phylum** arthropoda has **two classes** of veterinary importance

(i) Class : Insecta (e.g,) Flies, lice, fleas and bugs.

(ii) (ii) Class: Arachnida (e.g) Ticks and mites.

EXTERNAL ANATOMY - INSECTS

- The body of an insect is divided into **three parts, (i) Head (ii) Thorax and (iii) Abdomen.**



HEAD - INSECTA

- Paired antenna, Compound and simple eyes, Mouth parts

- The head is an ovoid or globular capsule. The dorsal wall is formed by vertex and lateral wall by **genae (Cheek)**. The anterior wall of the









capsule is formed by **frons (fore head)** which articulates dorsally with the vertex and ventrally with clypeus. The incomplete posterior wall is known as **occiput** which articulates with neck.

COMPOUND EYES

- (i) **The compound eyes** are made up of individual eyes that consist of large number of hexagonal shaped facets termed **<u>Ommatidium</u>** which is the basic unit of compound eye. These ommatidia have rods and cones which will help in the **vision.**

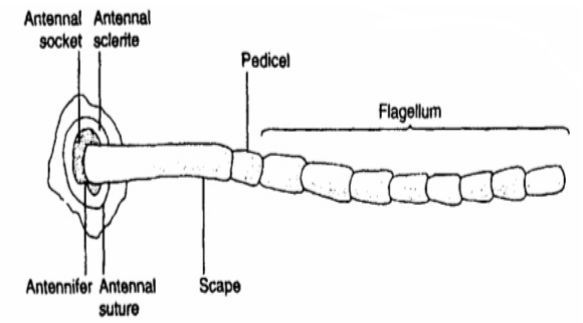
  Holoptic eyes: Compound eyes are very close to each other or may meet one another in the mid line (e.g) Male insects.

  Dichoptic eyes: The eyes may be wide apart (e.g) female insects.

- (ii) **Simple eyes** or **<u>Ocelli</u>** (singular-ocellus) : These are photoreceptors (not for vision) and arranged as an inverted triangle on the dorsum or vertex.

ANTENNA

- All the insects have filamentous sensory organs called **<u>Antenna</u>** (**absent in arachnids**). It is a segmented structure, inserted between the eyes and varies from species to species. It is composed of three jointed filaments



1. The first segment attached to the vertex is called **<u>scape</u>.**

2. The second segment is the pedicel which has an **olfactory and auditory** apparatus called **<u>the 'Organ of Johnston'.</u>**

3. The third segment is collectively called the **flagellum**

Types of Antenna:

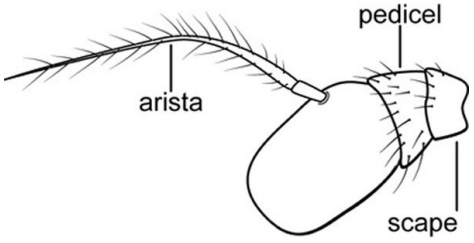
- There are 16 types of antenna, which help in identification of insects. The most common types found in insects of veterinary importance are



- **(i) Plumose type**: Large numbers of bristles on the antenna is called plumose antenna. (e.g.) **Male** mosquitoes.



- **(ii) Pilose type:** Few numbers of bristles on the antenna is known as pilose antenna. (e.g.) **Female** mosquitoes.



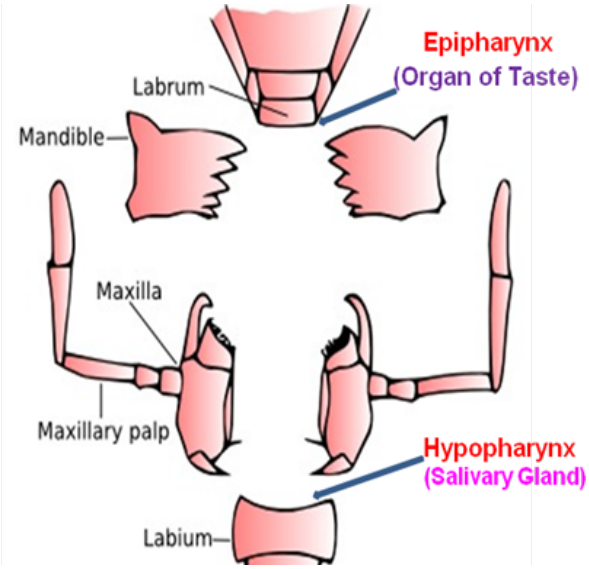
- **(iii) Aristate type:** A specillized bristle on the third segment of antenna is called as arista, which is sensory in function.

Functions of Antenna:

- (i) The segmented antenna has specialized bristles which are sensory and tactile in functions.
- (ii) It is an organ of smell and hearing.

MOUTH PARTS

- These consist of the **labrum (upper lip)** which forms the upper boundary of mouth and the **labium (lower lip)** which forms the lower boundary of the mouth. Between these two structures are two pairs of biting jaws, an upper pair, the mandibles, and a lower pair, the maxillae.



- On the underside of the labrum there is a small membranous structure, the **epipharynx** which bears **the organ of taste.** These two are frequently fused to form the labrum - epipharynx.
- On the upper surface of the labium is a further membranous structure, the **hypopharynx**, which bears **the opening of the salivary duct.**
- There may be modifications of these parts according to the habit of feeding. The labium may be greatly expanded for **imbibing liquid food (House fly)** or all parts may be modified into fine **piercing stylets (mosquitoes)**

Types of mouth parts :

1.**Based on structure:**

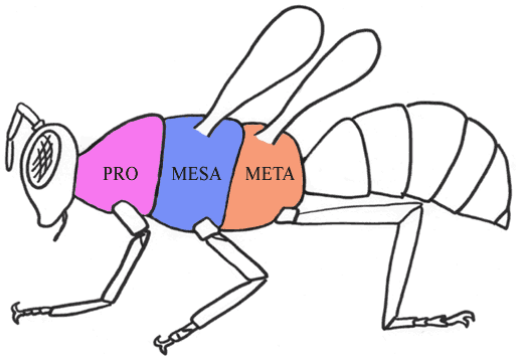
- (i) **Prognathus** - projecting forward (e.g) Lice, Sheep ked
- (ii) **Hypognathus** –Projecting downward (e.g) Mosquitoes, Musca, Fleas
- (iii) **Opisthognathus** - projecting backward (e.g) Bed bug.

2. Based on feeding habit:

(i) **Lapping/sponging/sucking type**-(e.g) house fly (Most of Cyclorrhapha flies have lapping type mouth parts)
(ii)**Piercing and sucking type** - (c.g) Mosquitoes, phlebotomus, Culicoides, lice, fleas, and bugs.
(iii) **Cutting and sponging type** - (e.g) *Tabanus sp., Simulium sp*.
(iv) Chewing type - eg. Lice

THORAX - INSECTA

- Has three segments
  1.Prothorax 2. Mesothorax 3.Metathorax
- Appendages on the thorax include
  - **3 pairs of walking legs**, one for each segment
  - **2 pairs of wings** (Meso and Meta thoraxic wings)

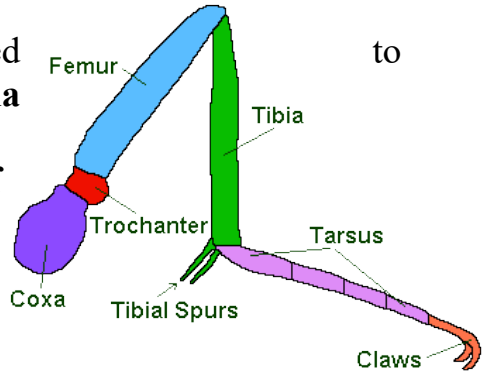


ABDOMEN - INSECTA

- Clearly segmented, soft and membranous
- ***Copulatory claspers*** are seen in male on the last abdominal segment called **aedeagus** while in the females called ***Ovipositor***.

LEGS

- Consist of basal **coxa** by which the leg is attached to the body, followed by **trochanter, femur, tibia and tarsus.**
- Last tarsal segment is provided with a **pair of claws**.
- Below each claw a pad like structure called ***pulvilli*** is seen.



WINGS

- Normally two pairs-on **meso and meta thorax wings**
- In Diptera, the posterior pair is reduced to a pair of ***balancers or halteres***
- Wings are supported by veins or breathing tubes (trachea) called **wing venation.**
- Identification of insects is based on wing venation.

INTERNAL ANATOMY - ARTHROPODS

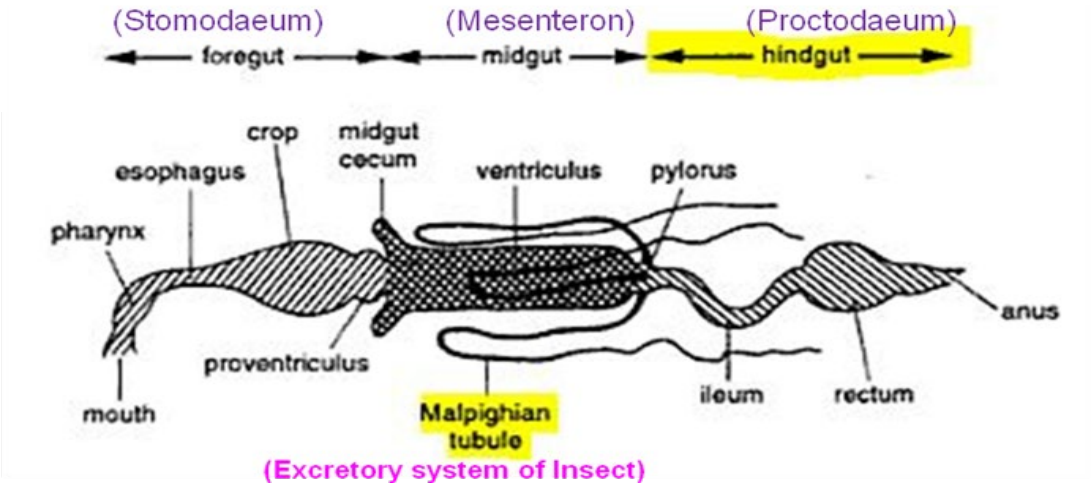
- The internal body cavity - ***haemocoel*** is filled with blood called ***haemolymph***

ALIMENTARY/DIGESTIVE SYSTEM - ARTHROPODS

- Includes
  - Anterior - **stomodaeum** or foregut
  - **Mesenteron** or midgut

- Porterior- **proctodaeum** or hindgut
- Lined by **chitinous exoskeleton.**
- **Anterior part of alimentary canal** may have pharynx, behind this, a dilatation -**the crop, followed by proventriculus**. The proventriculus acts as a valve to prevent regurgitation and may have "teeth" to aid in the **grinding of food particles** (flea)
- This leads to **mesenteron or mid gut**. It is flask shaped and its anterior narrow part is called cardia.It is here that food is **digested and absorbed**.
- In midgut, food is covered by a membrane is called **Peritropic membrane** that prevents pathogens enters into body.
- The **proctodaeum** consists of an anterior ileum, colon, dilated rectum and anus. It opens out into exterior through anus. The main function of the hind gut is the **absorption of water from the faeces and urine.**

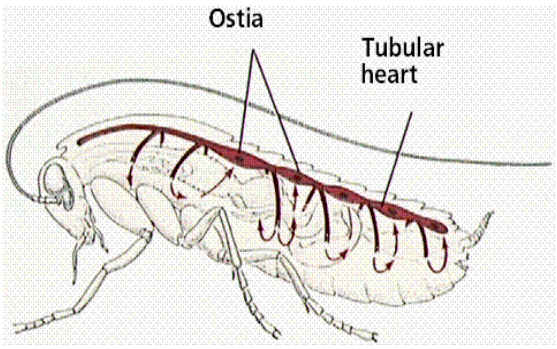
- Urine passes into the hindgut from **the malpighian tubules (Excretory system of insects),** which open just behind the midgut. **Faeces are excreted** as dry pellets and nitrogenous waste as **uric acid**.



(Excretory system of Insect)

CIRCULATORY SYSTEM - ARTHROPODS

- **Heart** is an enlarged **tubular dorsal blood vessel**
- organs are bathed in **hemolymph**
- Blood is propelled through the body by the heart



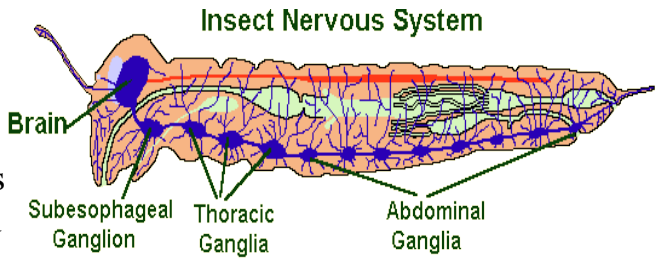
- It is enclosed in a compartment called **pericardium**
- Pericardium is like rest of **haemocoe**l filled with **hemolymph**
- When heart sucks hemolymph through openings on its wall called **OSTIA** and expels it again forwards to head.

RESPIRATION - ARTHROPODS

- Through **spiracles** in the exoskeleton - exchange of gases takes place. e.g. parasitic mites
- Through **Gills**
  - Portions of body modified to form gills. e.g. Aquatic larvae of mosquitoes
- Through **organs** developed which can take air into interior of body
  - Air breathing organs include
    - Lung books e.g. Scorpions /spiders/Crabs
    - Trachea e.g. Ticks, insects
    - Tracheal lungs e.g. **larvae of *Hypoderma***
    - Tracheal system has large thin walled dilations- air sacs e.g. ***Lucilia***

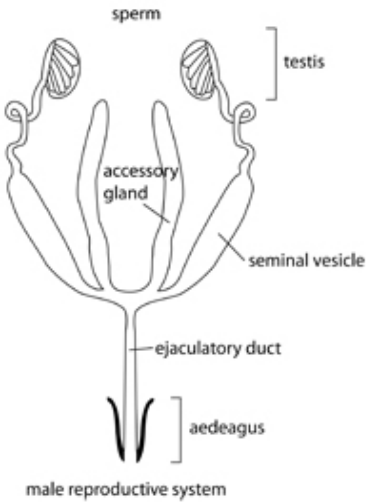
NERVOUS SYSTEM

- Head has dorsal brain then connected to a double ventral nerve cord
- Each thoracic and abdominal segment has one ganglion (i.e. 3 thoracic ganglia and 11 abdominal ganglia).



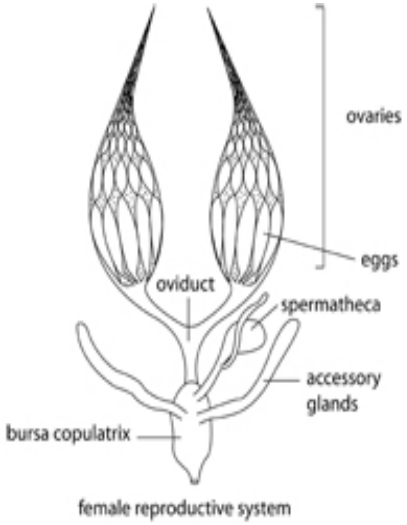
EXCRETORY SYSTEM - ARTHROPODS

- **Excretory organs of insecta are called *Malpighian tubules*** which are arranged in a ring around alimentary canal at the junction of mid gut and proctodeum
- **Coxal glands and Malpighian tubules** used for excretion by **Arachnida (Ticks)**



REPRODUCTIVE SYSTEM - ARTHROPODS

Male : The male has a two testes and from these arise the vas deferens which conduct the sperm to the seminal vesicles for storage. The common duct (ejaculatory) opens into aedeagus which conduct the sperms into the female. Accessory sex glands are seen on either side of the ejaculatory ducts which secrete a fluid for lubrication of aedcagus. External genitalia are the **aedeagus**, which is provided with **claspers.**



female reproductive system

Female : The female has two ovaries which consist of groups of ovarian tubules, all arising from an apical filament. The ducts unite to form a common duct which bears the receptaculum seminis that ends in **ovipositor**. **<u>Accessory glands are usually present whose secretion serves to attach the eggs to the hair of the host.</u>**

Oviparous - Flies that lay eggs (e.g) Mosquitoes, *Tabanus*, House fly etc.

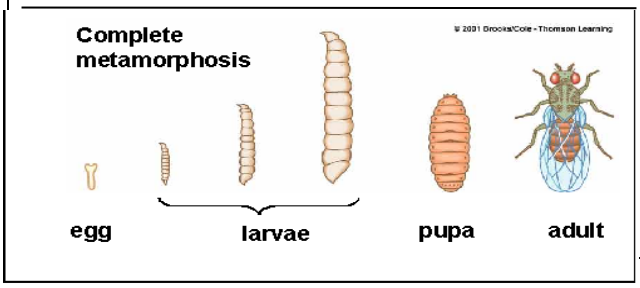
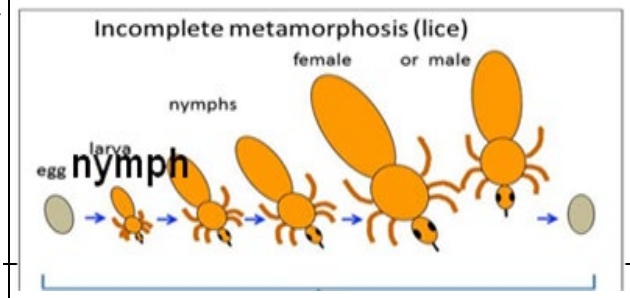
Larviparous - Flies that deposit larvae (e.g) *Oestrus ovis, Sarcophaga sp, Sheep ked (Melophagus sp)*

Pupiparous - Flies which give birth to larvae that are ready to pupate (e.g) *Hippobosca* sp.

METAMORPHOSIS - ARTHROPODS

- Change in **form of the insects** associated with **ecdysis or moulting** is called **Metamorphosis**
- Two types of Metamorphosis,
  - Complete Metamorphosis
  - Incomplete Metamorphosis
  - Unchanged or Metamorphosis is absent. e.g. **silver fish**

Complete Metamorphosis (Holo-metabola)	Incomplete Metamorphosis (Hemi-metabola)
Examples: Flies, Fleas	**Examples:** Lice, Bugs, Ticks & Mites,
LIFE CYCLE	

Egg-larva-pupa-adult **(Flies& Fleas)** 	Egg-nymph-adult e.g. **lice & bugs** Egg-larva-nymph-adult- **ticks & mite** 
Complete metamorphosis is when the adult stages are totally different from the immature stages morphologically	Incomplete metamorphosis is when the adults and immature stages resemble one another morphologically
• The young one is called *larvae*. It is immature stage of insect	• Larvae/Nymph
• Larvae have ocelli only. No compound eyes	• Nymph and adult have compound eyes
• There is a prolonged resting phase-pupal stage	• No resting stage
HABITAT	
• Adults and immature stages occupy different habitats e.g. mosquito larvae/pupae are aquatic while the adult is terrestrial(Land)	• Occupy same habitat • Mites larvae/nymph and adult are all seen in the skin of host
FEEDING HABIT	
• Adults and immature stages feed differently • Adults and immature stages have different types of mouth part • E.g. Mosquito piercing and sucking mouth part in adult, chewing mouthparts in larvae, pupa non-feeding stage	• Similar feeding habits and mouth parts • E.g. In biting louse chewing mouth parts in larvae, nymph and adult

TYPES OF LARVAE

Classification of types of larvae is mainly based on the **head and number of legs**

Eucephalus

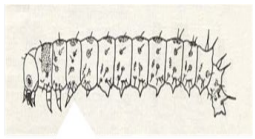
- Larvae with distinct head and mouth part. e.g. larvae of mosquito

Acephalus

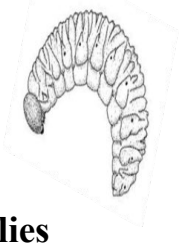
- Larvae with **reduced head (or) no head.**
- e.g. larvae of dipteran flies

Polypod larvae

- **Eucephalus (True or well marked head)**
- Thorax with three segments, each with a pair of **clawed legs**
- Abdomen with ten segments, the first 5 segments bearing fleshy **hooked legs** called **prolegs**
- It has both thoracic and abdominal legs e.g. **Caterpillar of butterflies**







Oligopod larvae

- **Eucephalus**
- Thorax with three pairs of legs
- No abdominal legs. e.g. **beetle larvae**

Apodous larvae

- **Acephalus** (reduced head)
- No thoracic or abdominal legs e.g. **larvae of house flies/blow flies**

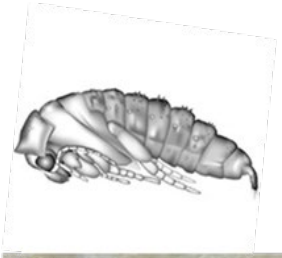
PUPA

- It is the quiescent phase between larva and imago (adult)

IMAGO

- young adult insect inside pupa

TYPES OF PUPA



1. **Exarate or Free Pupa**

- Active pupa
- The wings and legs of developing adult can be seen externally and they are free from the rest of the body. **e.g. beetles (Coleoptera-Order)**



2. **Obtectate Pupa**

- The legs and wings of developing adult is attached to the body by moulting fluid
- They can be seen externally
- The adult emerges from pupa through a **'T' shaped opening**. e.g. **Nematocera and Brachycera-Order**



3. **Coarctate Pupa**

- Last larval skin is not cast off but forms a puparium or Cocoon inside which adult develops
- Developing adult cannot be seen externally
- Young adult emerges out through **circular opening** on pupal case e.g.**Cyclorrhapha (Order) - pupa of house fly, stable fly**

Reference books

1.Veterinary Entomology by Richard wall and David Shearer

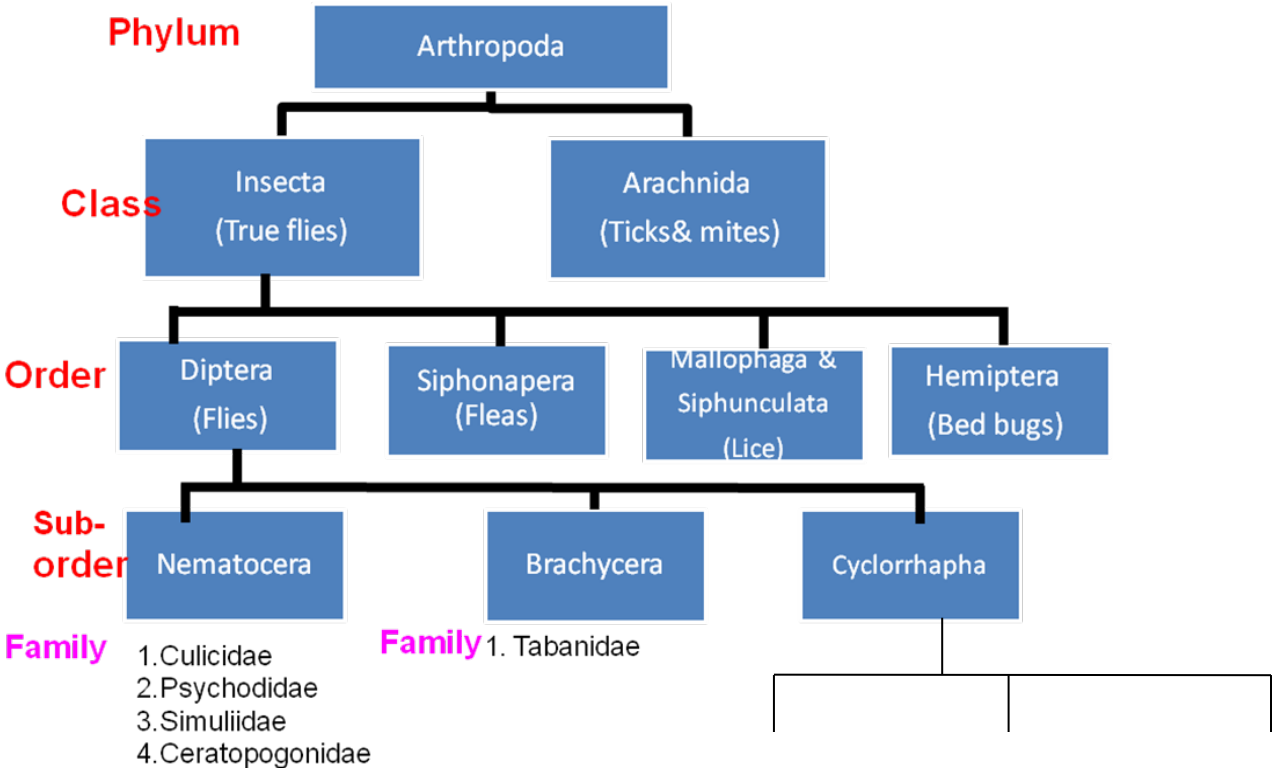
2.Medical and Veterinary Entomology by D.S. Kettle

3.Veterinary Parasitology by J,M,Urquhart

4. HELMINTHS ARTHROPODS AND PROTOZOA OF DOMESTICATED ANIMALS

by **SOULSBY.E.J. L.**

CLASSIFICATION OF ARTHROPODS



Section: Acalypterae Calypterae Pupipara

Family: Gastrophilidae 1.Muscidae 1.Hippoboscidae

2.Calliphoridae

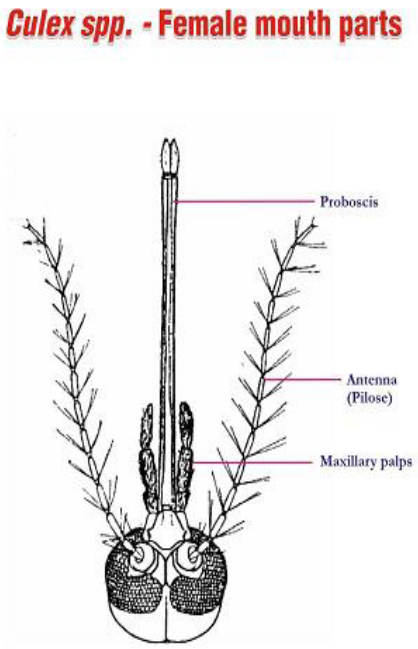
3.Oestridae

Sub-order: NEMATOCERA (Nemato means long, cera means antenna).

- **Family**
  - **Culicidae**
  - **Psychodidae**
  - **Simuliidae**
  - **Ceratopogonidae**

Culicidae- MOSQUITOES

- **Family: Culicidae**
- Species:
  - ***Anophles stephensi***
  - ***Culex fatigans***
  - ***Aedes aegypti***



MOSQUITOES -GENERAL MORPHOLOGICAL CHARACTERS

Head

- Small and spherical
- **Eyes**: Large compound eyes, holoptic in males and dichoptic in `females , **Ocelli absent**
- **Antenna:** Long and slender antenna, 14-15 segmented, **plumose in males** and **pilose in females**
- **Mouthparts: Piercing and Sucking type**
- Only females feed on **blood**
- Females show the presence of a pair of mandibles which are long and needle like –they pierce the skin
- A pair of maxillae which are stylet like are present
- Male mosquitoes live on **nectar or fruit juices** and
- have reduced (or absent) **mandibles and maxillae**

Thorax

- **Wedge shaped**

Legs: Three pairs of legs, the third pair is called the **floating pair** since it does not touch the substrate while resting.

Wings:

- Wings are narrow, **lanceolate** and bears scales
- Wing venation is characteristic in that **the 2nd, 4th and 5th longitudinal veins are forked**

Abdomen

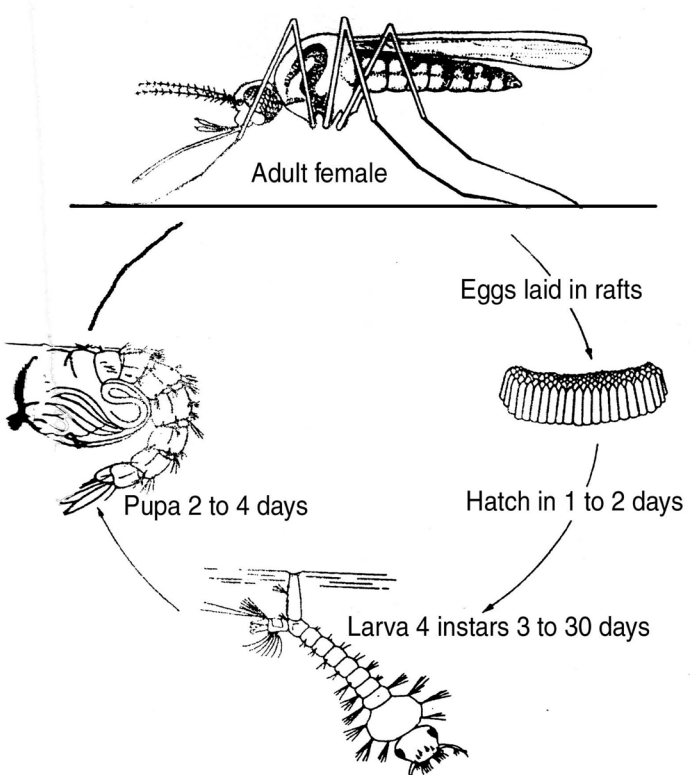
- Long and slender

LIFECYCLE

- Egg -Larva(L^1-L^4) -Pupa- Adult

EGG - MOSQUITOES

- Laid on water
- Wide variation in habitat occurs
- It depends on the individual species preference for presence



or absence of decayed material, acidity and alkalinity

MOSQUITOES - LARVA

- Mosquitoes - Larva is called as *"**wigglers**"*
- Four larval stages in the life cycle
- Larvae feed on **algae and other organic matter available in the water**
- Body has head, thorax and abdomen
- Head bears simple eyes, antennae and hairs. The mouth parts are mastigatory and are surrounded by brushes called the **feeding brushes**.
- Thorax is unsegmented and bears hairs
- Abdomen has 10 segments.
- Stigmal opening is located at the junction of the 8^{th} and 9^{th} abdominal segments. The opening is called **respiratory fossa in Anophelines** while in the **Culicines** it is covered by a tube called the ***Siphon tube***
- On the ventral aspect of the siphon tube is a row of spines called the ***Pecten***

PUPA - MOSQUITOES

- Commonly called the *"**tumblers**"* due to the tumbling movement they exhibit
- Aquatic, comma shaped
- The head and the thorax are fused together to form the *Cephalothorax*
- On the dorsal aspect of the head a **pair of *breathing trumpets*** are seen
- The 9^{th} abdominal segment shows the **presence of a pair of paddles** which enable the pupa to move
- The life cycle is usually completed in a **week time**-it may be prolonged under adverse conditions

Difference between Anopheline and Culicine mosquitoes

Character	Anophelines	Culicines
Genus and species	Genus : *Anopheles* Species: ***A. stephensi***	Genus: *Culex* Species: ***C. fatigans*** Genus: *Aedes* Species: ***A. aegypti***
Common Names	• *Anopheles* is referred to as the **dappled mosquito** due to the **presence of dappling on the wings**	• *Aedes* ***aegypti*** is called **yellow fever mosquito** • *Aedes albopictus*-Tiger mosquito

Difference in the adults		
Resting Posture	• Rests at an angle to the surface. The proboscis is held forward, thus proboscis and abdomen are in a straight line	• Rests with the abdomen parallel to the surface while the proboscis is bent down. So abdomen and proboscis are at an angle to one another
Mouthparts	•	
Male	• Maxillary palp is as long as the proboscis and has a **club shaped appearance**	• Maxillary palp as long as the proboscis and not clubbed
Female	• Maxillary palp as long as the proboscis	• **Maxillary palp is short** and is one third the length of the proboscis
Thorax		
• Scutellum	• Unilobed and crescent shaped	• Trilobed
• Wings	• Accumulation of scales at the anterior border of the wing giving it a **dappled appearance**	• No dappling
• Legs	• No white bands at the joints of legs	• **White bands are seen at the joints of legs** in the case of the **Aedes** alone
Abdomen	• Last abdominal segment is broad and rounded at the tip	• Last abdominal segment is narrow and pointed
Habits	• Fly almost a mile from their breeding areas, anthrophilic, nocturnal biter, painful bites and prefer the ankle of man and in animals the fetlock region	• While *Culex* spp. Can fly more than a mile from the breeding place *Aedes* spp. Do not fly far from their breeding area. The bites of the culicines are not as painful as that of the

		anophelines.
Difference in the lifecycle		
Breeding areas	• Prefer **fresh water such as running water, rain water**, water used for irrigation purposes, streams, lakes etc.,	• *Culex* spp. **oviposit in dirty, contaminated water such as those in the drains, and ditches** etc., *Aedes* spp. usually prefers **water held in containers, such as tanks, water stored in buckets, rain** water in the tree holes, tyres, tins, pots etc.,

Egg	• **Laid single, boat shaped with lateral floats** and frills • One female can lay 40-100 eggs at a time	• ***Culex*** spp. **lays eggs in masses.** The eggs are arranged vertically with the pointed end towards the surface of the water. It's referred to as the "**Egg raft"** A female can lay around 200-600 eggs at a time. • ***Aedes*** spp. **lays single eggs**. The eggs are cylindrical and reticulated
Larvae	• **Absence of siphon tube** Larvae lie parallel to the water surface with the respiratory fossa applied to the water surface. **Palmate hairs present** on the body segments enable the larvae to float parallel to the water surface.	• **Siphon tube** is long and conical in *Culex* spp.and it's short in *Aedes* spp. Larvae hang down vertically from the water surface**. Palmate hairs are absent.** Pecten is present, its short in the case of*Culex* spp. while in *Aedes* spp. its long..
Pupae	• Breathing trumpets are **short and broad.** Abdominal segments with palmate hairs.	• Breathing trumpets are **long and narrow.** No palmate hairs.
Difference in the vector potentiality		
Humans	• **Human malaria**(caused by *Plasmodium falciparum, P.vivax, P.ovale* etc.,) • Filariasis in man caused by *Wuchereria bancrofti, Brugia malayi.*	• **Avian malaria (Culex sp.)** • Filariasis in man caused by *Wuchereria bancrofti, Brugia malayi.* • ***Culex* spp**. is responsible

Animals	• *Dirofilaria immitis* in dogs • *Setaria digitata* in cattle	for the transmission of **Japanese B encephalitis virus in children** which causes **brain fever**. • *Aedes* spp is involved in the transmission of **Yellow fever virus, dengue,** Rift valley fever virus, **Chikungunya** fever virus, ***Zika virus*** • Both the genus are involved in transmission of *Dirofilaria immitis* in dogs, *Setaria digitata*in cattle, Eastern equine encephalitis virus and St.Louis encephalitis virus

MOSQUITOES – CONTROL –Larva & Pupa

Managemental practices

- This is done by **elimination/reduction of the breeding areas**
- **Stagnation of water to be avoided** –fill up pits with sand
- Removal of vegetations and weeds over the water bodies
- ***Aedes* spp**. can be easily controlled by **covering stored water in buckets** or over head tank, water in tree holes can be drained or covered up, proper disposal of tires and other containers that can hold water and be a potential source for breeding of the mosquito
- ***Application of kerosene on water surface suffocate the mosquito larvae***

Biological control

- Fishes such as ***Gambusia* (Mosquito fish*)***, Guppies,Gold fish,Cat fish, tadpoles and frogs feed on the larvae of mosquito
- Predators such as **birds, bats, naiads of dragon fly, spider** on adult mosquitoes
- *Toxorhynchites* spp -**Elephant mosquito** feed particularly on larvae of the **Aedes** mosquito species.
- Spray of ***Bacillus thuringiensis* (Bacteria)**–in water kills larvae of mosquitoes

- Two species of **fungi** can kill adult mosquitoes: **Metarhizium**sp and **Beauveria** sp.
- **Sterile male insect technique-** Large numbers of male insects are made **infertile** using gamma radiation. These males are then released into the wild and allowed to mate with females and progeny will be sterile.

Chemical control

- **Spraying insecticides is not recommended in fresh water sources** – however, the insecticides can be sprayed in sewage, drains etc to control the larvae
- Spraying of paris green mixed with **kerosene** is a safe larvicide.
- **Methoprene** (Insect growth regulator-IGR) – **Larvicide**- interferes with natural growth hormones in mosquito larvae, preventing its development.

MOSQUITOES – CONTROL -Adults

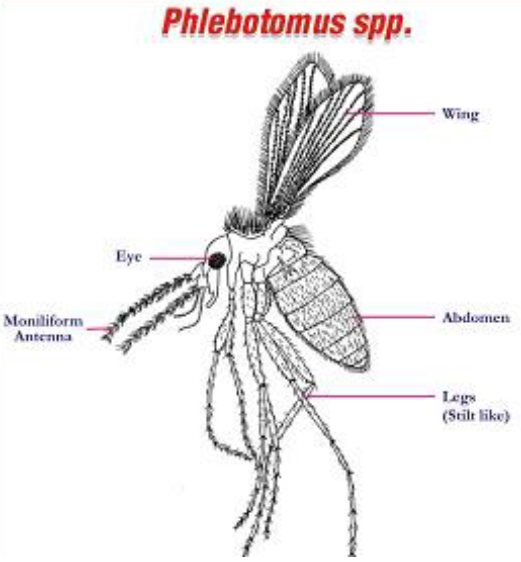
- Use of nets, impregnated nets, repellents on individuals
- **DEET (*N*,*N*-Diethyl-*meta*-toluamide)**, or **diethyltoluamide (Odomos)** is the most common ly used **Mosquito repellent**. It is a slightly yellow oil intended to be **applied to the skin or to clothing**, and provides protection against **mosquitoes**, ticks, fleas, chiggers, leeches, and many biting insects
- Use of insecticides in the form of mats, coils, vapourisers and sprays
- Currently used insecticides are the **synthetic pyrethroids**. Mosquito control professionals apply pyrethroids as an ultra low volume (ULV) spray. ULV sprayers dispense very fine aerosol droplets that stay aloft and kill adult mosquitoes on contact. Pyrethroids used in mosquito control are typically mixed with a synergist compound, such as piperonyl butoxide, which enhances the effectiveness of the active ingredient. **Note:** Nilavembu Kudineer, also called **Nilavembu Kashayam**, is Siddha Medicine recommended for prevention and management of all types of viral infections/fevers. It acts as immunostimulant and immunomodulator, which boosts immunity and modulates defense response in the body, which helps to protect from infections and their complications. It also plays a protective role in **dengue fever and chikungunya**. It is very popular medicines among people using Ayurveda and Siddha Medicine.

Psychodidae-SAND FLIES

- Family : Psychodidae
- Genus : *Phlebotomus*
- Species : ***P.argentipes*, *P.sergenti*** and *P.papatasii*
    - Small **hairy flies** about 2.5 mm in length
    - Wings heavily clothed with hairs/scales so venation is obscured, wings are held **roof like over the abdomen during rest**
    - Referred to as **Sand Flies/Moth Flies/Owl Midges**

SAND FLIES - MORPHOLOGY

- Small, like miniature mosquitoes
- 2-3 mm long, rarely 5 mm
- Light yellow to grey in colour- hence the common name sand fly
- **Body densely covered with hairs**



Head

- Elongated, hangs down from the thorax
- **Eyes: Conspicuous large dark compound eyes**-hence the common name **owl midges**
- **Antenna**: similar in both males and females - *Moniliform* (with a beaded appearance),
- 16 segmented
- Mouthparts: **adapted for piercing and sucking**
- Palps: pendulous, hairy and 5 jointed

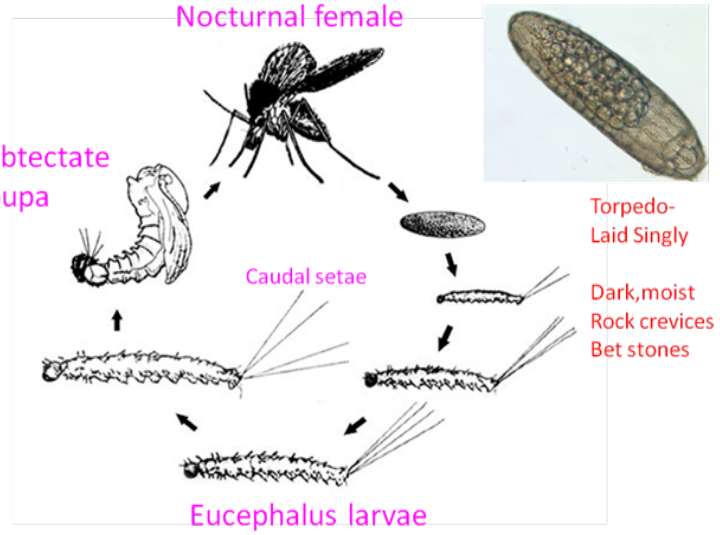
Thorax

- Raised/arched/humped, covered with hairs
- Wings: large lanceolate, **held roof like over the abodomen**.
- **2 nd longitudinal vein- forked twice**.
- Legs: long slender and **stilt like** covered with hairs

Abdomen

- Long, 8-10 segmented, and covered with hairs

LIFECYCLE- SAND FLIES

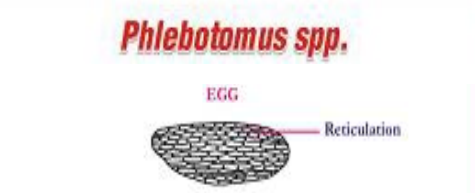


- Egg -Larva(L^1-L^4) -Pupa- Adult

Breeding habitat

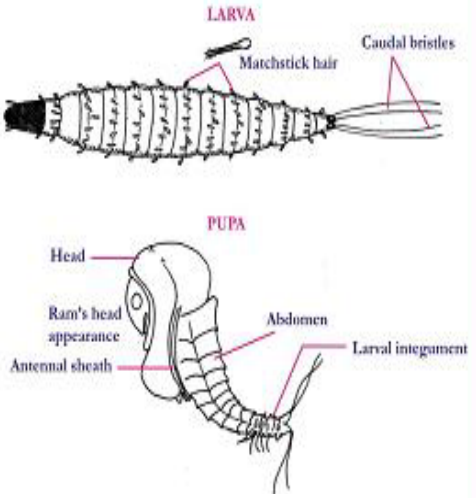
  - **Cracks, crevices, holes in the wall, rocks**
  - Non aquatic
  - Dark, moist areas with decaying organic matter

SAND FLIES - EGGS



- Ellipsoidal in shape, 0.3 to 0.4 mm long with rounded endsShow the **presence of shining longitudinal black wavy lines**, raised slightly and joined by **slender cross lines**
- 40-50 eggs are laid in a lifetime by the female fly

SAND FLIES-LARVAE



- Eggs hatch in 1-2 weeks, the emergence of the L_1 is by using the egg breaker situated at the anterior end
- Larvae **feed on faeces of lizard** and other animals, **decaying organic matter and even dried leaves**
- They have a distinct sclerotized head **(Eucephalus)**
- Eyes are absent
- They have 12 segments, 3 thoracic and 9 abdominal
- All segments have feathered hairs resembling match stick
- **Terminal segments have the characteristic caudal bristles, 4 bristles in L_3 and 2 in L_1 and L_2**
- The first seven segments possess small **false legs** called the ***Pseudopods***

SAND FLIES - PUPA

- Pupal stage lasts for 1 to 2 weeks

- Last larval skin is not discarded, so the pupa remains in an upright position with the last larval skin attached to it
- It has a triangular head and a curved abdomen
- It resembles a **miniature ram** since the long antennal sheath curves below its eyes making it to look like a **rams horn**

SAND FLIES - HABITS

- Females suck blood while the males feed on plant juices
- Active at night and hides during day time
- They are weak fliers and make short hopping flights
- Seen only in the ground floor of buildings
- Females bite dogs, men, rodents, reptiles, lizards and other vertebrates
- In India, life cycle is completed in one and a half to two and a half months time

SAND FLIES - EFFECT ON THE HOST

Direct

- Nuisance due to the bites at night

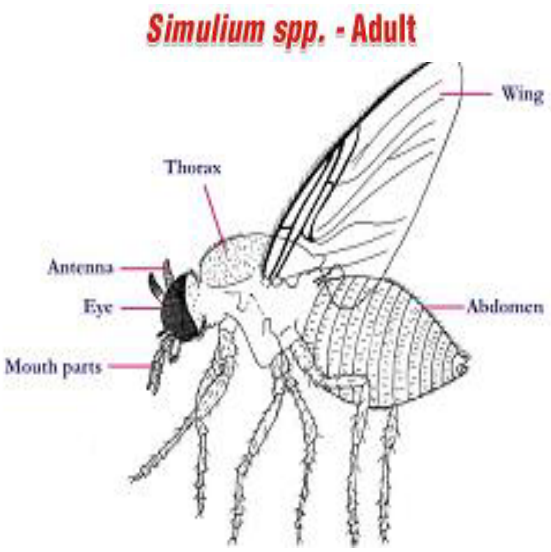
Indirect

- ***Phlebotomus argentipes***-vectors for the protozoan ***Leishmania donavani*** (which causes visceral leishmanosis)
- ***Phlebotomus sergenti*** is the vector for ***Leishmania tropica*** (which causes cutaneous leishmanosis)
- ***Sandfly fever or Papatasi fever*** due to a virus which is also transmitted by this fly

SAND FLIES - CONTROL

- Removal of dense vegetations to discourage breeding of the flies
- Mosquito eradication measures also enable control of *Phlebotomus* species

SIMULIDAE- BLACK FLIES



- Family: Simuliidae
- **Genus:** *Simulium*
- Species: ***S. indicum***
- Common Name: **Black flies**, **Potu fly** (Himalayas), **Buffalo gnats, Turkey gnats**
- Small, dark (hence the name **black flies**), squat bodied, thick set flies
- **Hump backed**, larger than the ceratopogonids

BLACK FLIES - MORPHOLOGY

- Body covered with short golden or silvery hairs

Head

- ***Eyes:*** **Kidney shaped compound eyes**,
- dichoptic in females and holoptic in males
- ***Antenna****:* Short, thick, cigar shaped which projects forward (**resembles the horn of a buffalo and hence the common name**)
    - 11 segmented, compacted and is moniliform or beaded in appearance
    - **Not plumose or pilose- bare**
- *Palps:* 5 segmented, pendulous, longer than the proboscis
- *Mouthparts:* **Piercing and sucking type** in female

Thorax

- **Humped over head**

Wings: short, broad with large anal lobe

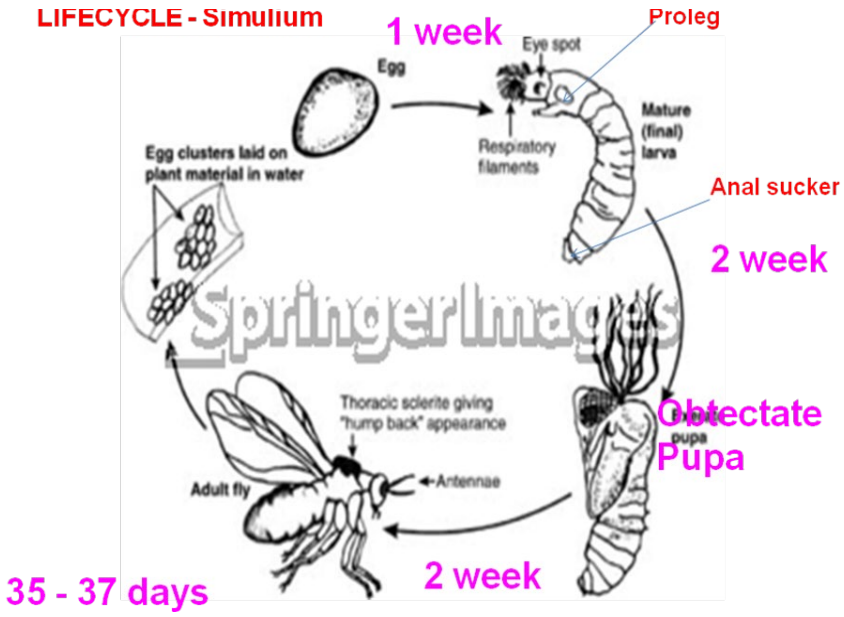
- **Well developed anterior veins**, weaker cubital and median veins (posterior veins)

Abdomen

- Male terminal compact and inconspicuous

BLACK FLIES- LIFECYCLE

Egg- Larva (L_1-L_{6-9})-Pupa- Adult.

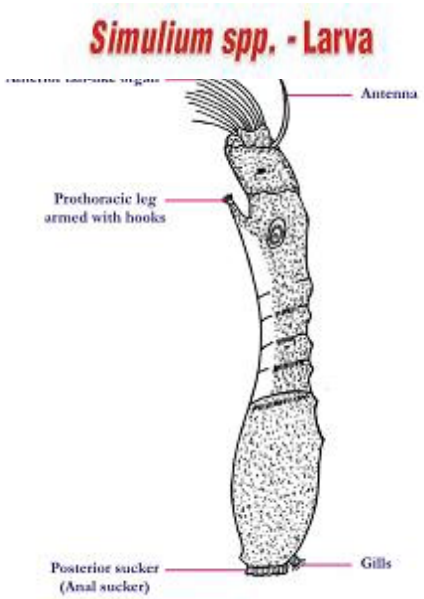


Breeding site

- Running water, ranging from torrential mountain streams to slow moving lowland rivers
- In India seen in the waterfall areas of **Himalayan mountains** and in Tamil Nadu recorded at **Kuttralam, Nilgiri and Palani hills**.

BLACK FLIES - EGGS

- Laid during the afternoon and evening times, laid in batches of 200-800
- Communal egg mass is common
- Laid on water/objects close to the waterline or in areas wetted by water or in the splash zone
- 100-400 µm in size, long ovoid triangular in shape and covered with a gelatinous sticky substance
- Hatch in 3-4 days or even 12-14 days



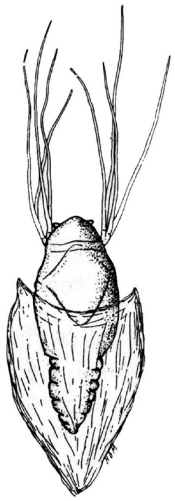
BLACK FLIES – LARVAE

- Whitish or greenish in colour
- 6-9 larval stages, mature larva is 4-12 mm long, elongate, **Indian club or hour glass shaped body**

- Prominent **pair of cephalic fans (labral fans**) which aid filter feeding by the larvae
- Larvae are anchored to the rocks by means of the thoracic and abdominal **prolegs**, these are provided with a **circlet of hooks** which enables adhesion with the substrate
- Mature larva is recognized by a gill spot on either side of the thorax
- Larva is also provided with **3 pairs of retractable anal gills**
- Larvae are carnivorous and predacious on aquatic organisms

BLACK FLIES – PUPA

- The larvae moult 6 times to become pupa
- **Obtectate pupa**
- Triangular cocoon



PUPA

BLACK FLIES - HABITS

- Adult females suck blood, attack in swarms
- They are opportunistic feeder; feed either on human or animals.
- They are **diurnal**, exophilic and exophagic
- body

BLACK FLIES - EFFECT ON THE HOST

Direct Effect

- Annoyance, **painful bites** resulting in severe reactions which may lead to death of an individual
- Petechial haemorrhages especially on areas of fine skin, oedema of throat and abdomen is common
- Flies enter the natural orifices especially the nose, eyes, ears and mouth of individuals
- The flies attack in swarms and gadding is seen in animals
- Milch cows are badly bitten and the teats are bloody and blocked or so sore that they do not tolerate milking, calves cannot suckle
- Repeated biting in man results in a syndrome called the black fly fever. This is characterised by headache, fever, sweating, shivering, nausea, swelling and

tenderness of the lymphnodes, aching joints, lassitude and psychological depression

Indirect Effect (vector potentiality)

- Transmits ***Leucocytozoon smithi*** in turkeys and ***L. simondi*** in ducks
- Intermediate host for ***Onchocerca gutturosa*** in cattle and ***O. volvulus*** of man which is very important since the filarid is the cause of river blindness in man
- It also transmits eastern equine encephalitis virus and vesicular stomatitis virus in cattle

CONTROL - BLACK FLIES

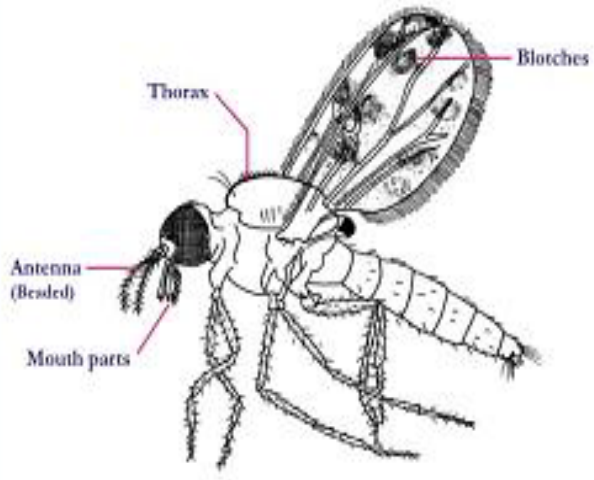
- **Very difficult** since the flies breed far away from habitations and the flies can fly 3-5 kms or more in search of hosts.
- Since they are exophilic, medicated screen can be used in animal houses and animals must be restrained within the houses during the fly season.
- WHO has recommended the use of a biodegradable product – Abate(Temephos) to be sprayed aerially using helicopters .This is a part of the 20 year programme along the nile river to control river blindness in man.
- Cholphoxim can be used in areas where resistance to abate has developed.
- For poultry, dust baths with 0.5% Lindane is recommended.
- Biological control using ***Bacillus thuringiensis*** has been attempted.

Ceratopogonidae - BITING MIDGES

- Family : *Ceratopogonidae*
- Genus : ***Culicoides***

Species: **C.fulvithorax**, C.pungens, C.nubeculosus, C.himalayae, C.robertsi

- Common names : **Biting midges, No-see-ums, Punkies**
    - **Small inconspicuous flies with wings folded over the abdomen,**



usually appear as swarms

MORPHOLOGY - BITING MIDGES

- Small, 1-2mm long

Head

- Small with prominent eyes
- Antenna : 12-14 segmented, plumose in male and pilose in female
- **Mouthparts Piercing and sucking type**
- Maxillary palps : Long

Thorax

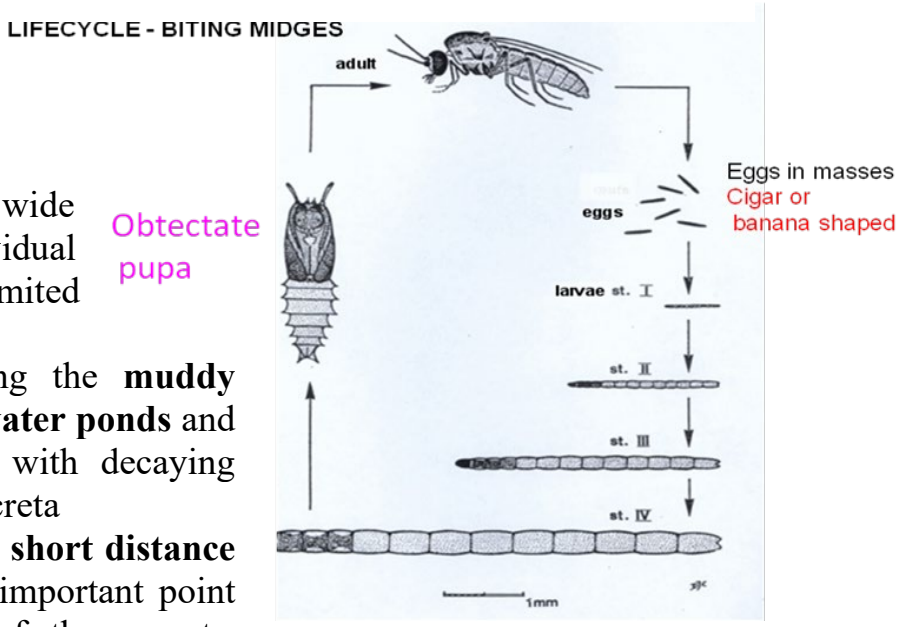
- Wings with light and **dark pattern, due to pigmentation** in the wing membrane-grey with pale spots covered with minute setae
- Legs are relatively short

Abdomen

- 9 segmented, dull grey to yellowish black or brown in colour
- Male slender than female with conspicuous claspers
- Posterior end is rounded in females

LIFECYCLE - BITING MIDGES

Egg- Larva (L1-L4)-Pupa-Adult



Breeding site

- **Wet soil**- can be seen in a wide variety of habitats. Individual species utilize only a very limited range of breeding sites

Obtectate pupa

- Usually can be seen along the **muddy shoreline of dairy waste, water ponds** and muddy sites contaminated with decaying vegetable matter or even excreta
- **Most species disperse only short distance from their breeding site**- important point to be noted for control of these pests, Mostly are **crepuscular or nocturnal** in habit

EGGS - BITING MIDGES

- Small, 0.5 mm long, laid in batches of 30-40
- They are banana shaped, cylindrical and curved
- They are dark in colour and hatch in 2-9 days

PUPA



LARVAE - BITING MIDGES

- Four larval instars
- They are cylindrical, white with well sclerotized head
- There are 11 body segments i.e. 3 thoracic and 8 abdominal and are without appendages
- Larvae show a characteristic ***eel like or serpentine movement***
- At the posterior end they have 2 pairs of narrow, bifid anal papillae (gills) which are retractable into the rectum
- This stage lasts for 14-25 days

PUPA-BITINGMIDGES

- 2 - 4 mm, brown and highly chitinised
- Head and thorax are fused together
- It bears moderately long, **tubular prothoracic horns for respiration**
- Dorsal surface of pupa is covered with spines and tubercles
- Segmented abdomen ends in a pair of caudal spines with the help of which the pupa moves over the substrate.
- This is a short lived, non feeding stage
- Usually seen buried in the substrate and only prothoracic horns protrude on the surface
- This stage lasts for 3 - 10 days

HABITS - BITING MIDGES

- Females suck blood from both man and animals
- They **are painful biters, crepuscular in feeding habit**
- Following a blood meal, the female usually appears like a drop of blood flying in the air

EFFECT ON THE HOST- BITING MIDGES

Direct

- They cause very painful bites and are a source of irritation to man and animals
- *C. robertsi* is known to cause an **allergic dermatitis in horses in Queensland**, Australia, The condition is called as **Queensland itch, sweet itch, sweat itch or summer dermatitis**
- The withers and base of the tail of the horse which are bitten by the fly are mainly affected
- There is an **immediate hypersensitivity reaction** and intense pruritis is observed in affected horses
- Further, there is **loss of hair and hyper pigmentation**

Indirect (vector potentiality)

- They act as vectors for,
    - **Blue tongue virus in sheep**
    - African Horse sickness virus
    - Bovine ephemeral fever virus

- Eastern equine encephalitis virus
- **Epizootic haemorrhagic disease in Deer-Emerging disease**
    - ***Leucocytozoon caulleryi*** in fowls
    - *Haemoproteus nettionis* in ducks, geese etc.
- They also act as intermediate host for filarid nematodes like ***Onchocerca cervicalis*** in horses and ***O. gibsoni*** in cattle
- **Dipetalonema perstans**-Nematode

CONTROL - BITING MIDGES

- Identification and modification of breeding areas is essential
- Since *Culicoides* spp. breed around leaking water troughs- stagnation of water giving rise to the optimum breeding condition of this fly should be prevented
- For man, clothes impregnated with **DEET (N N diethyl m toulamide**) is recommended
- **Light/U.V traps are available for trapping *Culicoides***
- **Baits using a potential attractant - 1 Octane 3 Ol** which simulates the body odour of cattle can be made use.
- Biological control can be affected using ***Bacillus thuringiensis***

Sub-order:BRACHYCERA



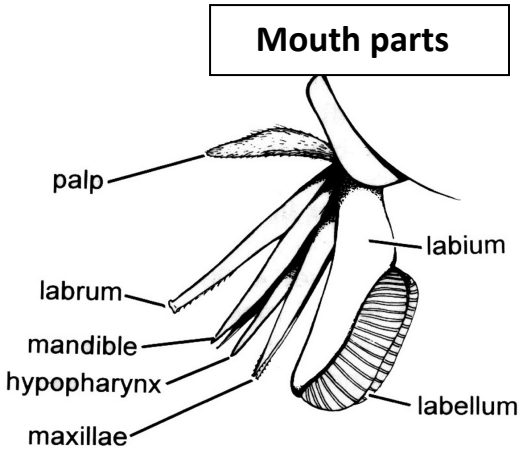
Tabanidae - HORSE FLY

Family : Tabanidae
Genus : *Tabanus*
Species: ***T.striatus****,T.orientus*
Common Names: **Blind fly, horse fly,** gad fly, marsh fly, breeze fly, green heads

MORPHOLOGY- HORSE FLY

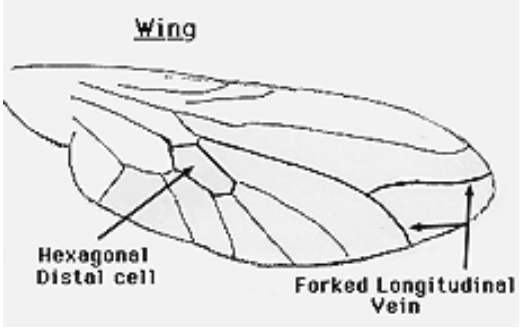
- Large and robust fly

Head



- ***Eyes:*** Large compound eyes, unicolorous and horizontally banded. Holoptic in males and dichoptic in females. Ocelli vestigial
- ***Antenna:*** 3 segmented. Third segment is the largest and equal to the 1st and 2nd put together. Third segment has **a tooth like projection/spur at the base and 4 annulations**
- ***Mouthparts:*** **cutting and sponging type**. Coarse biting parts, mandibles are blade or sword like, maxillae ending in rasp like structures distally. Mandibles cut the skin of the host while the maxillae probe deeper, hypopharynx adds the anticoagulant and blood is drawn into the food channel.
- **The flies are pool feeders**
- Labium ends in labella containing **the pseudotracheal membrane** which also helps to lap up blood during the feeding process.
- Maxillary palps are two segmented and prominent
- The coarse mouth parts and feeding habit of the tabanids frighten the host and hence the tabanids are interrupted while feeding which necessitates the **intermittent feeders to visit many animals for engorgement**. This intermittent feeding habit of Tabanids makes them potential vectors of diseases

Thorax



- Has **longitudinal white stripes**
- **Wings** are clear with the **3rd longitudinal vein being forked** at the apex
- is hexogonal in shape

Abdomen

- Brown in colour
- Frequently has **longitudinal stripes**

LIFE CYCLE - HORSE FLY

Egg - Larva ($_{L1}$-L $_{7\text{-}11}$) - Pupa-Adult.

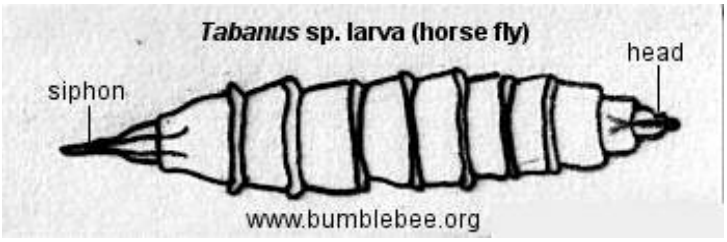
Breeding areas

- They lay eggs on the soil or vegetation near water

EGGS - HORSE FLY

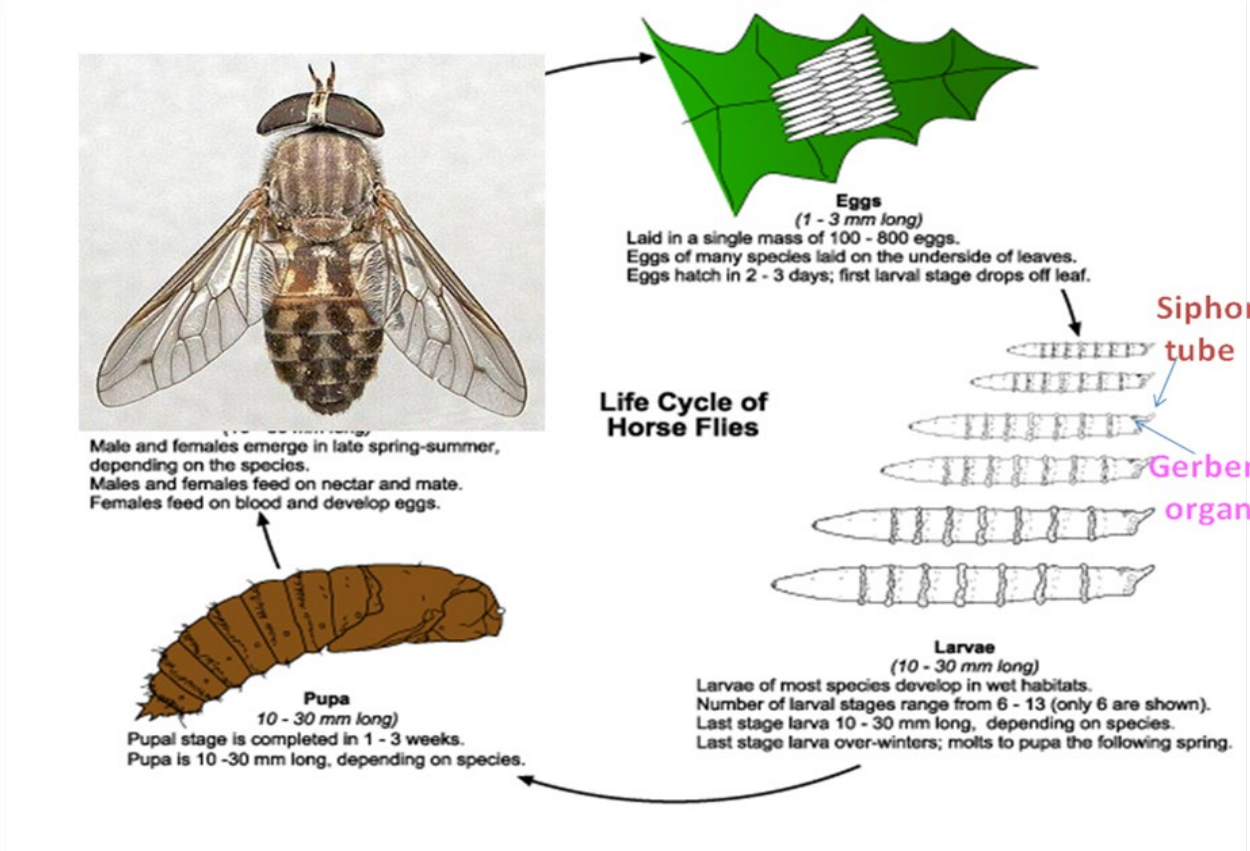
- Laid in masses of 200-1000, glued to the surface of substrate especially vegetation overhanging water
- **Cigar shaped and water proofed**

HORSE FLY - LARVAE



- Hatch out in 4-7 days and drop into the water or the mud
- 7-11 larval instars are seen
- They are 11 segmented, maggot like, cylindrical with pointed ends.
- The larvae are carnivorous and can even bite man
- They have a distinct chitinous head, 3 thoracic and eight abdominal segments,which **has fleshy tubercles**.
- A **retractible siphon tube** is seen on the 8th abdominal segment. An organ called the **Graber's organ** is located on the **penultimate segment** and is known to have **respiratory and sensory functions**

- The 1-7 abdominal segments show the presence of fleshy projections on the ventral aspect which are referred to as the **pseudopods (False legs)**



- Terminal abdominal segment has fleshy anal papillae

PUPAE - HORSE FLY

- **Obtectate** with distinct cephalothorax and 8 abdominal segments
- Usually seen in the drier parts of the breeding area
- Have ear shaped spiracles to enable respiration
- The terminal abdominal segment has six lobes bearing spine like processes called the caudal aster
- This stage lasts for 1-3 weeks

HABITS - HORSE FLY

- **Flies are very fond of sunlight, usually seen in morning hours**
- **Flies have a habit of skimming over water** and occasionally dipping their bodies into it

- Females suck blood around the **naval area, neck, withers, abdominal region also the back and hindlegs**
- Vicious biters and **bite intermittently**. They bite indiscriminately and cannot be easily disturbed while feeding and hence the common name blind fly
- Feed during the hottest parts of the day
- Flies prefer large animals like horses, cattle but attack man when animals are not available

EFFECT ON THE HOST - HORSE FLY

Direct Effect

- The sight of the fly results in panic amongst the animals and they run madly-gadding. This results in the animals getting fractured, abortion in pregnant animals and even death
- The **bites are painful and irritating and may give rise to weals in soft skinned animals**
- The tabanids also feed **blood @0.2-0.3ml per day which can result in anaemia**
- Due to the addition of anticoagulant through the saliva of tabanids, blood continues to ooze out of the wound and this attracts other flies like ***Musca domestica*** to feed on the oozing blood- which can result in myiasis of the affected animal
- 17% reduction in feed conversion efficacy has been recorded in animals affected by Tabanid infestation

Indirect Effect (vector potentiality)

- Interrupted method of feeding of Tabanus makes **mechanical vector** for ***Trypanosoma evansi*** and **cyclical vector** for ***Trypanosoma theileri***
- Mechanically they can also transmit ***Anaplasma marginale*** and the causative organisms of anthrax, tularaemia, rinderpest and equine infectious anaemia

CONTROL - HORSE FLY

- Very difficult since they fly far from their breeding areas

Adults

- Residual sprays of malathion on the shed walls

- **Since the fly skims over water kerosene on water was used earlier to control the flies**
- Ear tags with cypermethrin are effective
- Avoid the sunny parts of the day for grazing the animals
- Traps which are coloured black can be placed near breeding areas to trap tabanids

Immature stages

- Biological control using **hymenopteran** insects such as ***Hunterellus hookeri*** and ants such as ***Telenomus* s**pp., which feed on the eggs of tabanids

******Note:** Species of **Nematocera and Brachycera** have no ptilinal sac and pupa emerge from the pupal case through a "**T-shaped split**" on dorsal surface where as species of **cyclorrhapha** emerge from puparium by pushing Ptilinal sac through "**circular opening**" in the anterior end of pupal case.

Sub-order: CYCLORRHAPHA

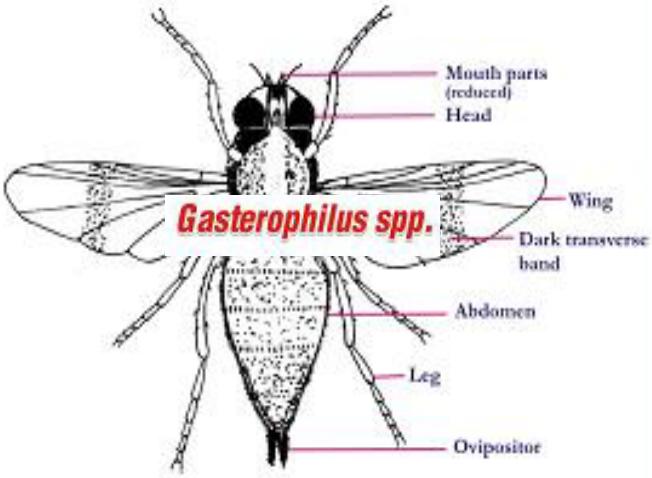
1.Section: Acalypterae

Family: Gasterophilidae-HORSE BOT FLIES

Genus :Gasterophilus
Species : ***G.intestinalis(G.equi)***, *G.nasalis, G.haemorrhoidalis*

- **Common Name** : **Horse bot fly**, Horse grub fly, Stomach bot
- Adult stages are non parasitic and the **larval stages are parasitic**
- They are seen in the **stomach of horses**

MORPHOLOGY - HORSE BOT FLIES



- Adult flies are brown in colour, hairy, somewhat **resembling bees**
- 18mm long

Head

- **Vestigial (non functional) mouth parts**

Thorax

- Wing shows the presence of a **dark, irregular transverse band** running across it

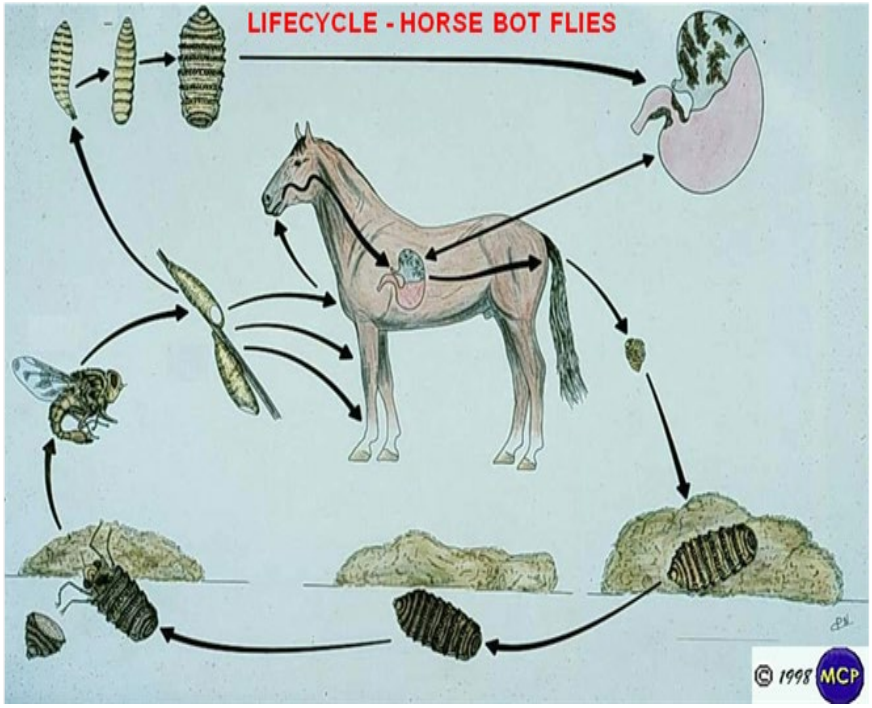
Abdomen

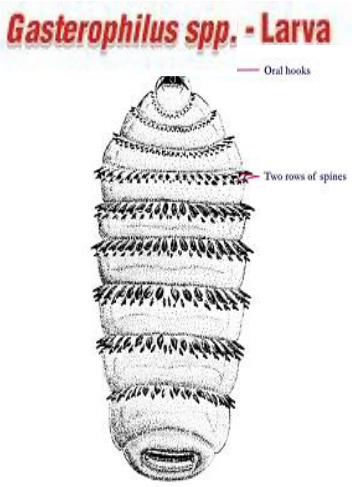
- Ends in a characteristic **crooked prominent ovipositor**

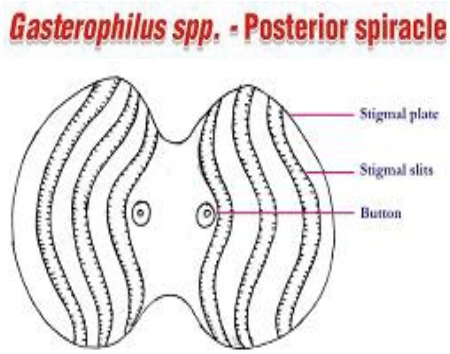
LIFECYCLE - HORSE BOT FLIES

- **Female fly hovers around the animal and oviposits around scapular or the fetlocks region of the forelimb**.
- The eggs are glued to the hair and hatch 5-10 days later only when the horse rubs and licks the area
- The moisture and friction is essential for the hatching of the eggs

- The first stage larvae penetrate the mucosa of the tongue and wander for a period of 28 days
- They moult to the second stage and this stage passes down the pharynx, oesophagus and reach the cardiac end of the stomach where they attach themselves
- They remain for 5 weeks after which they moult to the third stage mature larvae
- **The larvae remain in the non glandular portion of the stomach for a period of 10 months and the mature larvae is excreted in the faeces**
- Pupation is on the ground and one month later the adult flies emerge
- Total life cycle takes a year for completion







DESCRIPTION OF THE LARVAL STAGE - HORSE BOT FLIES

- Brown in colour with **2 rows of spines dorsally and ventrally**
- **Oral hooks** present in all the three stages
- The posterior spiracle is **bean shaped with three wavy longitudinal slits**

EFFECT ON THE HOST - HORSE BOT FLIES

Adult flies

- The presence of the hovering flies result in gadding in horses
- and the resultant injury, loss of condition due to improper feeding

Larval stages

- The first stage larvae during its migration in the tongue can result in **ulceration of the tongue**
- The second stage larvae may attach itself to the epiglottis, the pharynx and can cause injury to these regions by its oral hooks
- Since the second and third stage larvae ultimately **attach to the non glandular part of the stomach** they do not seem to cause much damage
- However there is a inflammatory reaction to the attached larvae and the stomach mucosa is thickened into a rim around the site of attachment
- Debility is observed in animals with the infestation and is believed to be due to the toxicity of the excretions and secretions of the larvae
- **The third stage mature larvae is also capable of causing injury by its oral hooks and other spines to the rectal region** when its passed out in the faeces

TREATMENT - HORSE BOT FLIES

Old Treatment

- **Carbon disulphide given in a stomach tube** or in a capsule at the rate of 2-5ml/kg Bwt. after an 18 hour of fasting. Piperazine, Carbon disulphide complexor this mixture with phenothiazine complex @ 110mg/kg is effective against Gasterophilus larvae
- **Trichlorofon** in feed or in water by stomach tube @ 39.6 mg/kg
- Combination of Thiobendazole and Trichlorofon @ 2gm Thiobendazole and 18gm Trichlorofon per 50kg Bwt
- Dichlorovos @ 26-50mg/kg feed or as a paste @ 20mg/kg
- Butonate @ 45mg/kg given by stomach tube

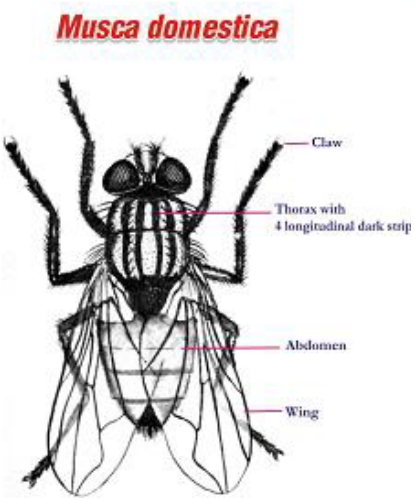
CONTROL - HORSE BOT FLIES: Sponging the fetlock and scapular areas of horses with a warm insecticidal solution will simulate the licking of horses and thus the eggs hatch. The released larvae are killed when they come into contact with the insecticide

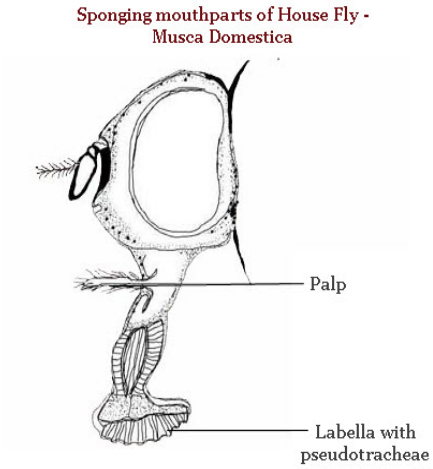
Cyclorrhapha

2. Section: Calypterae

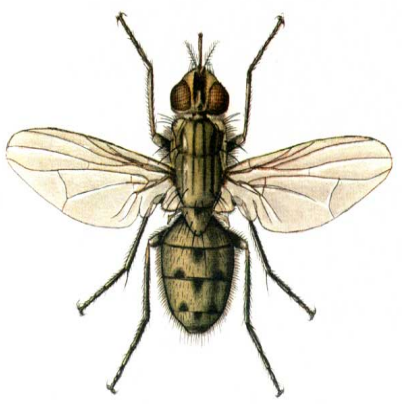
Family : **Muscidae**

Genus	***Musca***	***Stomoxys***
Species	*M.domestica,*	*S.calcitrans*
Common name	House Fly	Stable Fly





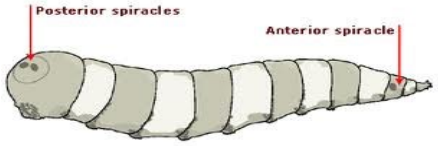
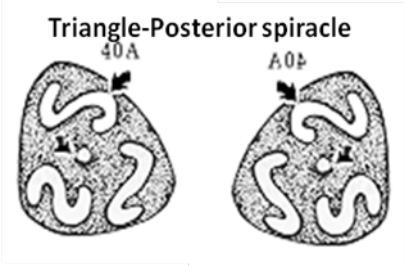
Stomoxys calcitrans



Difference between House fly and Stable fly

MORPHOLOGY		
Common Name	**House Fly (*Musca domestica*)**	**Stable Fly (*Stomoxys calcitrans*)**
	Medium sized, grey in colour, 6 to 7 mm long	Resembles *M.domestica*
Head	• Two large compound eyes • Three segmented antenna • **Arista bilaterally plumed upto the tip** • Mouthparts- **lapping and sponging** type of mouth • **Retractible into the head** • Flies are not blood suckers	• Differs in that **the arista is plumed only on the dorsal aspect**- has 8-10 bristles • Mouthparts are **non retractile** and a forwardly directed **baton like proboscis.**

		• **Biting type** of mouth part • Flies have **prestomal teeth** and are blood suckers
Thorax	• Grey with four longitudinal dark stripes all of which **extend to the posterior border of the thorax** • Wing venation is characteristic in that the 4th longitudinal vein curves upwards at about the middle and joins the 3rd vein to form the **closed apical cell**	• Grey with **four longitudinal stripes** but the lateral pair are narrow and **do not extend upto** the posterior border • **The apical cell is open** • Wing kept at divergent angle
Abdomen	• Yellowish round colour • Five segments of which 4 are visible. Presence of median black **longitudinal stripe which diffuses on the 4th abdominal segment** in male while in females either side of the abdomen is marked with a diffuse dark band	• Ground grey • Yellowish stripes on 2nd and 3rd segment which do not reach the lower border • **Three circular dots on 2nd and 3rd segment.**
LIFE CYCLE		
Breeding areas	• Garbage, manure- **horse dung** preferred, decaying organic debris ,Poultry manure, human excreta, abundant in rainy season	• Prefers to lay eggs on the **bedding material of horses**- that is straw which is soiled with urine of the horses • Never breed on human excreta, abundant in summer and autumn
Eggs	• 100-150 eggs are laid at a time and an average of 600/lifetime • Elongate creamy white, oval/banana shaped/ 1mm long with two ridge like thickenings on the dorsal	• 25- 50 eggs are laid after blood meal • Eggs are dirty white or yellow in colour, 1 mm, with only one dorsal ridge or hatching pleat • **Both male and female suck**

	aspect- the hatching pleat	**blood**
Larvae	• **Smooth larvae, Acephalus, apodous** • Three larval stages. Larval development takes a week  • L3 12 mm long, white, maggot like with 12 segments, 3 thoracic and 8 abdominal segments. o Head with two chitinised black oral hooks with sensory tubercles (2) o Mouth lies between them o Above mouth is a pair of hooks- black and chitinous o Oral (or) mouth hooks- Its part of cephalopharyngeal skeleton. Left hook smaller than right o Last segment largest with obliquely truncated shape o **Fan shaped lateral spiracles on Prothorax** o **D shaped with 3 'm' shaped winding slits- button-posterior spiracles** D shaped-Posterior spiracle  •	• **Acephalus, apodous**. The larval stages last 20 days • Similar to *Musca spp.* except that the posterior spiracles are widely separated and are roughly **triangular in shape with three 'S' shaped stigma slits** Triangle-Posterior spiracle  •

Pupa	• Last larval skin retained-puparium • Barrel shaped,6-8 mm long, creamy then turn • **Coarctate , brown**, oval shaped • **Pupa emerges out through circular opening** • This stage lasts for 3 days	• Pupation in drier part of breeding area • Similar to *Musca spp.* Pupal stage lasts for 8 days
Adult	• Sexually mature in 10-14 days after imergence • Average life span- 1 month • *Musca* adult flies do not feed on blood – they lap blood which flow out of wounds etc • Entire lifecycle is completed in 7 to 12 days	• Life span- 1 month • Entire lifecycle is completed in one month • Both male and female *Stomoxys spp.* are haematophagus
EFFECT ON THE HOST		
Direct effect	• Nuisance, fly worry is known to bring down production and feed conversion efficacy • Feed on wounds etc and result in production of myiasis	• Both male and female suck blood and are painful biters • Anaemia in young animals • Fly worry
Indirect effect-vector potential-lity	• *Musca* is a synanthrope and hence has a high vector potentiality • Bacterial diseases such as **cholera, typhoid, p**aratyphoid, T.B, salmonella, *E.coli* dysentery, anthrax etc., • Viral diseases such as poliomyelitis and infectious hepatitis • Protozoan diseases such as **amoebic dysentery,**	• Mechanically transmits ***Trypanosoma evansi*** • Also is a mechanical vector for anthrax, rinderpest, tetanus bacteria and poliomyelitis virus • Its an intermediate host for ***Habronema majus***

	giardiasis • Acts as the intermediate host for ***Habronema muscae, Draschia megastoma, Thelazia rhodesii****, Raillietina spp., Choanotaenia infundibulum* • Mechanical transmission of the eggs of the following is also possible*Taenia solium, Toxocara sp, Ancylostoma, Hymenolepis, Dipylidium caninum and Diphyllobothrium latum*	

Method of feeding

Vomit drops: Liquifiable solid foods such as sugars, may be made fluid before it sucked up by ejection of saliva and crop fluid.These fluid drops are called **vomit drops**, and important in disease transmission.

The fly regurgitates or vomits at frequent interval to aid its feeding and while **feeding they defecates at random (5-10 minutes).**The last tarsal claw ending in pulvillus has full of hairs. These activities are responsible for **the mechanical transmission of diseases by contamination of food.**

CONTROL - HOUSE FLY

Managemental

- Potential breeding sites should be avoided by
  - **Regular removal of manure**
  - **Stacking of manure-** heat generated kills fly larvae- treating sides of stack with insecticides
  - Improve sanitation, collect garbage in cans. with tight fitting lids, incinerate garbage/ **Hodge's garbage trap/ Babers Fly trap**, latrin system on open ground should be avoided
  - Do not expose food

- Use of various types of screens, electrocution grids
- Fly line (resin+paraffin oil sticky coat ---> 1,50,000 flies killed within 310 mts long string
- Insecticidal use,
    - Aerosol sprays
    - Residual sprays for walls, ceilings
    - Insecticide impregnated cards/strips
    - Insecticide in solid or liquid baits
    - Insecticide dust bags "back rubbers"
    - Impregnated ear traps, tail bands and halters **Insect Growth Regulations (IGRs)**

Cyromazine (Larvadex): it prevents larvae moulting, 1% premix@ 500 gms per tonne of feed.
Diflubenzuron : Chitin synthesis inhibitor in larvae @) 0.1% in feed, **banned due to presence of residues in meat.**
Methoprene (**Insect growth regulatori-IGF)**- juvenile hormone analog and can be used as **larvicide.** Methoprene does **not kill insects**. Instead, it acts as an insect growth regulator, mimicking natural juvenile hormone. Juvenile hormone must be absent for a pupa to moult to an adult, so methoprene-treated larvae will be unable to successfully change from pupae to adults. This breaks the biological life cycle. Methoprene is commonly used as a **mosquito larvicide** used to help stop the spread of the **West Nile virus**. Methoprene is also used as a **food additive in cattle feed** to prevent fly breeding in the manure
Sugar bait: sugar-0.25% mixed with 1% melomyl

Biological Control

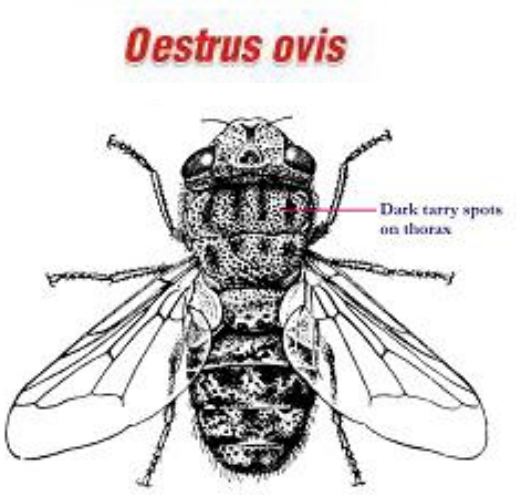
- *Steinernema feltiae*- a **common soil nematode** is used to **kill fly larvae (**box with granules of *S. feltiae*)
- **Fungus-** *Beauvaria bassiana* ***on larvae***
- **Sopres of Bacillus thuringiensis** (BT) **on larvae**
- **Parasitic wasps/cannibal fly**- Predators **on Pupa,**
- **Hymenopteron fly** –**on Pupa**

Family : Oestridae

1. Oestrus ovis - Sheep nasal flies

Common name: **Sheep nasal fly, nasal bot fly**, Sheep head fly, Sheep gad fly

Morphology - Sheep nasal flies



- **Dark grey coloured hairy fly**

Head

- **Arista bare**
- Mouth parts **vestigial in adults**

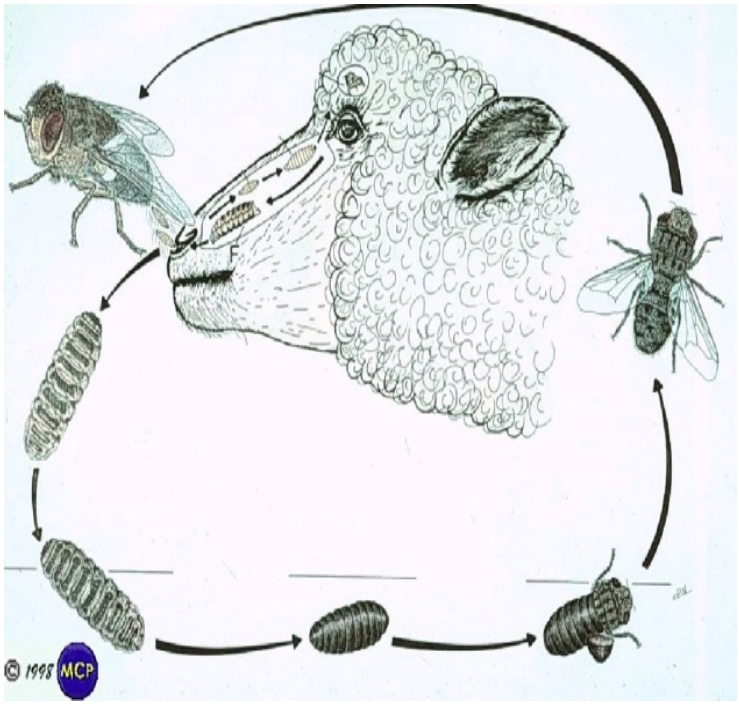
Thorax

- **Tarry spots** are seen on the thorax
- **Muscid type wing venation**

Abdomen

- **Few black coloured spots** are also seen on the abdomen
- The adult stages are non parasitic while the larval stages are seen in the nasal cavity and other sinuses of sheep/sometimes in goats and man as well

LIFECYCLE-SHEEPNASAL FLIES

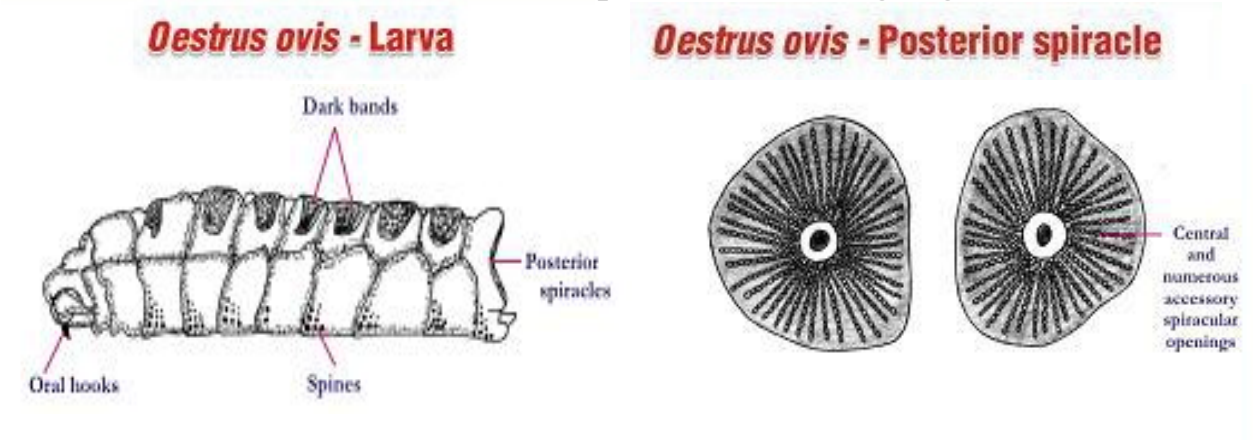


- The flies are **larviparous**
- The female fly darts at the sheep
- When the sheep raises its head it deposits a larvae around the nostril of the sheep
- The first stage larvae then crawls into the nasal passage
- The larvae moves within using its oral hooks and feeds on the excess nasal discharge produced by the affected sheep
- The rate of the development of the first instar varies, may take just 2 weeks or could get extended to many months
- The larvae moults to form the second stage larvae which moves into the frontal and maxillary sinuses, here they develop rapidly and form the third stage mature larvae

- Generally the third stage larvae is sneezed and the pupation occurs on the ground
- Usually the larval development is completed in 25 days time but can be extended to 9 months in unfavourable conditions
- The adult emerges in a month's time

DESCRIPTION OF THE LARVAE - SHEEP NASAL FLIES

- The first stage larvae is whitish in colour
- The mature third stage larvae is large, around 3 cm long, with black oral hooks, **dark black bands on all the segments on the dorsal aspect**
- On the ventral aspect they have small rows of rose thorn shaped spines
- The posterior end of the larvae appears large and truncated and the posterior spiracles are very clearly visible
- The **spiracles are brown. 'D' shaped with radiating stigma slits**



EFFECT ON THE HOST - SHEEP NASAL FLIES

Due to adult fly

- The very presence of the flies causes **panic in sheep**
- The flies may cause gadding in animals which run madly about resulting in injury and even death of young animals
- The animal stops feeding, becomes restless, shake their heads or even press their noses to the ground or between other sheep in an attempt to avoid the fly from larvipositing. Since the feed intake is affected the condition of the animals deteriorate

Due to larval stages

- **The first stage larvae move** around in the nasal passage causing considerable irritation **with its oral hooks and spines**. This result in the secretion of viscid mucous exudates on which the larvae feed. At times the damage may result in blood tinged mucous being secreted
- The infected sheep shakes its head, has a nasal discharge and sneezes frequently
- The nasal region of the affected sheep is dirty in appearance and hence the condition is sometimes called ***'snotty nose'***
- Sometimes from the frontal and maxillary sinus the second stage larvae may accidentally move towards the brain, causing injury to the brain and even erosion of the skull all of which leads to neurological symptoms in sheep which resemble the condition caused by **Coenurus cerebralis**. Hence the condition is termed as ***'False gid'* or *'sturdy'***
- At times the larvae are deposited by the adult fly on man- frequently affected are the shepherds who are in close contact with the animals
- **The larvae have been reported to have been deposited on the eyes, nostrils, gums, lips etc., of man**

TREATMENT - SHEEP NASAL FLIES

Treatment of the affected animals

- **Rafoxanide (7.5mg/kg) -** drench **orally**
- **Ivermectin** (200 micro gram or 0.2 mg/kg BWT Subcutaneously)
- **Closental** (10mg/kg BWT) orally –highly effective
- **Instillation of HCH in oil 1-4% into the nostrils or applying tobacco powder into nostril to remove larvae by inducing sneezing**.

CONTROL - SHEEP NASAL FLIES

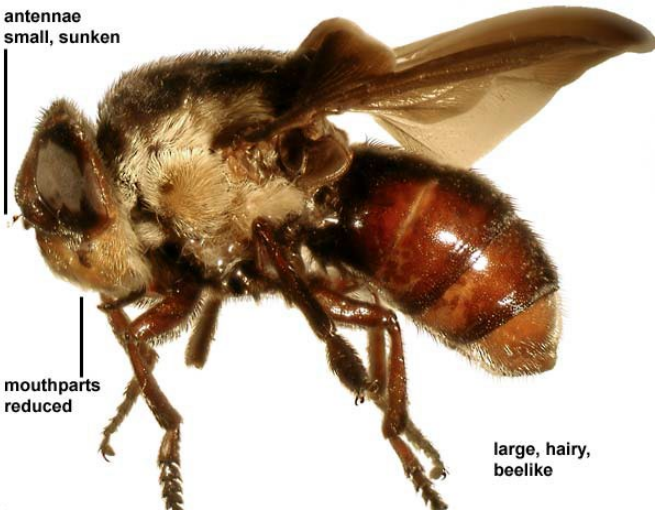
- Feed sheep in **narrow troughs**
- The edges of the trough should be smeared in tar. This enables the animals to smear themselves with a repellent
- **Neem oil** can also be used as **repellent**

2.Hypoderma bovis - commonly known as **Northern Cattle crub**

3. Hypoderma lineatum - Ox warble flies

- Common name : **Ox warble fly**, **Heel fly**, Cattle grub fly

MORPHOLOGY - OX WARBLE FLIES



- **Hairy flies, resembles a bee**

Head

- **Vestigial mouth parts**
- Covered with yellowish white hairs

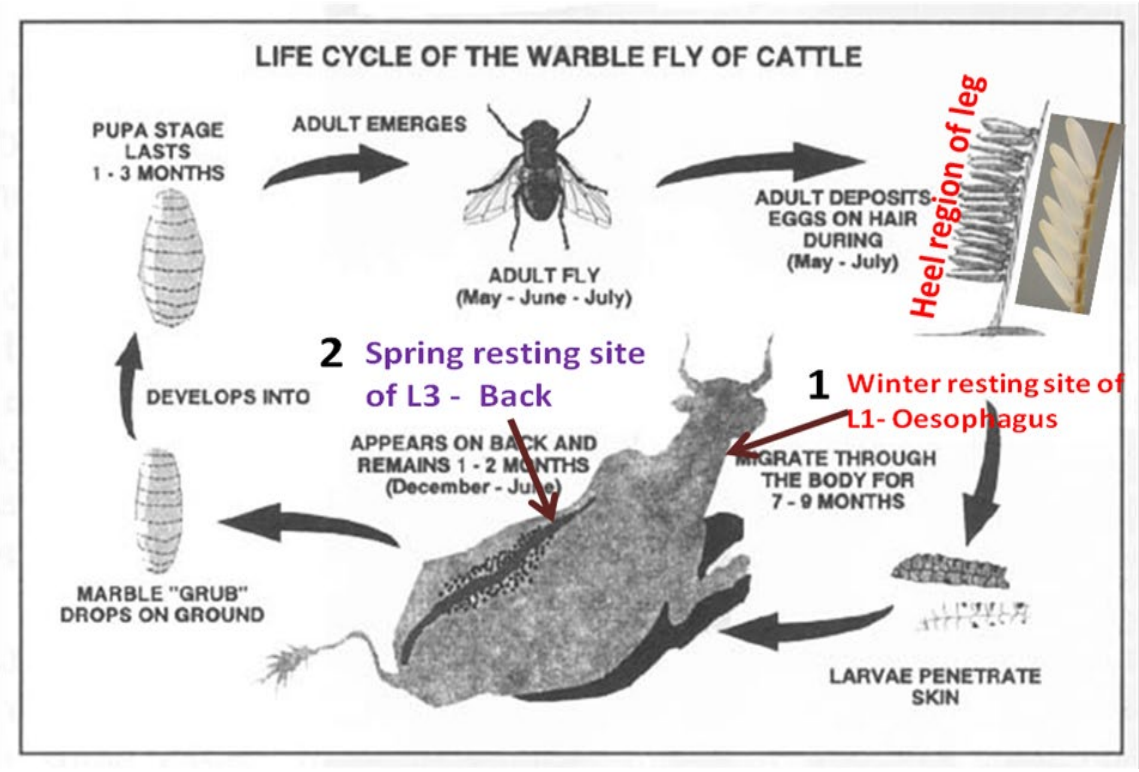
Thorax

- Covered with yellowish white hairs

Abdomen

- Light yellow hairs on the anterior end, darker hairs in the middle, posterior end of abdomen has orange yellow hairs

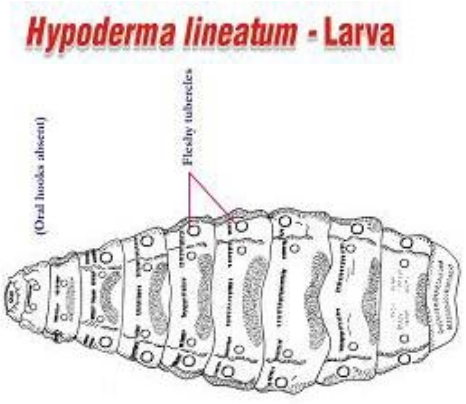
LIFECYCLE - OX WARBLE FLIES

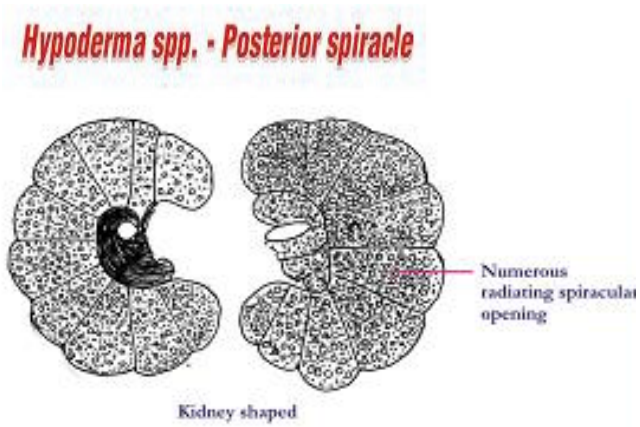


- The adult fly does not feed and only **oviposits on the cattle – usually the lower regions of the hind legs**, hence the common name ***'heel fly'***
- A fly **oviposits atleast 6 eggs towards the base of the hair of the cattle** during the summer months
- The eggs are spindle shaped and provided with a clasper with the help of which they hold on to the hair
- The egg hatches in 3-4 days
- The first stage larvae pierces through the skin and migrates in the inter muscular connective tissues to reach the diaphragm
- Most larvae reach the tissues of the oesophagus in 4 months time and spend the winter in the **submucosal connective tissue of the oesophagus**- hence the site is referred to as the **winter resting site of L1 larvae**
- The first stage larvae moults to form the second stage larvae which in the beginning of spring, i.e., January migrate towards the dorsal aspect of the body, reaches the subcutaneous tissue of the back and moults to the third stage.The back of the animal is hence referred to as **spring resting site of L3 Larvae**
- When the larvae reach the skin of the back an inflammatory reaction results in the formation of swellings
- The second stage larvae perforates the swelling
- It then moults and the third stage larvae lies upside down with the posterior spiracle directed against the perforation.The mature larvae have no oral hooks and feeds on the inflammatory exudates in the swelling. These swellings in the skin of the cattle are referred to as **warbles or warble stage of infection**
- The warble stage lasts for 30 days
- It falls off the warble into the soil and pupates
- Pupation take 1 month time
- Entire lifecycle is completed in one year

DESCRIPTION OF THE LARVAL STAGE - OX WARBLE FLIES

- **Mature larvae lacks oral hook**, 2.5 cm in size, **presence of fleshy tubercles on all the segments except last**, presence of fine spines on the segments
- **Posterior spiracles are kidney or bean shaped with radiating slits**





EFFECT ON THE HOST - OX WARBLE FLIES

Due to Adult fly

- The characteristic buzzing noise and the persistant ovipositing behaviour of the fly causes **panic** in cattle called "**Gadding**"
- The flies may cause gadding in animals which run madly about resulting in injury, spontaneous abortion, and even death of young animals
- The animal stops feeding, becomes restless. Since the feed intake is affected the condition of the animals deteriorate
- There is retarded growth and reduced milk yield

Due to larval stage

- ***Due to first larval stage***
    - Many larvae enter through the same opening in the skin which results in an exudate from the injured heel region
    - The opening made by the larvae is prone to bacterial infection and to myiasis-**Cutaneous myiasis**
    - The entry holes are oedematous and inflamed
- ***Due to the second and third stage larvae***
    - Migration of the larvae through the subcutaneous tissue results in the production **of greenish yellow tracts** with **Eosinophilic infiltrations**
    - The affected beef is called '**licked beef'** while the gelatinous tracks in the beef are temed ***'butchers jelly'***
    - The beef is unaesthetic and hence extensive trimming of the affected areas are required before sale, this results in extensive loss to the farmer
    - The affected beef even following trimming has a short shelf life
    - The presence of the first and second stage larve in the oesophageal region can cause stenosis of the oesophagus
    - The presence of the second and the third stage larvae on the back of the animal results in formation of warbles
    - In addition to being painful to the animal these warbles due to the perforation in them downgrades the quality of hide to a great extent
    - Accidental rupture of the warbles can result in anaphylactic shock
    - It can also result in the production of abscess, due to bacterial infection
    - The perforation can also attract other myiasis producers
    - Thus carcass and hide depreciation are the most important features of this infestation
- ***Abberant host***

- Man has been known to be affected – result in painful warbles in the chest region
- Horses can also be affected

CONTROL - OX WARBLE FLIES

- Mechanical removal of the larvae – can be done when the larvae is mature
- However attempts to squeeze out the larvae may rupture it which in turn results in localised swelling and abscess formation
- Insecticides can be used – **Ivermectin at 0.2mg/kg or 200 micro gram/kg BWT subcutaneously** is highly effective.
- Dry dressing could be applied to the warble especially to clog the pores which results in the death of the mature larvae

CONTROL or PROPHYLAXIS - OX WARBLE FLIES

- Prevention of the fly from ovipositing is possible if water bodies are available for the cattle to wade into and thus protect their heel region
- Prophylaxis using vaccine is under study
- **Hypodermin A is a potential vaccine candidate for *H.lineatum***

FAMILY: CALLIPHORIDAE

- Includes large number of species whose larvae are saprophagus-flesh feeders
- Family has 2 subfamilies- **Calliphorinae and Sarcophaginae**

CALLIPHORINAE

- **Sub Family : Calliphorinae**
- Genus : ***Lucilia***
  - Species: ***L.cuprina*** and *L.sericata*
- Genus : *Chrysomia*
  - Species: ***C.bezziana***,*C.megacephala*
    - *Callitroga hominivorax*
- These are the *"**blow flies**"*
- Metallic blue or green in colour

Lucilia cuprina



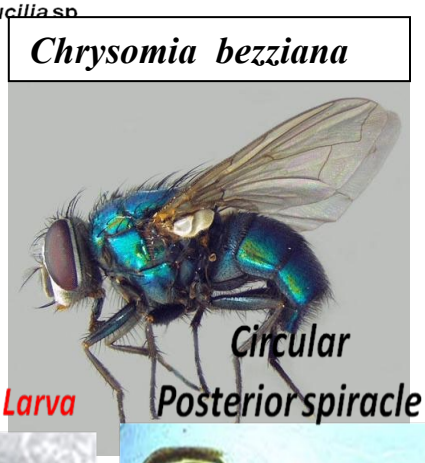
1. Genus: and *L.sericata*)

- Causes **blow fly strike**

- Common name: **Green bottle flies, Copper bottle flies**
- Flies with **bright metallic colours**
- Bright green
- **Primary myiasis producer fly**
- **Hypopleural bristles are prominent**
- **Mouth,Wing- similar to *Musca***
- **Adults are free living and**
- **larval stages are parasitic**
- **Oviparous fly**



2.Genus : *Chrysomia* (*C.bezziana*)



- Common Name: **Old world screw worm fly or Blue green bottle fly**
- Medium sized, stout
- Bluish green fly
- Four dark stripes on prescutum
- **Face is orange** – yellow
- Mouth,wing- similar to ***Musca***
- **Adults are free living and**
- **larval stages are parasitic**
- **Lay eggs on living tissue,**
- **Never on carcass -**
- **(Oviparous fly)**



- **Secondary myiasis fly**

<u>Strike</u>

- A disease condition called "STRIKE" is caused by the larvae of genus ***Lucilia sp,* and *Chrysomyia sp*.**

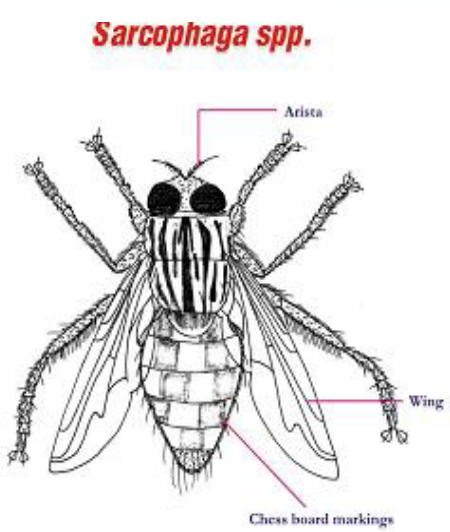
MATURE LARVAE

- L_3 larva resembles larvae of *Musca*
- 10-14mm long
- Greyish white/pale yellow in colour
- Anterior extremity with a pair of oral hooks
- Posterior spiracle on broad, flattened posterior end

Posterior spiracle

- Three long slender slits more or less parallel to one another
- Two types of larvae recognised
    - Smooth larvae eg. *Lucilia* sp
    - Hairy larvae – has thorn like projections with small spines at the tip eg. larvae of *Chrysomyia* sp

SARCOPHAGINAE



- Subfamily: **Sarcophaginae**

3. Genus : *Sarcophaga*

***Sarcophaga ruficornis*- Flesh flies**

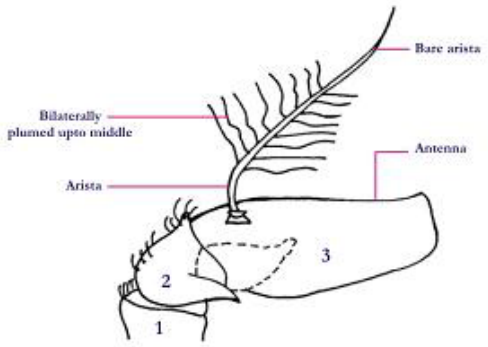
- Common Name : **Flesh flies Scavenger fly, Carrion fly**
- Species of this genus lays **their larvae in decomposing flesh, wounds and ulcers -**
- **<u>Larviparous fly</u>**
- **Secondary myiasis fly**
- *Sarcophaga dux* is seen in lesions in skin of camels, cow and bullock in India

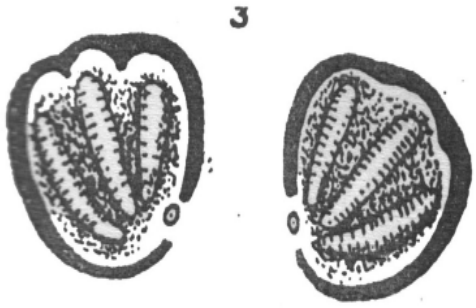
Morphology

- **Arista: Bilaterally plumose to middle and rest of its bare**
- Grey **3 longitudinal striped thorax**
- **Checker– board marking on abdomen/chess board marking on abdomen**

Sarcophaga spp. - Arista

Sarcophaga spp. - Posterior spiracle



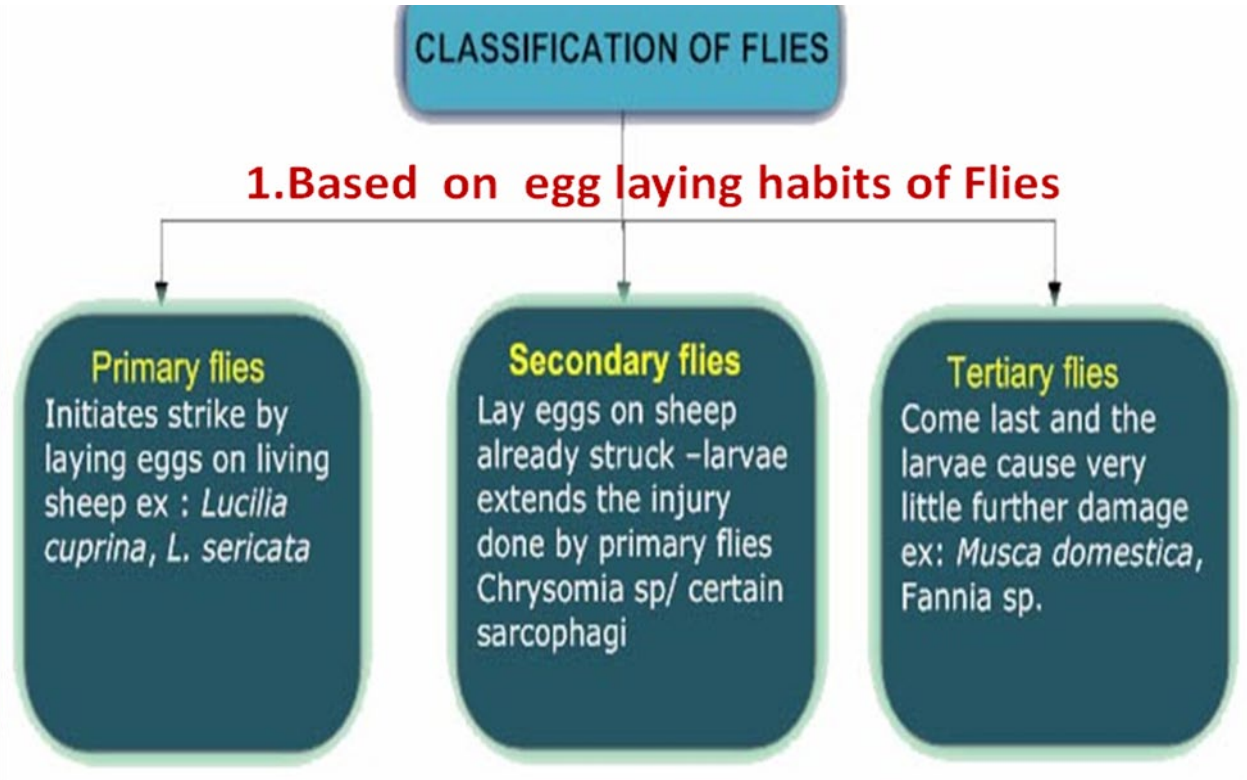


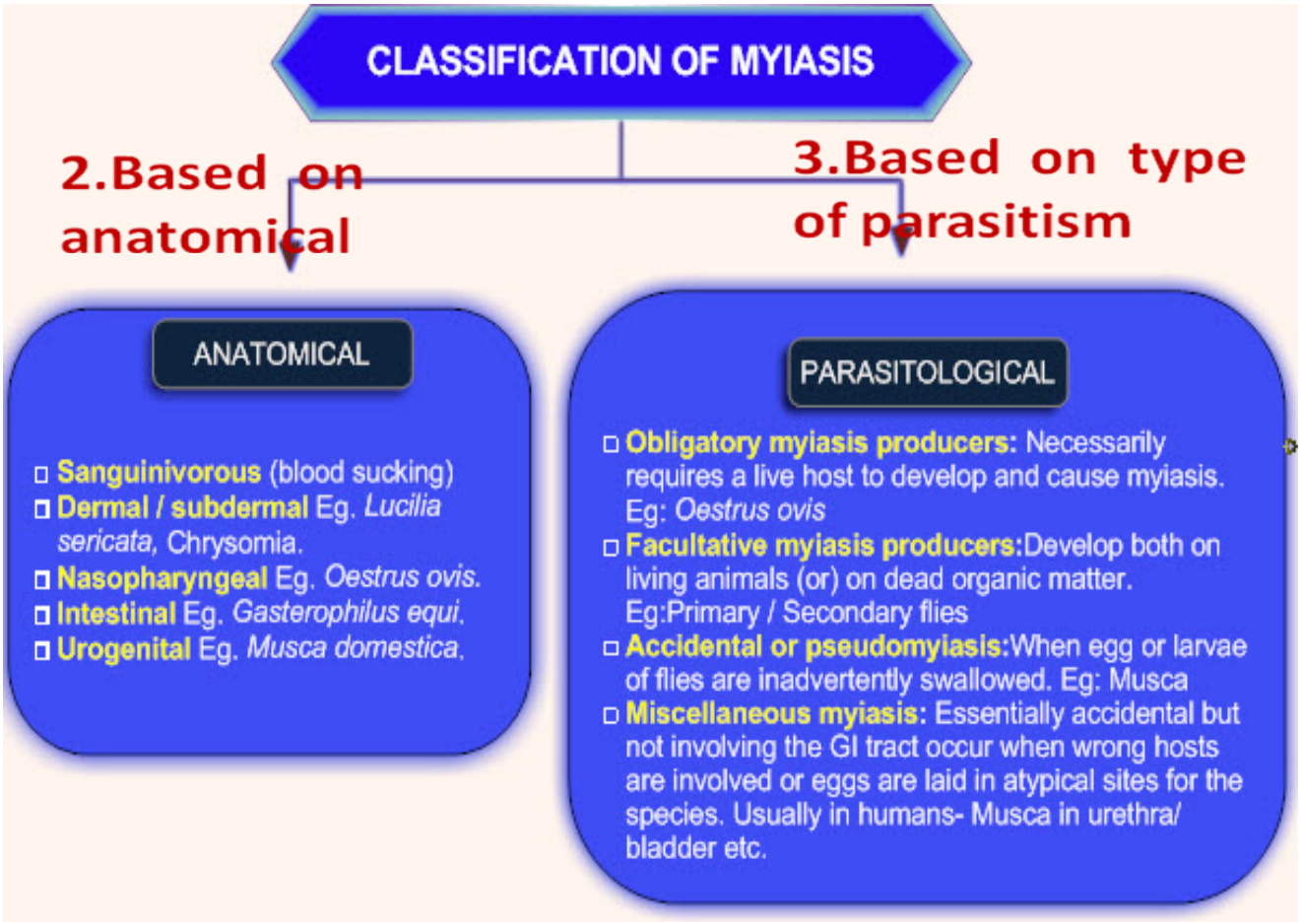
- **Arista-** Bilatearlly plumosed to middle and rest of its bare
- **Circular posterior spiracle** with 3 longitudinal stigmal slits with imcomplete peritreme
- **Flesh fly lays fully developed larvae on flesh, and fresh wounds of animals and even on dead carcass- Facultative myiasis**

Myiasis

MYIASIS - INTRODUCTION

- Myia - (Greek word for fly)
- Hope 1940 coined it and it refers to animal disease due to fly larvae
- Zumpt (1965) defined myiasis as:
    - **"Infestation of live human and vertebrate animals with the larvae of dipteran fly which atleast for a certain period feed on the host's dead or living tissues, liquid body substances or ingested food"**
    - In sheep it is referred to as "strike" or blow fly myiasis. Generally caused by larvae of *Chrysomia, Lucilia, Phormia*


CLASSIFICATION OF FLIES
1.Based on egg laying habits of Flies
Primary flies
Initiates strike by laying eggs on living sheep ex : Lucilia cuprina, L. sericata
Secondary flies
Lay eggs on sheep already struck –larvae extends the injury done by primary flies Chrysomia sp/ certain sarcophagi
Tertiary flies
Come last and the larvae cause very little further damage ex: Musca domestica, Fannia sp.



4. Based on area in which strike occurs

- Depends on inherent and temporary factors. Sheep are struck mostly in breech region – breech or crutch strike (Merino breed has narrow breech with excessive wrinkling)
- Around tail – **tail strike**
- In Rams and wethers penile sheath has a narrow opening and is soiled by urine resulting in **pizzle strike**
- Rams with deep head folds or with horns lying close to head – sweaty condition of head results in **poll strike**
- Any wounds can be struck – **wound strike**
- When dorsal region of body is affected it is called **Body strike** (after prolonged wet weather + bacterial activity) leads to fleece rot. Sheep with long, fine wool commonly affected
- Foot rot also predisposes sheep to strike

REASONS FOR MYIASIS

- Wool of sheep which is kept moist for long time, soiled skin with urine and faeces, these produces decomposition and smell of it attracts the primary flies. The larvae of these flies initiate strike and create favourable condition for secondary flies. **These flies liquify the tissue of host and feed on this material developing in the lesion**. The central portion of lesion heals by scab formation, with further extension of lesion due to action of larvae. The smell produced from such lesion attracts other flies to deposit the eggs

CLINICAL SIGNS IN AFFECTED ANIMALS- MYIASIS

- IrritationAnimal stands with its head down
- Does not feed, moves away from flock
- Attempts to bite affected area
- If lesion is in tail region, animal stamps or jerks its hind legs, wags its tail
- Examination reveals discoloured moist wool with bad odour and presence of foul smelling liquid
- Trimming the wool reveals presence of maggots
- Progression of disease lead to
    - Malnutrition
    - Loss of production
    - Death
- A condition called lightning strike occurs when toxaemia / septicaemia occurs wherein the animals dies within few days of strike
- Animal does not feed properly
- Weak and debilitated
- Toxaemic (absorption of toxic substances from lesion)
- Septicemia and death
- Financial loss:
    - decrease in the value of fleece
    - reduction in meat and milk production
- Death of animal
- Labour cost towards surveillance and handling of blow fly strike
-

Diagnosis

- Clinical signs
- Trimming the wool helps to reveal the presence of larvae

MYIASIS-TREATMENT

- Ascertain extent of lesion
- Clip hairs, remove larvae and kill them
- Dress wound with bland non toxic material

MYIASIS - CONTROL

- Render sheep less attractive to flies by
    1. **Selective breeding** to eliminate folds in poll region / narrow breech
    2. **Surgical removal of breech folds - Mules operation**
        - A crescentric area on either side of urinogenital area is removed, resultant scarring flattens the skin – effective for breech strike
        - '**Chemical mulesing'** -40% phenol when applied along prepuce of young wethers or even in breech region
    3. **Docking** at 4th instead of 2nd caudal vertebrae reduces strike. The short tail produced by docking at the 2nd caudal vertebrae results in a stump surrounded by folds – "rose tail" appearance which is susceptible to strike. A longer tail stump covers the anal area and thus makes it less susceptible
    4. **Crutching**
        - Regular clipping of wool around tail, breech to prevent soiling of wool
    5. **Dagging**
        - Removal of faecal soiled wool
    6. **Burial or burning of carcasses**
    7. **Use of chemicals** – Insecticides in wounds infested with larvae
- 5% coumaphos Ivermectin jetting fluid
- Oral ivermectin / closantel
- Chitin synthesis inhibitor – cyromazine is a larvicide
- Synthetic pyrethroids

MYIASIS-BIOLOGICAL CONTROL

- Wettable powder formulation of ***Bacillus thuringiensis*** was found effective against *Lucilia cuprina*
- ***Sterile insect technique (SIT)or Sterile male technique (SMT)***
    - Release of irradiated sterile male flies into a wild population is called **SITor SMT**
    - Female that mate with irradiated males produce eggs that fail to hatch

- When enough irradiated males are released, a large proportion of mating with fertile female is obtained, eventually driving the species to extinction

MYIASIS - GENETIC CONTROL

- **Female killing (FK) system or Genetically impaired female technique (GIFT),**
  - Genetic modification of male flies results in mutations, which affect eye colour
  - When wild females mate with these genetically altered males a large percentage of the progeny are homozygous for one or more of eye pigment mutations
  - Its expressed as white or yellow eye colour
  - These female flies lack the light filtering pigments and hence are blind in daylight such blind females die rapidly in wild

MYIASIS - VACCINES

- **PM44 / PM48/PM95 :** A concealed antigen, obtained from peritrophic membrane of larval gut of ***Lucilia cuprina*** (Sheep blow fly).It is used in vaccination against blow fly strike in sheep in Australia (Under experimental trials)

MYIASIS - BAITS AND LURES

- **Screwworm adult trapping system** (SWASS)
- chemical lure, food and 2% dichlorvos
- For *Lucilia spp*
  - Carrion baited traps were used along with insecticide / chemosterilant/ IGR to decrease the population of *Lucilia*
- **Swormlure** is a synthetic chemical attractant used against *Cochliomyia spp*

Series : **Pupipara**

Family : **Hippoboscidae**

- Genus **: Hippobosca; Melophagus,**
- These include flies which lay larvae which immediately pupates
- The larvae unlike that of Glossina spp. is incapable of movement, feeding and hence the group has been placed under pupipara

HIPPOBOSCIDAE

- **Family : Hippoboscidae**
- **Genus : Hippobosca; Melophagus;**

Common Morphological Characters

- Body is broad and flattened dorsoventrally

Head

- Large compound eyes are present, ocelli are absent
- Antenna immovable, single segmented and lies within a pit in the head region
- Mouthparts are biting type. Porrect
- The main portions of the proboscis is retracted into the head and generally the narrow terminal part is hidden by the 2 palps

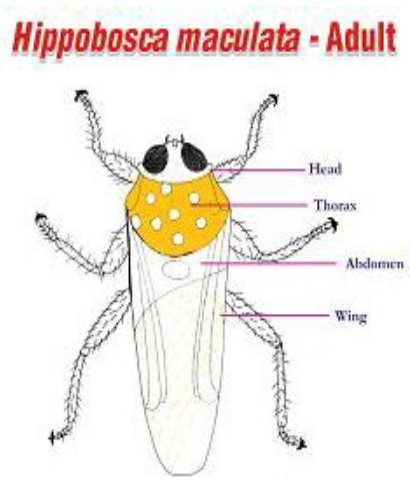
Thorax

- Wings may or may not be present
- Few of this series do have wings which fall off once the host is reached
- Wings when present have a characteristic venation- veins crowded in the anterior margin while the posterior portion reveals fine wrinkling
- Legs are provided with strong claws, since the flies of this series are generally almost permanent ectoparasites of the host the strong claws provide them with firm attachment to the host
- In species affecting birds additional spurs are observed

Abdomen

- Abdomen is indistinctly segmented, soft and leathery

Family : Hippoboscidae



(Hippo-horse.Bos-tofeed)

Genus : Hippobosca

1. Species : **Hippobosca maculata – cattle ked**
   H.capensis–dogked
   H.equina-equineked

Common name: **Forest flies, Louse fly, horse keds.**

MORPHOLOGY



- **Flies are known as pupiparous flies**
- Thorax is marked with clear yellow markings.
- **Veins are crowded together at the anterior margin,**
- **legs are provided with powerful claws**

LIFE CYCLE

- Female flies are viviparous, oviposit one larvae at a time in sheltered spots off the host such as crevices in mud walls
- They are creamy white, flattened posterior end with dark spiracular plates
- **The larvae pupates immediately within 4-6 hours**
- Initially its yellow in colour and then turns red black in colour,
- The pupal stage gives rise to the adults usually in 4 weeks
- The adult female fly attaches to the host in areas which are thin and hairless and feeds frequently several times
- In horses it is seen feeding under the tail/genitlia, in cows the tail, udder region, in buffaloes the inner aspect of the thigh, genitalia while in dogs the ears and the neck region are preferred feeding sites
- They feed for long periods on blood of their hosts and their claws are so efficient that neither the host, nor human beings can dislodge them easily

HABITS

- Active in summer, remain long periods on the host, not inclined to fly although they are strong fliers, usually leave the host to larviposit only

- They cluster in hundreds in the perineal region, under the tail, between the hind legs to the pubic region. Female fly does not lay eggs but it deposits the larvae singly in dry soil

EFFECT ON THE HOST

Direct

- The flies are a source of irritation to newly infested animals
- Animals which are not used to the fly react adversely
- No such reaction is seen in animals where infestation is common
- Blood sucking habit of the fly can result in anaemia in young animals

Indirect

- Transmits *Trypanosoma theileri* cyclically to cattle

CONTROL

- The flies can be readily controlled by use of insecticides such as synthetic pyrethroids, 0.25% DDVP etc., oral ivermectin



2. SHEEP

- Genus : Melophagus
  Species : ***M.ovinus***

- Common names : **Sheep ked, sheep tick fly**.

MORPHOLOGY

Characters similar to Hippoboscidae with the following exceptions,

- Head **short broad and immovable**
- **Wingless**
- Abdomen is large, broad and hairy **strong legs provided with claws**
- **both sexes suck blood**

PUPA



LIFE CYCLE

- They are **permanent ectoparasites** and the females glue the mature larvae to
- The larvae is initially yellowish and **soon turns into chestnut brown colour pupa**
- Pupa is ovoid with broad ends and lasts for 21days
- The female fly survives for 5 months and produces 10-15 larvae during her lifetime
- **The gestation period is 10-12 days for each larva**. The infection from sheep to sheep is spread by contact
- Sheep with dense wool are known to spread the infestation

EFFECT ON HOST

Direct

- The keds are **permanent ectoparasites** and live on the host and suck blood, large infestations can result in **anaemia**
- The irritation caused by the biting fly is so great that its feeding is impaired-loss of condition of the sheep
- The infested animal bites the wool, rubs the body on hard objects which in turn leads to injury to the animal and damage to the wool
- The bites and the wounds are susceptible to myiasis
- The excreta of the ked stains the wool, **the stain cannot be washed off, so downgrading of wool occurs**
- The **skin blemish affects the quality of leather**
- Heavy infestation leads to a condition called '**sheep cockle or rib cockle'** – the affected skin is pitted due to allergic reaction to the bite of the ked which results in scattered brown nodules on the skin.
- Another condition reported due to sheep ked is '**back loss'** wherein the intense irritation leads the sheep to fall on its back to alleviate the irritation, then its unable to rise, suffocates and dies
- Transmits ***Trypanosoma melophagium*** in sheep

CONTROL

- Shearing especially before winter markedly reduces keds
- Rafoxanide 7.5 mg/kg BWT

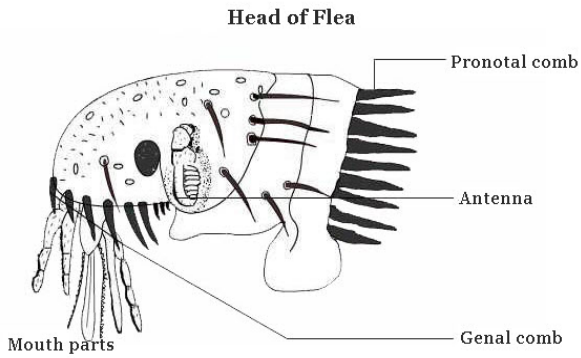
FLEAS

SIPHONAPTERA

- Order : Siphonaptera (siphon: suck blood from host; aptera- no wings)

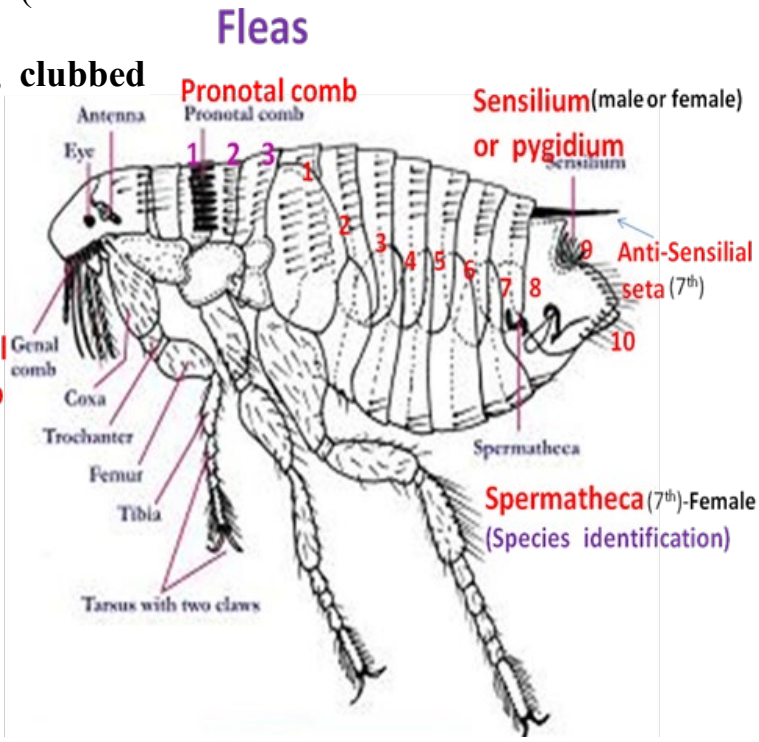
MORPHOLOGY

- The body is laterally flattened- an important adaptation for parasitic lifecycle, enable the fleas to move rapidly, minimise damage from host reactions to their bite
- Thick dark brown chitinous covering- mahogony brown in colour 1-6mm long
- Females larger than males
- Not host specific and are found parasitizing a large number of hosts



HEAD

- **No compound eyes**, lateral ocelli are present on either side of the head (certain authors feel that these are the reduced compound eyes)
- Antenna is three segmented, short, **clubbed** and found recessed in deep antennal fossa- another adaptation of the flea to easily move about on the host
- Mouth parts are **piercing and sucking type in the adult** and its **mastigatory type in larvae**
- Backwardly directed bristles or spines are seen in the gena region- called **<u>the genal combs</u>**
- Adaptation to impede flea being dragged backwards due to the host activity



THORAX

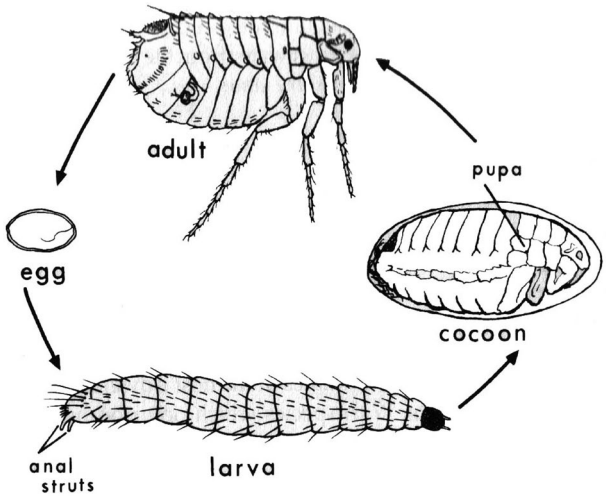
- Three segmented – the first segment shows the presence of spines or bristles which are backwardly directed- **the pronotal combs**
- Three pairs of legs present, **the third pair being long and powerful** - aids in **the jumping and leaping movemen**t exhibited by the flea-energy for jumping is stored in the pleural arches which are pads of a rubbery protein called **resilin**
- Legs end in **powerful claws and bristles**
- Two pairs of spiracles are seen on each segment

ABDOMEN

- Shape of abdomen helps to distinguish the sexes
- Female fleas have both ventral and dorsal surfaces convex while in male the dorsal part is more or less flat while the ventral surface is curved
- **10 abdominal segments** 8 being easily recognisable
- The 8th ,9th and 10th segments are fused –anal segments
- 9th abdominal segment in the case of both the male and the female bears a pincushion like **dorsal plate called the sensilium or pygidium** –this is covered with sensory setae which aids in detection of air currents etc
- The tergum of the 9th abdominal segment in the male forms the paired manubria **– a part of the aediagus or the penis**
- In females the 7th abdominal segment bears a single **spermatheca - this is 's'** shaped haing a head , a small constriction-base, and a tail portion. This enables **species identification in fleas**

LIFE CYCLE

- Both male and female suck blood
- The female produces eggs



EGG

- Large **pearly white**, glistening and oval in shape
- 200 eggs produced in 2-4 days time
- Eggs may be sticky or dry as in *E.gallinacea*- enabling the egg to roll off the host
- It falls on the floor or bedding and L1 develops in 2 days time

- The first stage larvae use the **hatching spine or egg tooth** to emerge from the egg

LARVAE

- Three larval stages
- Has a distinct head and 13 body segments, with no difference between the thoracic and abdominal segments
- Whitish in colour 4-10mm in size
- Has **mastigatory type of mouth parts** and feeds on organic matter as well as undigested blood from the adult flea
- They are semipredatory and attacks damaged adults and even kills them

PUPA

- The third stage larvae spins a cocoon around its body
- The cocoon is sticky and so becomes covered with dust and debris-camouflaged
- Remain quiescent till the arrival of the host
- The pupa emerges from the cocoon in response to the bark of the dog or the footfall of the host
- Usually the pupa is ready to moult by 1-3 weeks

FAMILY : PULICIDAE

Genus	Species
Ctenocephalides	• *C.canis* • *C.felis felis* • *C.felis orientalis*
Echidnophaga	• *E.gallinacea* (poultry) - stick tight flea
Pulex	• *P.irritans* (human flea) • *Xenopsylla cheopis* - Rat

CTENOCEPHALIDES

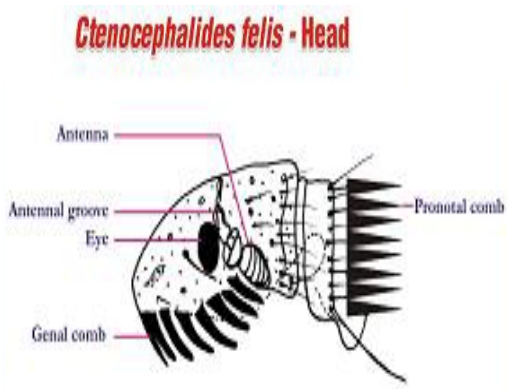
- Ctenocephalides
  C.canis-dog flea, combled flea)
- **C.felis felis- cat flea, combled flea)**

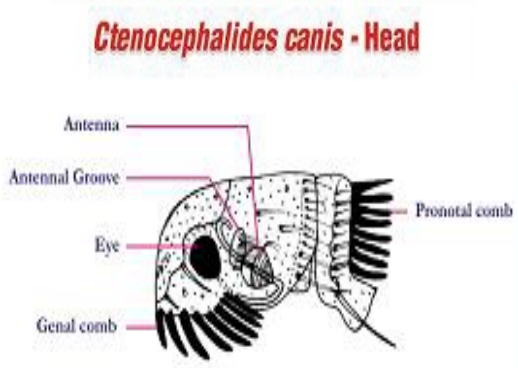
- Important morphological characters include,
  - Thorax is not reduced and is well developed
  - **Presence of genal combs**
  - **Presence of pronotal combs**

DIFFERENCE BETWEEN *C.CANIS* AND *C.FELIS*

- Difference between C.canis *and* C.felis is as follows,

Character	***C. felis***	***C. canis***
Head	Long and slender head	Short and rounded head
Frons	Frons elongate	Sloping frons
Comb	First genal comb is as long as the second one	First genal comb is half the length of the second





EFFECT ON THE HOST

Direct Effect

- ***Flea bite dermatitis*** is common in dogs and cats
- It is due to the sensitization of the animal to the saliva of the flea, a **hapten** in the saliva of the flea becomes antigenic by fusion with skin collagen and incites an immediate hypersensitive reaction followed by delayed hypersensitivity reaction
- This results in intense pruritus in the **lumbosactral area, abdomen, hind legs and neck region**
- Lesions vary from moist dermatitis to acathosis, hyperpigmentation, hyperkeratinisation etc
- Moist dermatitis may be further complicated by secondary bacterial infection

- In cats, small papules are seen in affected animals which is associated with pruritis which is referred to as **Miliary dermatitis**
- Excess grooming results in diffuse alopaecia
- The affected animal loses its condition rapidly, usually a high level of infestation is seen in animals especially cats which are already in a poor condition due to probably some debilitating diseases
- Older animals are also commonly infested with fleas
- Restlessness due to the itching and scratching results in poor body condition and poor appearance of the coat
- Since the fleas suck blood, a heavy infestation can also result in **anaemia**

Indirect Effect

- Intermediate host for the tapeworm of dogs- ***Dipylidium caninum*** - the eggs of the tapeworm are seen in faeces and the larval stages of the flea feeds on it
- The infective stage of the tapeworm- the cysticercoids develops inside the flea larvae and reaches infective stage in the adult flea
- When the flea with the cysticercoid is accidentally ingested by dogs the dogs get the tapeworm infection
- Children are also prone to pick up the infection when they accidentally swallow the flea while in close contact with their pet dogs
- Also transmit a filarid worm of dogs- ***Dipetalonema reconditum***

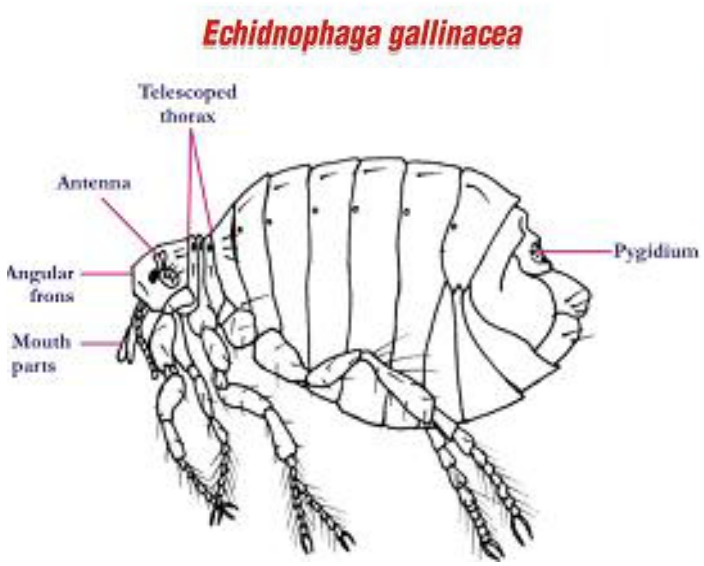
FOWL FLEA

- Genus : *Echidnophaga*
- Species : ***E.gallinaceae***
- Common name : **Stick tight flea, stick fast flea or the fowl flea**

MORPHOLOGY - FOWL FLEA

Head

- **Absence of genal combs**
- **Angulate fron.**



- Strongly developed mandible with recurved teeth, which helps them to hold on to the host

Thorax

- Foreshortened thoracic segments- the thoracic segments are telescoped into one another and are ill developed
- Legs are not very powerful
- **Absence of pronotal combs**

Abdomen As in general characters

FOWL FLEA

- The fleas are attached to the **combs, wattles and around the eyes of infested fowls**
- Heavy infestations reveal clusters of these small fleas in the head region
- The fleas are permanently attached to the host which is why they are referred to as **stick tight fleas**
- Hence the modification in the morphology (absence of combs, less powerful legs and a foreshortened thorax)
- The area around the attached flea swells up and encloses the flea's body
- Due to the swelling of the eyelids the birds may lose their eyesight temporarily or even become blind
- The fleas consume blood and in large infestation can result in anaemia and death of birds
- The swellings around the flea may also ulcerate and the fleas eggs will be seen in these ulcers, once the larvae hatches out it falls off the host and develops like the dog flea on the ground
- Presence of fleas and the irritation and anaemia it causes leads to drop in egg production and severe weight loss in birds

CONTROL - ADULT FLEA

- **Flea collar** –plastic strips impregnated with dichlorvos (DDVP) 9.3% for dogs and 4.65% for cats is effective
- Impregnated medallions for dogs (19.6% DDVP)

Disadvantages

- The duration of protection is only 3 months

- Contact dermatitis may occur to the flea collar in some animals
- **Dog flea collar should not be used for cats, and never on nursing animals, sick or convalescent animals**
- Generally owners forget to replace the collar which is ineffective after 3 months
- Carbaryl formulated shampoos can be used in mild infestations
- Allethrin, resmethrin, other synthetic pyrethroids with piperonyl butoxide are also useful
- Fleas are able to jump to a height of 33 cm and mechanical control in dog kennels were made possible by increasing the height of the kennel from the floor to 35 cm
- Currently fleas are controlled mainly by using **insect growth regulators** -**The chitin synthesis inhibitor**- **Lufenuron** is commonly used. One tablet given to a dog or cat can protect the animal for a month

CONTROL - LARVAE AND PUPA

- This is the most important part of flea control
- **Insect growth regulators**- juvenile hormone analogue such as **methoprene** can be used to control **the immature stages of the flea within the house**
- Vacuum cleaning the carpet and areas where the dog/cat frequents is one of the best methods of mechanical control of fleas
- Spraying insecticides in the kennels/sheds especially the corners of the room is effective in killing the immature stages
- In heavy infestations it would be better to destroy the bedding material of the pets in order to destroy the immature stages
- Application of a **sodium borax** or **sodium polyborate** powder causes dessication of the immature stages
- Use of D-limonene- is a biological control option

CONTROL - STICK TIGHT FLEA

- 5% malathion dust is effective
- Earlier 0.1% DDT dips were used
- Also used were 5% DDT dusts

Xenopsylla cheopsis - oriental or black flea

- Genus :Xenopsylla
- Species :***X.cheopsis***
- Common Name: **Oriental rat flea or black rat flea**

ORIENTAL OR BLACK FLEA

- This flea is associated with the transmission of **Bubonic plague (by Y*ersinia pestis*). Murine typhus by Rickettsia mooseri, Salmonellosis**

Morphology

- Presence of vertical thickening in Mesopleuron
- Ocular bristle in front of the eye
- 9th sternite club shaped
- Thorax is foreshortened

Pulex irritans -Human flea, *combless flea*)

- Neither genal are Pronotal ctenidia are present
- Outer margin of the head is smoothly rounded
- Presence of single ocular bristle below the eye
- I/H : ***Dipylidium caninum***

LICE

- Permanent ecto-parasite of birds and mammals
- Wingless
-Dorso-ventrally flattened

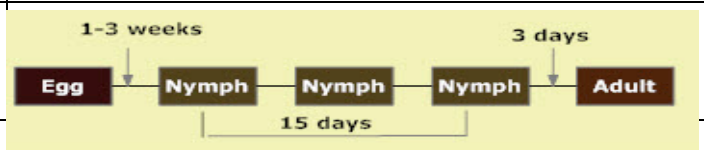
ORDER: MALLOPHAGA (BITING LICE) and

ORDER: SIPHUNCULATA (SUCKING LICE)

Difference between Biting lice and Sucking lice

BITING LICE	**SUCKING LICE**
• Order: Mallophaga • Small, wingless, dorsoventrally flattened	• Order: Siphunculata • Small, wingless, dorsoventrally flattened
HEAD	
• Antenna short 3-5 • Eyes vestigeal • Rounded head	• 5 segmented • Absent/Present • Conical pointed head
THORAX	
• Indistinct segmentation • Meso and Meta thorax fused • Pro thorax- distinct and seperate • Legs: Tarsi with 1 or 2 segments, • **2 claws for birds or one claw for animals** • Wings: Absent	• All three segments fused • Tarsi with 1 segment, • **2 claws for birds or one claw for animals**
ABDOMEN	
☐ 8 segment visible out of 11 and 9,10 are fused, 11- not seen ☐ **Incomplete metamorphosis**	☐ 7 of 9 segments are visible
LIFE CYCLE	**LIFE CYCLE**





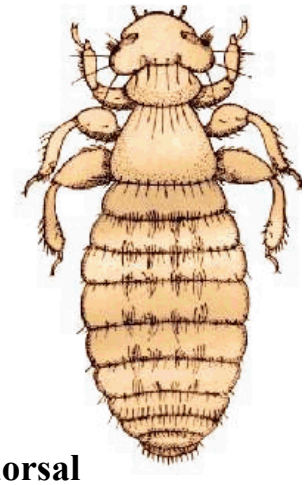
ORDER: MALLOPHAGA (BITING LICE or CHEWING LICE)

Difference between Amblycera and Ischnocera

1.Sub order: Amblycera	2.Sub order: Ischnocera
• Lice are active	• Lethargic
• Mandibles bite horizontally	• Mandibles bite vertically
• Antennae concealed in antennal grooves in ventral sides of the head • They may not be readily seen	• Antennae long, filiform visible at the sides of the head (Not concealed in grooves)
• Maxillary palp present	• Maxillary palps absent
• Meso and meta thorax not fused • **Tarsi of birds lice has two claws Tarsi of animals has one claw**	• Meso and meta thorax fused
• Examples: ***Menopon gallinae, Menacanthus stramineus,***	• Examples: ***Lipeurus tropicalis, Damalinia ovis***

Sub order: Amblycera

Menopon gallinae



Menopon gallinae- Shaft louse of poultry

- Sub Order : Amblycera
- Host: Pigeon, Fowl, Duck

Morphology

- Yellowish in colour
- **Head-Broad posteriorly**
- Rounded forehead and temples
- Legs tarsi end with two claws
- **Thoracic and Abdominal segments with one row of dorsal bristles**
- Legs tarsi end with two claws

Eggs

- Eggs in clusters on feathers.

Effect on host

- Moves actively around
- Birds restless
- Depluming occurs due to irritation
- Weight loss
- Egg yield goes down

Menacanthus stramineus **- Yellow body louse of poultry**

- Host : Fowls
- Area : **Breast, thigh, cloaca region**
- Morphology : **Thorax and Abdomen with 2 rows of bristles/spines**
- **Legs tarsi end with two claws**
- **Eggs**
  - Eggs with filaments at the anterior end
  - Eggs in clusters on feathers near skin

Menacanthus stramineus



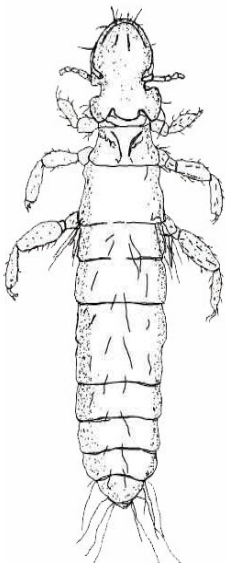
Sub order: Ischnocera

Lipeurus caponis and L. tropicalis **-Wing louse of poultry**

- Host : **Fowls, Pheasants**.
- Location : **Underside of wing feathers.**
- **Morphology**
  - **Slender, elongate, sluggish.**
  - Head rounded
  - Hind legs are larger than
  - other two
  - **Tarsi end with 2 claws**

The head end is angular in ***L. tropicalis*** *a* species common in Tamilnadu

Lipeurus



Damilinia ovis (Sheep louse)

Prothorax narrower than head
Abdomen covered with short hairs and 2 rows of setae on abdomen
Tarsi end with single claw

Damilinia ovis



Damilinia bovis (Cattle louse)

Damilinia equi (Horse louse)

Damilinia caprae (Goat louse)

Trichodectus canis- Dog louse

SUCKING LICE

Order: Siphunculata / Anoplura (Sucking Lice)

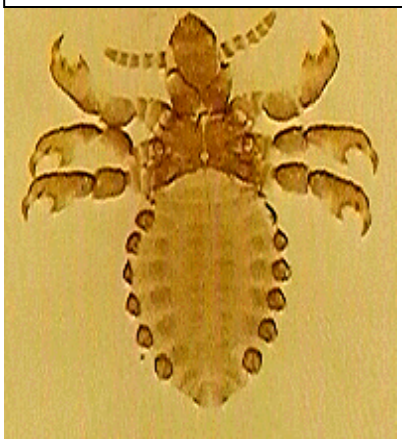
FAMILY	
• **Haematopinidae**	• **Linognathidae**
HEAD	
• Eyes absent • Head with forward prolongation- temporal angles behind antenna	• Eyes Absent
THORAX	
• Thorax broad • Marked paratergal plates	• Thorax narrow • Paratergal plates absent - membraneous
ABDOMEN	
• Abdomen broad • One row of spines on each abdominal segment	• Abdomen narrow • Hairs present
LEGS	

• All three pairs of legs similar in size • Tarsi with one claw, hair held between claw and a thumb like process on ventral apical angle of tibia- spiny pad- tibial pad	• 1st pair of legs smallest
Ex. • *Hematopinus eurysternus* (**Short nosed cattle louse**) • *Hematopinus tuberculatus (*buffalo louse) • *Hematopinus quadripertusus* (Tail switch louse) • *Haematopinus suis* (hog louse)	*Ex.* • *Linognathus vituli* (**Long nosed cattle louse**) • *Linognathus pedalis* (Foot louse of sheep) • *Linognathus stenopsis* (goat louse)

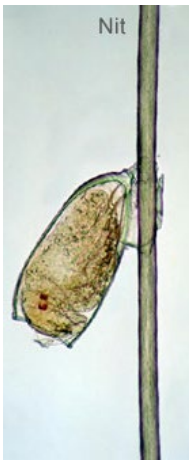
Hematopinus eurysternus (Short **nosed cattle louse**)

***Haematopinus quadripertusus*- Tail switch louse**

Hematopinus eurysternus



- Mostly seen on tails
- Eggs laid on tail
- Hatch in 9 days
- Egg to Egg may be 25- 30 days
- Head broad, short and blunt/anteriorly pointed
- All legs equal in size
- Thorax having a sternal plate which is distinctly longer than broad and has three anterior processes
- Abdomen with **paratergal plates**
- Abdominal segments with single row of bristles/hairs
- Abdomen very broad and with prominent spiracular openings
- Eyes absent
- **Tarsi end with single claw**



Nits: Egg of lice

- Characterised by operculaed eggs attached to the hairs with narrower end

***Haematopinus suis*- HOG LOUSE**

- Largest louse on farm animals

Morphology

- Male- 5mm; Female- 4.2mm
- Greyish brown
- Black markings covers entire body

Economic Importance

- From Sow to piglets- unthrifty growth/production
- 2% reduction in weight
- 2-6% loss in market value of hogs

Linognathus vituli



***Linognathus vituli* - LONG NOSED CATTLE LOUSE**

- Seen all over the body, more on calves
- Long and narrow pointed head
- Forelegs more slender than the rest
- Plates absent, transparent
- Abdomen comparatively narrower. Abdominal segments with two rows of long hairs
- Eyes absent
- Spiracular opening not very prominent
- Lay one egg per day, hatch in 10 days. Egg to Egg may be 30 days
- Eggs of lice are called *Nits.*
- Metamorphosis is incomplete. The phase which develops in the egg is first nymph which is structurally similar to adult

Lousiness (Pediculosis)

EFFECT OF LICE ON THEIR HOST

- The chief effects of lice on their host are due to the irritation they cause
- They are numerous in winter, because of longer hair on the host's coat, closer contact of animals and also lack of general vigour
- Hosts become restless, do not feed or sleep well and they may injure themselves or damage their feathers, hair or wool by biting and scratching the parts of their bodies irritated by the lice
- The egg production of birds and the milk production of cattle may fall
- In mammalian hosts scratching may produce wounds or bruises on the animals, while in sheep the wool is damaged
- It is also soiled by the faeces of the lice
- The coat becomes rough and shaggy and if the irritation is severe, the hair may become matted
- Excessive licking of hairs by calves may lead to formation of "**hair-balls**" in stomach
- The foot louse of sheep (*Linognathus pedalis*) is found most frequently around the dew-claws and severe infections may produce lameness

VECTOR POTENTIALITY

- *Haematopinus suis* transmits **swine virus**

DIAGNOSIS - LOUSINESS

- By finding lice or by detecting eggs or nits on hairs or feathers

TREATMENT AND CONTROL OF LICE

Poultry

- 0.5%-5% DDT as dust
- 1% BHC as dust
- 5% Chlordane as dust
- Fenitrothion (Sumithion 50% EC). 0.125% as spray (25 ml in 10 litres of water)
- Malathion (Cythion)- 100ml in 10 litres of water for 300 birds. 200 ml in 4 litres of water for wall spray.

- Coumaphos (Asuntol 50%wp), 2g/litre of water for 300 birds. 200 ml in 4 litres of water for wall spray
- **Deltamethrin (Butox liquid) 2ml /litre of water as spray**
- Fenvalerate (Sumicidin 20% EC) 0.5 ml/litre of water as spray on body, 1-2ml/litre of water for shed
- Carbaryl (Sevin) 5% dust or spray
- Propoxur (Baygon) 0.05% as spray
- Permethrin (Ectiban) 0.05% as spray

Cattle / Sheep / Goats

- Crotoxyphos (ciodrin) 3% dust
- Ciovap (1% Cotoxyphos + 0.25% dichlorvos) as spray
- Coumaphos as 0.06% spray
- Crufomate-35% dip, 25% spray, 13.5% pour-on application
- Ronnel-0.25% spray
- Malathion-0.5% spray
- **Cypermethrin-a synthetic pyrethroid used in a concentration of 150 ppm as a dip**
- **or Spray**
- **Ivermectin-0.2 mg/kg. b.w.s/c injection**

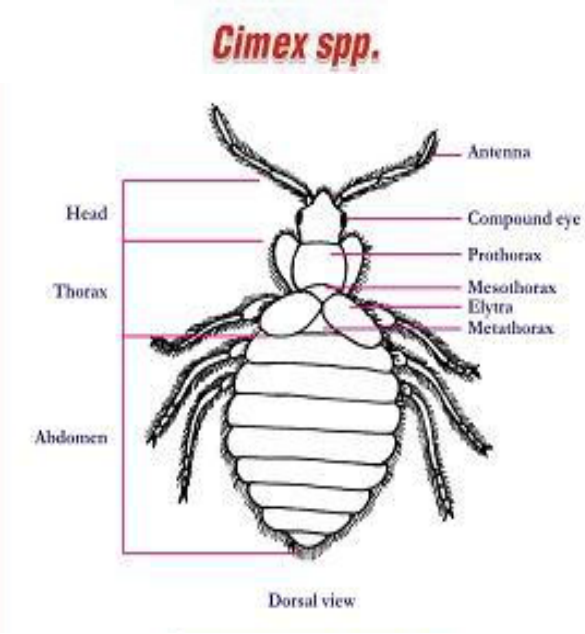
Dogs

- Coumaphos-0.5% as dust
- Ronnel-0.25-1% topical solution
- Lindane-as 1% spray or dip
- Carbaryl is available as shampoo or soap
- Ivermectin-0.2 mg/kg b.w.s/c injection
- **Deltamethrin (Butox)-2 ml/litre of water as spray**

BUGS

HEMIPTERA

- Order : Hemiptera (Hemi-half;ptera-wings-half winged- 2 pairs of wings the basal pair leathery while the other is membraneous)
- Family : Cimicidae (Cimex in latin means bug)
- Genus : Cimex



- Species: ***C.lectularius,C.hemipterus,*** ***Triatoma sp.***

***Cimex lectularius*- BED BUGS**

Common name: Bed bugs

- 4-7 mm males smaller than the females
- Dorsoventrally flattened, oval in shape
- Yellowish brown to dark brown in colour

Head

- Compound eyes large, well separated and project characteristically at the sides of the head
- 4 segmented antenna , last three segments are long and slender
- Mouthparts are piercing and sucking type
- Labium with 3 obvious segments bearing the piercing mandibles and mandibles- reflected backwards under the head, reaches as far back as the coxae of first leg -ophisthognathous type

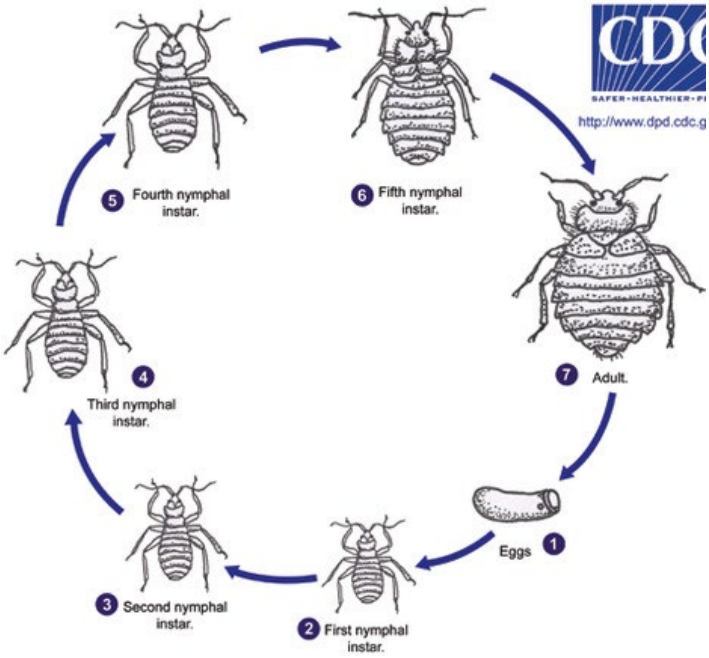
Thorax

- Prothorax is deeply notched anteriorly where the head is inserted
- Appear wingless- micropterus however, forewing being reduced to form hemelytral pads and the hind wings are absent
- Hemelytral pads are oval pads seen laterally on the mesothorax
- Ventrally on the metathorax opens the scent glands- also called the stink glands in adults

Abdomen

- 11 segmented with 2-9 segments being easily recognizable
- When the bed bug engorged the abdomen increases in volume and exposes the intersegmental membranes which are called the hunger folds- situated in the mid ventral lines of segments 2-5
- 7 pairs of prominent spiracles are seen.
- In females on the posterior margin of the 5th segment is present the organ of **Rebaga inside which is a gland called the Berlese gland or organ of Berlese which is the ectospermalege**
- Young bugs show the presence of the stink glands in the abdominal region

LIFE CYCLE - BUGS



- Eggs are laid by the females in cracks and crevices
- Eggs are creamy white,1mm long with an operculum
- Egg hatches in 3-14 days to give rise to the nymphal stages
- Five nymphal stages which resemble the adult are produced
- Adult stage under favourable conditions is reached in 8 weeks
- The bugs are nocturnal but bite the host during day time when the host is quiet
- They travel long distances, attack man and animals to suck blood
- They can withstand long duration of starvation

EFFECT ON THE HOST - BUGS

- All the stages bite the host and suck blood, heavy infestation can lead to anaemia
- They cause intense irritation to animals and birds, restless and the associated debility
- Disturbs the sleep of the host
- Intense irritation due to the saliva of the bug is also observed

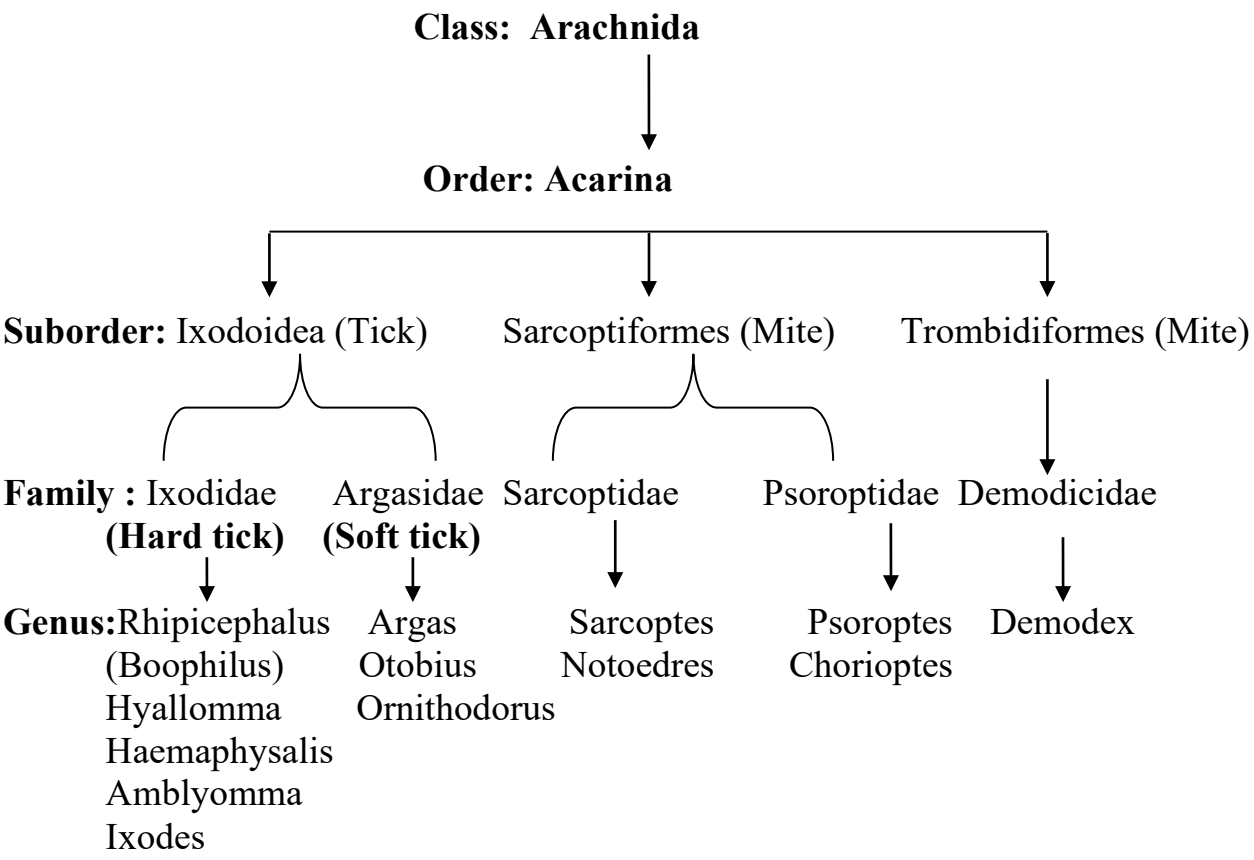
- Bugs feed, then turns round and then defaecates on or near the bite wound which could provide a possibility for disease transmission
- Hepatitis B antigen is seen excreted in the faeces of bugs and this can infect susceptible individuals
- Triatoma bugs are used in 'Xeno-diagnosis' technique to detect ***Trypnosoma cruzi*** in humans

CONTROL

- Organophosphorus –Malathion and 1% Chlorpyriphos and Organochlor compounds can be used as sprays and powders to be applied in the cracks and crevices
- Synthetic pyrethroids are also effective

ARACHNIDA (Ticks and Mites)

CLASSIFICATION OF ARACHNIDA



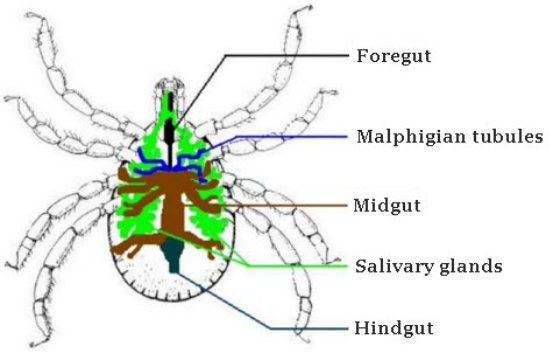
Difference between insects and arachnids

Insects	Arachnids
• Body is divided into head, thorax and abdomen	• Body division is not marked. It consist of a single large piece
• Head usually has of antenna	• Antenna mayor may not be present
• Wings may be present or absent	• Absent
• Adults show the presence of three pairs of legs	• Four pairs of legs in adults and nymphs and three pairs in larvae
• Metamorphosis is complete or incomplete	• Metamorphosis Incomplete
• Oviparous or larviparous	• Oviparous only

Order: Acarina

Suborder: IXODOIDEA , Family: IXODIDAE and ARGASIDAE TICKS

- Suborder: **Ixodoidea(ticks)**
  Family : **Argasidae**–the soft ticks
  Ixodidae - the hard ticks



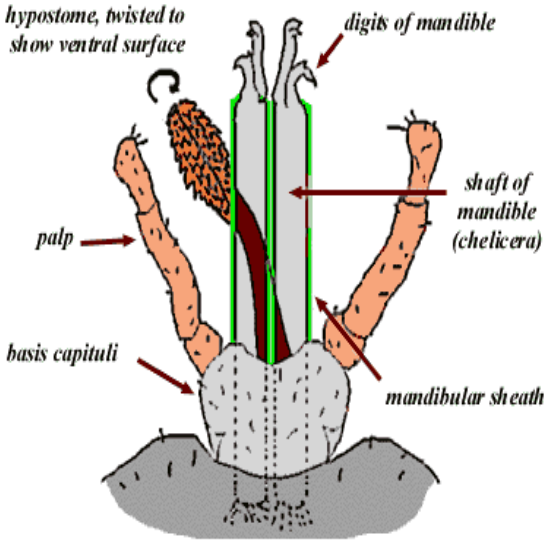
INTRODUCTION

- Ticks are amongst the most important vectors of human and animal diseases
- They rank second to mosquitoes as vectors of life threatening or debilitating human and animal diseases
- Amongst the arthropod group they transmit greater variety of infectious diseases. and even surpass mosquitoes in the variety of pathogenic organisms (bacteria, virus, rickettsiae, protozoa etc.) transmitted
- In addition to their vector potentiality they are important as pests-causing tick paralysis, toxicosis, irritation, bite allergies, immune responses and economic losses due to blood loss
- They are obligate blood sucking arthropods and nearly 850 species are known worldwide
- The major families are
  - **Ixodidae or 'Hard ticks'**
  - **Argasidae or 'Soft ticks'**
- They infest every class of terrestrial vertebrate, mammals, birds, reptiles and even amphibian

MORPHOLOGY - TICKS

- Body is usually elongated, longer than wide.
- Range from 2 mm to even 30 mm in size.
- When engorged female ticks appear swollen and more rounded.

Body consist of



- **Capitulum (=Gnathosoma)**
- **Idiosoma**
- Idiosoma is further divided into
    - Podosoma which bears the legs and genital pore.
    - Opisthosoma- region posterior to the legs, bears the spiracle and anal aperture.

Capitulum

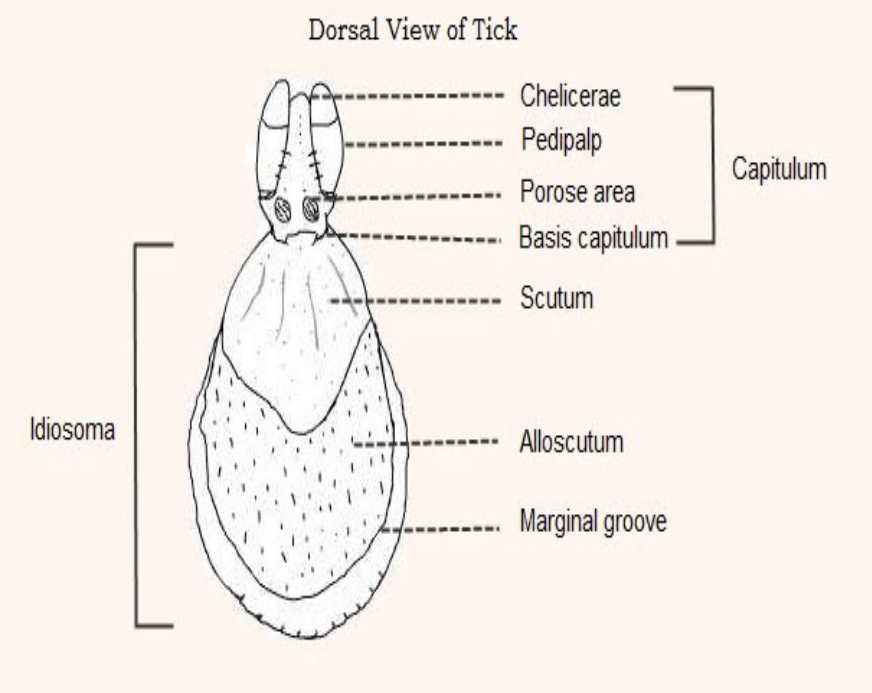
This articulates with the idiosoma via a cavity- the emarginatum (Ixodids) or camerostome (Argarsids).

- It is connected by soft articulation membrane that allows ventral flexation of capitulum.
- Capitulum consists of
    - The basis capitulum – an integumental ring which completely encircles the mouth parts.
    - The paired four segmented palps.
    - The paired two segmented chelicerae.
    - The hypostome.
- Basis capitulum forms the posterior part of the capitulum.
    - It serves as an anchor for the more flexible mouth parts associated with it.
    - Female ixodid ticks bear clusters of pores on the dorsal aspect of basis capitulum- POROSE AREAS.
    - The porose areas secrete antioxidants that inhibit degradation of waxy compounds in the secretions of Gene's organ.
- Chelicerae are located on the dorsal aspect of the basis capitulum.
    - Their shafts are surrounded by spinose sheaths.
    - They lie between the palps and each chelicera bears two digits distally.
    - Both digits have sharp denticles.
    - The chelicerae are used to cut host tissues to facilitate attachment.
- The Pedipalps consist of four distinct segments.
    - In nymphs and adults of most ixodid ticks only three segments are visible since the small terminal segment is recessed in a cavity in segment three, segment four bears sensory receptors.

- The Hypostome is a prominent ventrally located structure that bears rows of recurved teeth on its ventral surface.
    - Teeth are absent in certain non-feeding males.
- In argasids
    - The capitulum is similar. However, it is situated just below an anteriorly protruding body extension or hood and is not visible dorsally in nymphs or adults.
    - The four palpal segments are about equal in size.

Idiosoma

- It is the body exclusive of capitulum.
- It is divided into 2 parts - anterior **PODOSOMA** which bears the legs and genital opening and the posterior **OPISTHOSOMA** which is the region behind the coxae bearing spiracles and oval apertures.



Dorsal surface

- Ixodids or hard ticks have a hard cuticular plate or SCUTUM on the anterior half of the dorsal body surface.
- In males the scutum occupies almost the entire dorsal surface.
- The body of the female expands enormously during feeding and so the scutum is restricted to 1/3 of the dorsal surface. When present a simple eye occurs along the postero –lateral margin of the scutum.
- The dorsal body surface posterior to the scutum is the **ALLOSCUTUM**.
- In female ticks, a paired protrusible organ – **GENE'S ORGAN** lies in the dorsal formen between the scutum and the capitulum. The ends of the Gene's organ protrude during oviposition and apply wax to each egg as it is deposited.
- The argasid body is very different in appearance from that of ixodid ticks.
    - The body lacks scutum.

- In most species the body is covered by tiny elevations termed mammillae.
- An important exception is the nymph of ***Otobius megnini*** where the body is covered with dense coarse spines.
- Except *Argas*, in all argasids the body margin is rounded.

- Other structures on the ventral aspect include genital pore in females which is a 'u' or 'v' shaped opening with prominent marginal folds whereas in males it is covered by a movable plate.
- In addition, there are paired spiracular plates behind coxae 4 and the anal aperture located near the posterior margin.

Legs

- Legs are jointed and attached with the body by the **coxae**.
- Larva can be easily recognized because it **has 3 pairs of legs** called **SEED TICK** where as nymphs and adults **have 4 pairs**.
- Leg is divided into 6 segments -coxa, trochanter, femur, patella (genu), tibia and tarsus.
- A pair of claws and a pad like pulvillus are present in most tarsus.
- Pulvillus is absent in argasid nymphs and adults.
- **Haller's organ:** It is a sensory organ or pit on the end of the **first of pairs of legs** and used to detect **the suitable host.**



Ventral Surface

- On the ventral surface there is the presence of the 4 pairs of legs in nymphs and adults and three pairs in larvae
- In the anterior region there is the presence of genital opening in the case of the female ticks
- Posteriorly there is the anal opening, covered with anal plates
- In the male tick in most cases there are plates adjacent to the anal plate- the adanal, accessory adanal and sometimes even a subanal plate
- Ventral plates may also be seen in areas corresponding to the festoons

TICK LIFE CYCLE PATTERNS

- ARGASIDS : Multi-host life cycle, involves more than 3 hosts, has several nymphal instars, each feeding on different hosts

Differnce between Soft and Hard ticks

Characteristics	Argasidae	Ixodidae
MORPHOLOGY		
I. Capitulum		
• **Location**	• Subterminal and so not visible on the dorsal aspect of adults • Terminal and visible from dorsal aspect in larval stages	• Terminal, visible from the dorsal aspect in all stages
• **Basis capitulum**	• Porose areas are absent	• In female ticks the porose areas are seen on the dorsal aspect of basis capitulum
• **Pedipalps**	• Leg like, all 4 articles sub equal and flexible	• Article IV recessed in a cavily in article III and the 1st article of the pedipalp is rigid
• **Chelicerae**	• Cheliceral sheath is smooth and distended	• Cheliceral sheath is covered with teeth/ spines
II. Body		
• Appearance of the surface	• Leathery, mammillated or wrinkled	• Smooth or superficially striated
• Scutum	• Absent	• Present, entire dorsal surface covered in male ticks, half the surface covered in nymphs and larvae while in females only 1/3 rd of the dorsal surface is covered by scutum
• Festoons	• Absent	• Present

• Eyes (when present)	• Ventro-lateral on the supra coxal fold, 2 pairs, between 1st and 2nd and 2nd and 3rd pair of legs	• Dorso-lateral in position, one pair is seen between the 1st and 2nd pair of legs
• Spiracles	• Small, seen between the 3rd and 4th coxae on ventral aspect	• Seen on large spiracular plates posterior to the 4th coxae
• Plates/grooves	• Absent	• Present
III. Legs		
• Coxae	• Unarmed	• Armed, with internal and external spurs
• Pulvilli	• Rudimentary or absent	• Present
IV. Sexual dimorphism		
	• Not marked	• Marked
BIOLOGICAL CHARACTERS		
• Feeding habits	Intermittent feeders, rapid feeding in case of nymphs and adults, could also be slow in larval stages, cuticle expands to accommodate the blood meal but does not grow. They feed for few hours on the host and hence there is no formation of attachment	• Takes a single blood meal over a period of days. Slow feeder and hence attachment to the host becomes essential, they secrete attachment cement • Cuticle grows to accommodate the large blood meal
• Nymphal instars	• Many	• Only one
• Mating	• Off the host • Single sex pheromone	• On the host with the exception of *Ixodes* Multiple pheromone

• Reproduction	• 200-300 eggs deposited by the female after each feeding • Several batches of eggs are laid, so females feed and oviposit repeatedly • Eggs emerge from opening on ventral side • Eggs are waxed by the Gene's organ	• Following engorgement the mated female deposits around 10,000-20,000 eggs per tick • Only one batch of eggs and following oviposition the female tick shrivels and dies • Eggs emerge from the dorsal aspect through a slit in between the scutum and basis capitulum • Initially covered by the secretion of the accessory glands of the vagina followed by the Gene's organ
• Host seeking behavior	• Nidicolous, seen in protected areas such as the nest, cave, burrow etc of the host	• Non nidiculous, seen in pastures and other areas where the host frequents, it ambushes the host
• Seasonal activity	• Active throughout the year	• Active during the warmer months of the year
• Habitats	• Sheltered environments	• Open environments
• Life span	• Long lived, infrequent blood meals, numerous nymphal stages and high resistance to starvation are the causes for the increase in life span	• Not so long lived. Less resistant to starvation, only one nymphal stage and single blood meal

Ixodidae

HARD TICKS

MORPHOLOGY - HARD TICKS

Riphicephalus (Boophilus) microplus **- ONE HOST TICK (TROPICAL CATTLE TICK)**

- **Short rostrum (brevirostrate)**
- A pair of eyes present -at the margin between first and second coxae in males and at the margin of the scutum in the region between 1st and 2nd coxae in females
- **1st coxa has hump on dorsal border and is notched ventrally**
- Adanal and accessory adanal plates are present in males and these plates are having median posterior spine
- Additionally a caudal process is present in males
- **Festoons are absent** and the anal groove is faint
- Acts as a vector for ***Babesia bigemina*** in cattle

Riphicephalus (Boophilus) annulatus **- ONE HOST TICK (NORTH AMERICAN TICK)**

- Similar to *B. microplus*
- In males, the caudal process is absent
- Acts as vector for ***Babesia bigemina*** in cattle

Hyalomma marginatum, H.anatolicum **- TWO HOST TICK (*BONT LEGGED TICK*)**

- **Long rostrum (longirostrate)**
- Eyes and festoons : Present.
- **First coxa is deeply bifid.**
- **Joints of limbs have white bands**
- Males have anal, adanal and subanal plates
- Acts as vector for ***Theileria annulata, Theileria mutans***

Haemaphysalis bispinosa **- THREE HOST TICK –(Inornate Tick)**

- Short rostrum
- Eyes : Absent
- **Basis capitulum rectangular on dorsal aspect**
- **The second article of the pedi palp projects laterally**
- **First coxa has pointed spine.**

- Festoons : Present
- Ventral plates in males : Absent
- Acts as vector of ***Babesia gibsoni*** in dogs, ***Babesia*** **and** ***Theileria*** of sheep

Rhipicephalus sanguineus, R.haemaphysaloides **–(THREE HOST TICK (BROWN DOG TICK, KENNEL TICK)**

- Brevirostrate
- **Basis capitulum is hexagonal**
- Eyes and festoons : Present
- **First coxa bifid**
- Male ticks show presence of adanal plates - with straight median border
- Acts as vector of ***Babesia canis, Babesia gibsoni, Hepatozoon canis and Ehrlichia canis***
-

Ixodes ricinus **(Castor bean tick)**

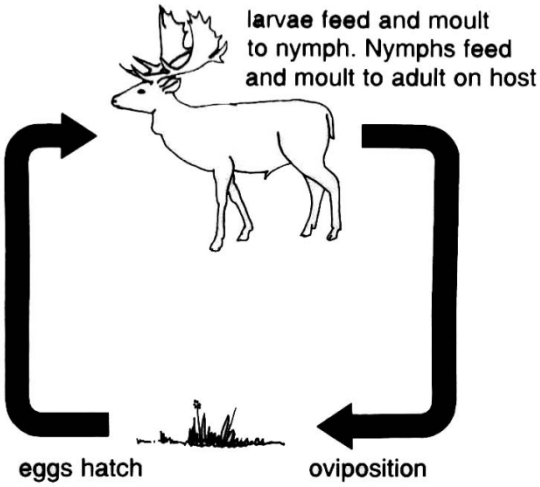
- Anal groove surrounding anus anteriorly - prostriata
- Longirostrate
- Inornate
- Eyes absent
- Festoons absent
- Male with pregenital, median, anal, epimeral and adanal shields
- Transmits : ***Babesia divergens***

Amblyomma maculatum **(Ornate tick) or A. americanum (lone star tick*)***

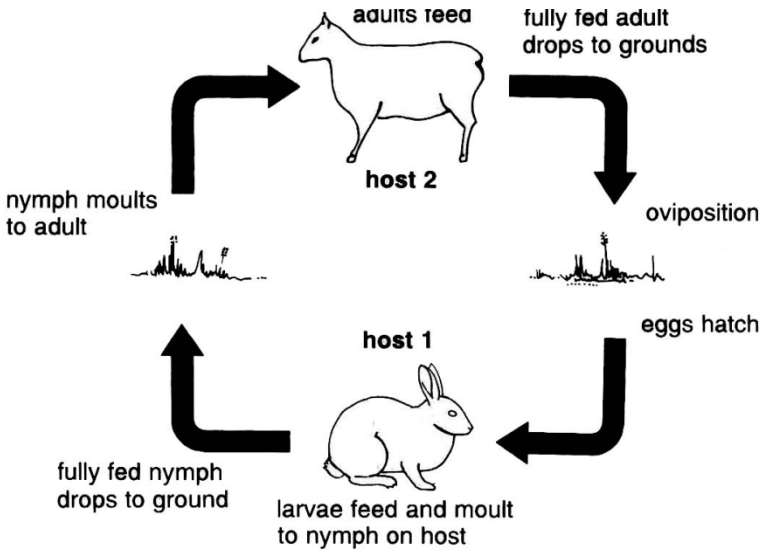
- Ornate
- Eyes present
- Longirostrate
- Second article of pedipalp longer than 1 and 2 Festoons present Males without ventral plates
- Transmits : ***A. hebraeum*** **transmits heart water disease in cattle caused by** ***Cowdria ruminatium***

LIFE CYCLE

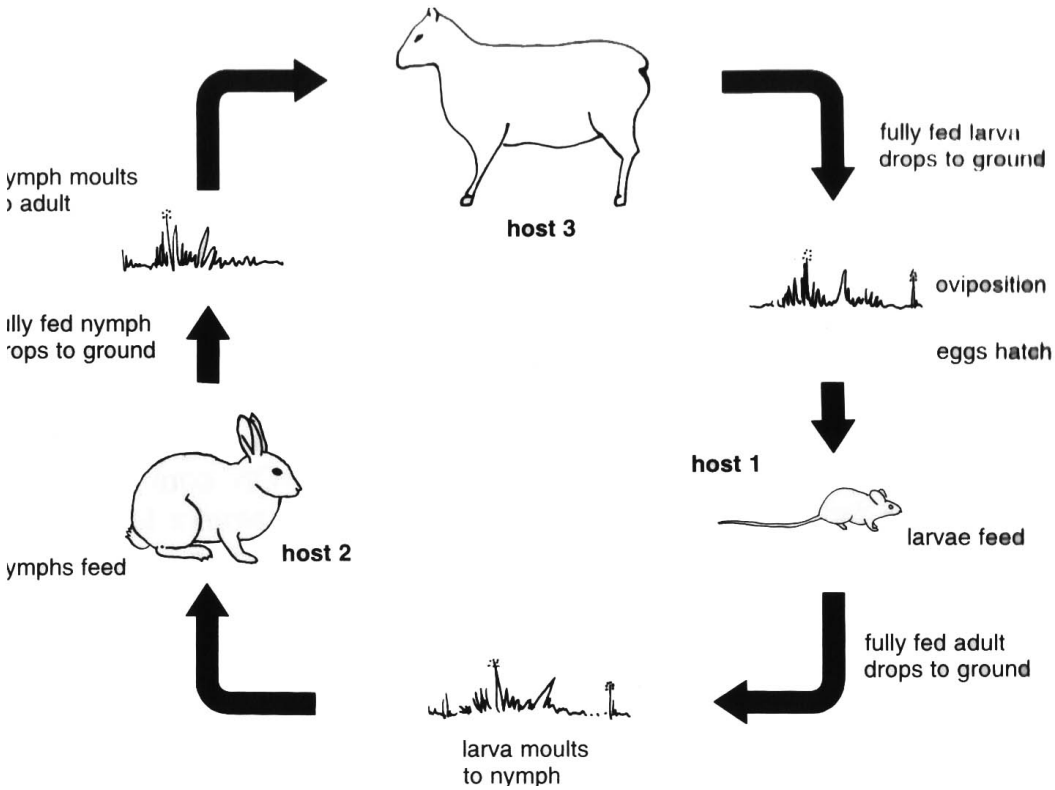
ONE HOST



TWO HOST



THREE HOST



EFFECT ON HOST

Direct effect

- Ticks injure animals by their direct biting process. The bite is **painful** and it annoys the host especially cattle and dogs. The effect is termed **'tick worry'** and this has an adverse impact on production of infested animals
- The wounds caused by the tick bites predispose the host to blow fly strike
- Ticks suck blood and heavy infestation results in anaemia due to heavy loss of blood. In hard ticks the females are heavy feeders and one tick can consume **0.2 to 2 ml of blood - in calves 500 ticks can kill the animal**. Soft ticks such as ***Ornithodorus*** **sp. sucks 1-2 ml of blood** at a time and kills the animal following an overnight infestation
- Ticks damage the hide, there is inflammation, swelling, ulceration and itching. Dermatitis results due to the tick bite especially the l**ongirostrate** ticks. The hide is affected and becomes unfit and is treated as third quality. It is often condemned. The marking on the leather due to the tick bite is referred to as white spot leather

Indirect effect

- Transmission
  of ***Babesia*** **spp.,** ***Theileria*** **spp.,** ***Anaplasma*** **spp.,** ***Ehrlichia*** spp.

Tick paralysis

- Caused by 46 species of ticks in 10 genera including Argasids and Ixodids
- Host: Livestock, pets and man
- It is an ascending motor paralysis induced by substances introduced into host with the saliva when ticks attach and feed
- Toxic substances
  - Proteinaceous material produced by salivary gland and secreted into saliva
  - Some say it produced by ovaries-Ixovotoxin
  - Holocyclotoxin- *Ixodes holocyclus* inhibits secretion at neuromuscular junctions
- Tick
  - Female
  - Sometimes nymphs
- Incidence- depends on
  - Number of ticks

- Period of feeding
- Area fed

- **Clinical signs**
  - Disruption of motor co-ordination
  - Brief incubation- 5-7days
  - General malaise, loss of appetite, headache, vomiting
  - 1st paralysis of lower extremity, flaccid paralysis (hind limbs)
  - Locomotor ataxia - erratic wobby gait
  - Muscular weakness
  - Lack of ankle, knee, or abdominal reflexus
  - Paralysis ascends affects forelimbs - upper body – neck head- collapse - death - flaccid tetraplegia
  - Decreased sensory perception
  - Paralysis of chest muscles leads to respiratory failure
  - Patient is in co-ordinated, unable to move arms / legs, sit upright, difficulty in speaking, chewing, swallowing
  - In young children, death occurs in 24-48 hrs
  - Tick when removed, recovery is seen– total recovery immediate to several weeks except in Ixodes holocyclus.
  - In dogs preceding all these symptoms, inflammation and conjunctivitis of eye,keratitis and cardiac abnormalities
- **Treatment**
  - Phenoxybenzamine HCl
  - Alpha adrenergic blocking drug

Tick bite allergies

- **IgE mediated immediate hypersensitivity reaction**
- Occurs early during tick attachment and feeding
- Small large local reaction
- Systemic- shock like symptoms
- Unsual allergic reaction- nausea, diarrhoea, vomiting, edema and erythema

Tick toxicosis

- Associated with soft tick – ***Ornithodoros savignyi*** – trembling, frothy saliva, gnashing of teeth, sometimes foreleg paralysis
- ***Hyalomma truncatum*** **- sweating sickness** which occurs in sheep, goat, pigs even dogs which occurs in S,G,P, even dogs
- Female while feeding increase incidence summer.

- Fever, anorexia, hyperaemia, hyperaesthesia of skin and mucous membrane, salivation, lachrymation and moist eczema
- No paralysis- cracked skin- screw worm.
- 75% mortality
- Symptoms within 4 days of tick attachment
- Immune for 4 years
- Toxin
    - Unknown
    - Epitheliotrophic

Anaemia

The Indirect effects include the vector potentiality of each tick which is given under each genera of ticks dealt with

Treatment and Control of Ticks

METHODS OF CONTROL OF TICKS

Ticks can be controlled by,

- Ecological control
- Biological control
- Genetic control
- Chemical control
- Novel methods of control

ECOLOGICAL CONTROL

- Modification of plant cover by removal of regetation covering / sheltering ticks
- Sanitation of local habitats - using acaricide, plastering walls, concrete on floors
- Eradication of rodent host
- Other practices such as pasture rotation, pasture spelling, rotational grazing, periodical with holding of cattle and strict quarantine control can also be used

BIOLOGICAL CONTROL

Predators

- Certain ants (e.g. Buphagus) and birds (e.g. Crows) are known to consume ticks - this happens naturally in mixed farming

Parasitism

- Parasitoids which are parasitic during the immature stages and destroy the host as the immature stage completes its development
- The control of ticks by this method is very limited.
- Significant reduction in tick population was exerted by **Ixodiphagus s**p and **Hunterellus hookeri**
- Bacteria such as ***Bacillus thuringiensis*** are known to cause tick mortality
- Some Fungus eg. Aspergillus grow on tick cuticle and cause mortality
- Similarly microsporidia - Nosema act as stomach poison following ingestion by ticks

Botanical

- A leguminous plant ***Stylosanthes scabra*** is known to cause mortality in larval and nymphal stages of ***Boophilus microplus*** **and*****Rhipicephalus sanguineus***

GENETIC CONTROL

Sterile male technique

- Cross between ***B. microplus*** and ***B. annulatus*** results in hybrid sterility
- Irradiation of ticks also results in sterility
- Development of cattle resistant to ticks

CHEMICAL CONTROL

- Traditional method, widely employed
- The following chemicals are widely used,
- Chlorinated Hydro Carbons,
    - DDT, BHC, Dieldrin, Chlordane, Lindane have been used extensively
    - Disadvantages : Hazardous, gets accumulated in environment and body tissues, milk and meat are found to be toxic
- Organophosphorus compounds (OPC),

    - Malathion, Diazinon, Rafoxanide, famphur belong to this group
    - Low mammalian toxicity and minimal residue in tissue is its advantage
- Carbamates,
    - Carbaryl, Baygon have relatively low mammalian toxicity and broad spectrum characteristics
- Synthetic Pyrethroids,
    - Fermented products of Streptomycetes avermititis with broad spectrum activity covering several ectoparasites

NOVEL METHODS OF CONTROL

Use of Pheromones

- Phenolic pheromones are used as an aid in tick control, using them as attractants to attract ticks to an insecticide treated site or location
- Aggregation pheromone with Toxaphene has been used as a tick decoy
- These decoys are tied to the tail of the animal
- Advantage is that only a small amount of chemical is needed to control the ticks

Use of insect growth regulator

- Use of juvenile homone analogue, ecdysones in large doses contribute to tick control

Vaccines

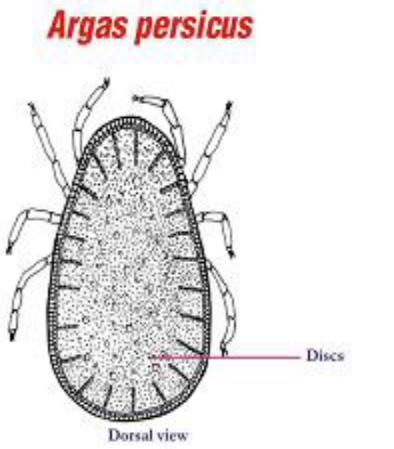
- **BM 86 –** A recombinant vaccine against ***Boophilus microplus*** in cattle. This vaccine is prepared from ticks mid gut wall.Commercially available as **TICKGARD in Australia & GAVAC in Cuba**.

ARGASIDAE - SOFT TICKS

Family: Argasidae (Soft Ticks)

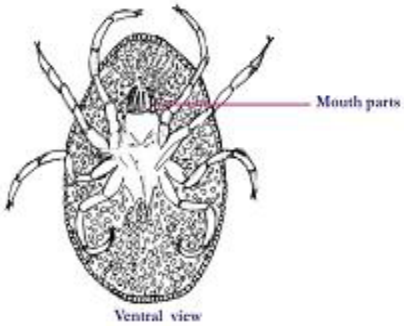
Genus	*Argas*	*Otobius*	*Ornithodoros*
Species	*A. persicus*	*O. megnini*	*O. savignyi*
Common name	**Fowl Tick**	**Spinose Ear Tick**	**Eyeless Tampan**

FOWL TICKS



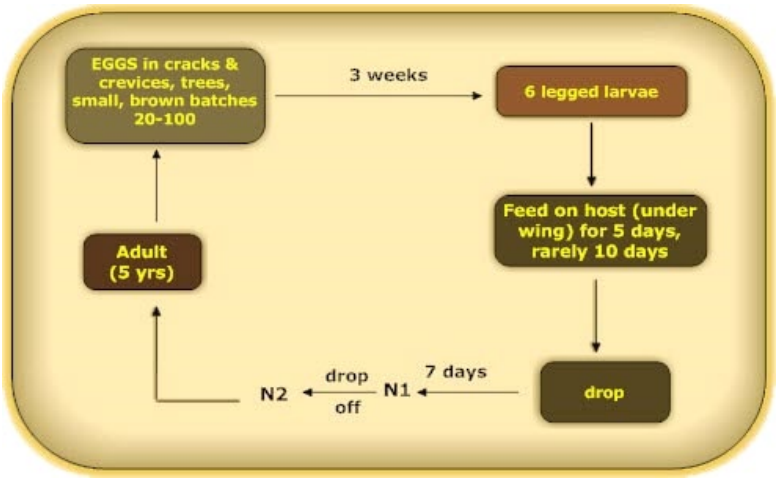
- **Genus :** *Argas*
- **Species :** ***A. persicus***
- **Common name : Fowl Tick**
- **Host :** Fowl, Turkey, Pigeon, Duck, Geese, Ostrich, Wild birds
- **Location:** Adults in cracks and crevices of fowl house, under trees

MORPHOLOGY - FOWL TICKS



- Adult 4-10 by 2-6 mm
- Oval in shape
- Narrow anteriorly than posteriorly
- Edges of body sharp
- Engorged tick slaty brown
- Starved yellowish brown
- Small difference between male & female
- Genital opening prominent in female than in male

LIFE CYCLE - FOWL TICKS



- Nymph engorges once during lifecycle
- Adult feeds once a month
- Lay eggs after each meal
- Larvae can live without food for 3 months
- Nymph and Adult survive starvation for 5 years

EFFECT ON THE HOST - FOWL TICKS

- Worry bird at night. So sleep of birds get affected
- Heavy infestation lead to blood loss, resulting into anaemia
- Egg laying decreases / stops
- Can cause tick paralysis in ducks
- Act as vector for ***Aegyptionella pullorum*** **and** ***Borrelia anserina*** (Fowl Spirochaetosis)

DIAGNOSIS - FOWL TICKS

- Presence of parasites in cracks and crevices

CONTROL - FOWL TICKS

- Bird must be removed and placed in wooden crates. Larvae drop in 5-10 days
- Afterwards, return fowls to their quarters which must be cleaned by then
- Spray chicken house with organo -phosphates or synthetic pyrethroids

SPINOSE EAR TICKS

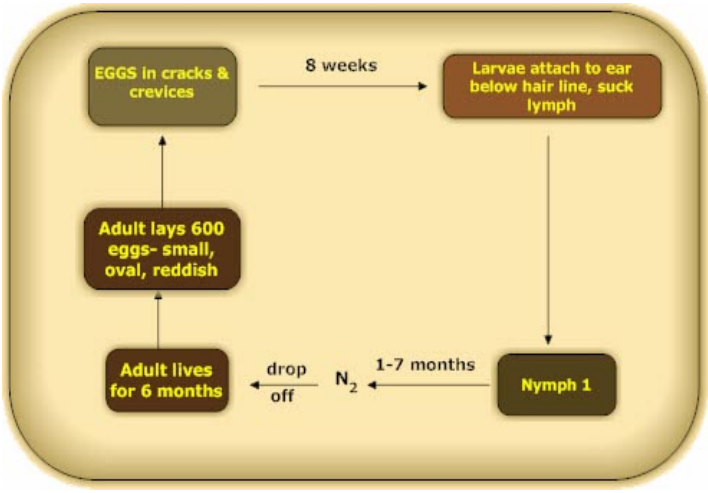


- **Genus :** *Otobius*
- **Species :** *O.megnini*
- **Common name : Spinose ear tick**
- **Host :** Dog, Sheep, Horse, Cattle, also goats, pigs, cats, man, rabbits etc
- **Location :** Nymph and Larva in internal ear
- Adult in cracks of poles, under food boxes or stones

LIFE CYCLE - SPINOSE EAR TICKS

- Larvae lives without food for 2-4 months

- Adult does not feed



EFFECT ON THE HOST - SPINOSE EAR TICKS

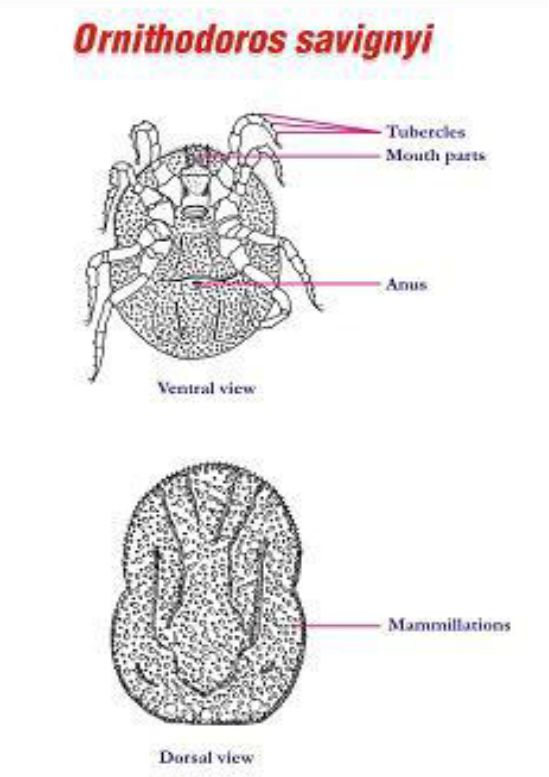
- Large numbers may be seen on one host
- Sucks blood, causes irritation, inflammation which may be subjcted to secondary bacterial infection
- Animal dull, off feed, condition lost
- Dogs shake their head and scratch their ears.
- Waxy exudate is seen oozing from the affected ear
- In heavy infestations there might be nervous symptoms, irritability, restlessness, grinding of teeth, perforation of ear, infection of middle ear & even death

DIAGNOSIS - SPINOSE EAR TICKS

- Probe ear for presence of ticks
- Waxy exudate examination

TREATMENT - SPINOSE EAR TICKS

- 1part HCH; 1part xylol; 17parts pine oil- kills larvae, protects for IM
- 1part 14% chlordane; 15 parts pine oil
- Amitraz- 15-20% - ear tags
- 10% Permethrin
- Infected shed should be treated by use of insecticide sprays



EYELESS TAMPAN

- Genus : Ornithodorus
- Species: ***O.savignyi***-Common Name: **Eyed tampan(Puzhuthiunni)**
- **O.moubata-Eyeless tampan**

MORPHOLOGY

- Body is flattened in unfed specimens
- strongly curvex dorsally when distended with blood
- Differs from Argas in being more globular

- Lacks sharp lateral margin and not distinctly ovoid when viewed from above

LIFECYCLE

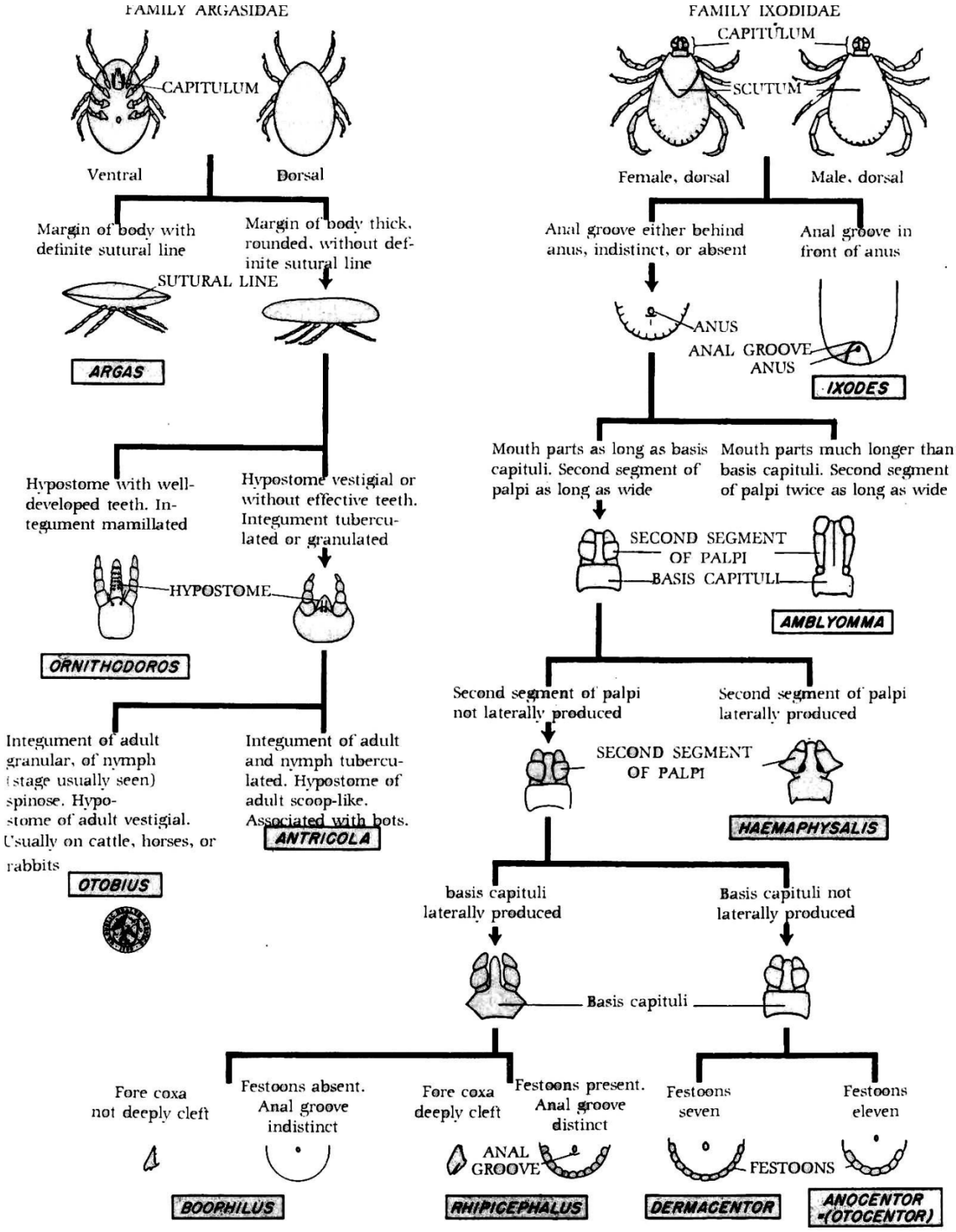
- Found in cracks and crannies of avian roosts, nests, rodent burrows and resting places of large mammals
- *O.savignyi* larvae hatch from the eggs but do not feed- non parasitic. 2 nymphal stages and adult feed on hosts
- The ticks may bite man too.

EFFECTS ON THE HOST CONTROL

- They can suck blood in large quantities and may kill the animal when attacking them in large numbers
- Known to be carriers of spirochaetosis
- Can transmit ***Anaplasma marginale***

CONTROL

- Difficult- hide in sand and hence difficult to access
- Spraying walls of huts, houses and animal buildings with residual insecticides
- Organophosphates, synthetic pyrethroids are likely to be effective
- Applied to animals directly or by providing them with dust baths containing insecticides



Key to the genera of adult ticks in the United States. (Prepared by H. D. Pratt. Courtesy of Federal Security Agency, Public Health Service, Communicable Disease Center, Atlanta, Georgia. December 1948. Rev. Nov. 1951.)

Difference between Ticks and Mites

Ticks	Mites
• Larger in size (macroscopic)	• Smaller in size (microscopic)
• Parasitic in nature	• Free living mites are present
• **Mammilated cuticle present in soft ticks**	• **No mammilations**. Bristles, scales, setae present
• **Eyes- present or absent**	• **Eyes- absent**
• **Jointed pedipalp**	• **Not jointed pedipalp**
• Chitinous extension of coxae (epimeres) - absent	• Epimeres present
• Legs end in claw	• Legs end in sucker or caruncles
• **Festoons present**	• **Absent**
• Ornamentations on dorsal surface of scutum	• No ornamentations
• Chitinous plate/shield (scutum) throughout the body divides ticks into soft and hard ticks	• No scutum
• **Haller's organ** on dorsal aspect of first pair of tarsus in leg for sensory functions	• No Haller's organ
• Respiration by spiracles	• Respire through cuticle
• Lifecycle of ticks involve "on the host" and "off the host" nature	• Lifecycle always in the host skin
• Act as vectors (biological) for protozoan disease transmission	• Not as vectors for disease

MITES

Family: Sarcoptidae

Suborder: Sarcoptiformes

- Few species parasitic
- Legs grouped in 2 pairs on either side of nymph and adult.
- In unfavourable conditions produce nymphs to resist adverse conditions - Hypopial Nymph or Hypopi.

Family: Sarcoptidae

SARCOPTES

Genus: *Sarcoptes*
Species: *Sarcoptes scabiei*

Condition caused: **Sarcoptic mange of** Sheep, Goat, Cattle, Pigs, Elephants, Foxes, Rabbits etc. **Scabies in man**

Sarcoptes scabiei

Mange Infestation in Animals

- An infestation of mites is termed as *Mange/Acariasis/Scabies*

Types of mange

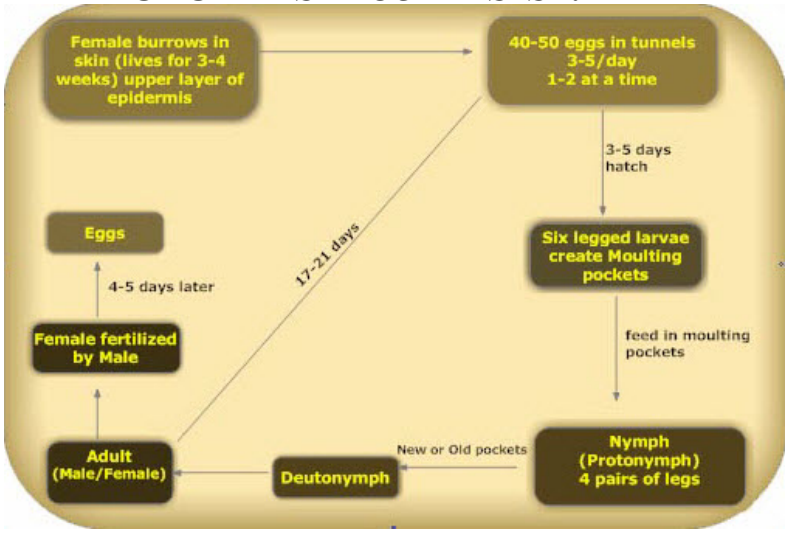
Sarcoptic mange - by *Sarcoptes* spp. - Dog, Sheep, Goat, Buffalo, Pigs, Equines, Camels, Human

- **Psoroptic mange -** by ***Psoroptes*** spp. - Sheep, Buffalo, Goat
- **Demodectic (Follicular/Red) mange - by *Demodex*** spp. - Dog, Sheep, Goat, Cattle
- **Leg mange (scaly leg)** - by ***Cnemidocoptes mutans*** - Fowls, Turkeys
- **Depluming mange (itch**) - by ***Cnemidocoptes gallinae*** - Fowls
- **Chorioptic / foot mange - by *chorioptes* spp**. - horse, Sheep, Cattle
- Otodectic mange (otoacariasis) - by *Otodectes* spp. - Dog, Cat

MORPHOLOGY -

- **Globose**
- Striac of skin interrupted by scaly spinose areas
- **Legs short**
- **Tarsi of 1, 2, 4- male & 1, 2 - female (Bell shaped suckers)**,the rest end in bristles
- Pedicels unsegmented
- **3rd & 4th pair of legs do not project beyond margin of body**
- Dorsal surface covered with fine grooves

LIFE CYCLE – *SARCOPTES SP.*



SARCOPTES SP.



SPREAD OF INFECTION - SARCOPTES

- Contact with wandering larvae (most important), nymph, fertilized young female
- Mite susceptible to dryness, can't live more than few days off the host
- Female feeds on liquid oozing out of damaged tissues

EFFECT ON THE HOST - SARCOPTES

- Pierce skin and suck lymph & feeds on young epidermal cells,
  - Irritation, itching, scratching
  - Condition aggravated
  - Exudation, coagulation, crust formation
  - Excessive keratinization and proliferation of connective tissue, skin thickened and wrinkled

SARCOPTIC MANGE IN PIGS

Site of Affection

- Ear is most common affected site
- Spreads to back, flank, abdomen

Transmission

- Sows to piglets during sucking signs seen within 3weeks of birth
- From infection boar to gilts

Symptoms

- 1st sign papules, generalized erythema around eyes, snout & external ear, axilla, front of hocks
- Scratching – encrustations – thickened skin with crack open, leaving deep wounds

Diagnosis

- Confirmatory diagnosis by examining the wax from the ear

Treatment

- Treat Sow before farrowing
- Boars – treat at 6 monthly interval with Ivermectin at 300 µg/kg can be given

SARCOPTIC MANGE IN HORSES

- Rare, notifiable in Britain
- Weeping surface covered with thick crusts
- Emaciation, Cachexia, Death in advanced cases

SARCOPTIC MANGE IN CATTLE

- Rare but can occur in housed cattle
- "**Neck & tail mange**, but can spread
- Other symptoms similar
- Loss of meat / milk production / downgrading of hide value (damaged)
- Loss of hair

- At times severely encrusted lesion with no pruritis also occurs

SARCOPTIC MANGE IN DOG

Predilection site

- **Ear, muzzle, face, elbows, inguinal / axillary region**

Symptoms

- 1st sign erythema, papule formation, rupture- encrustation of lymph, scale, formation, pruritis, alopecia
- Then skin is dry & thickened with intense pruritis, results in self inflicted trauma – secondary infection (pyoderma) /self mutilation occurs
- After primary infection, dogs get sensitized and scratch even before 1st signs are seen
- In neglected cases whole skin surface is involved, progressive weakness, emaciation and strong sour odour. They become cachectic & even die

Diagnosis

- Scratch reflex when ears are rubbed
- Mostly intense itching is seen
- Highly contagious, so all animals in contact are affected
- **Examination of deep skin scraping**

Treatment

- **Benzye benzoate emulsion**
- **Tetmosol (Tetraethylthiuram monosulphide) - 5%**
- 20% Tetmosol soap as prophylaxis
- Carbaryl shampoos
- **Ivermectin 200µg/kg .Bwt**

Control

- Supportive nutrition / Good hygiene in animal quarter / Disinfect animal houses & utensils

SARCOPTIC MANGE IN SHEEP

- **Rare, affects non woolly portion of the body**
- Starts near mouth and spreads slowly
- Intense itching, sheep don't graze, progressive emaciation

SARCOPTIC MANGE IN GOATS

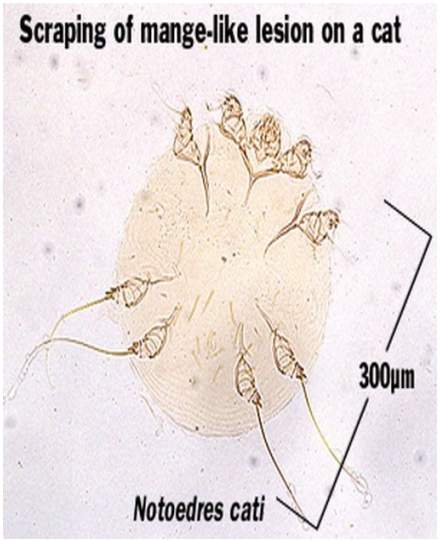
- The condition is more chronic with nodules developing on less well haired parts of the body (even ear)

SARCOPTIC MANGE IN RABBITS

- Condition is seen on head and ear, and then generalized.

SARCOPTIC MANGE IN HUMAN

- Man picks up infection from affected animals-Dairy Man's itch / from dogs / pigs.
- Palms, wrists, arms and chest are usually affected.
- Animal origin scabies is less severe since mite won't burrow and multiply.
- Redness, papule, prurites for few weeks and then it disappears.
- Repeated exposure causes hypersensitivity – transient rash appears within few hours of animal contact.



NOTOEDRES CATI (Cat)

- The genus is similar to Sarcoptes
- Body is **globose,** covered with scales or spines
- Has 2 vertical setae on dorsum of propodosoma
- Legs are short with unsegmented pedicels
- Sucker/bristle distribution similar to Sarcoptes
- Important difference from Sarcoptes is that
- **The anus is dorsally placed while in Sarcoptes**
- **it is terminal**

EFFECT ON THE HOST

- Burrowing mites causes mange like lestions
- Lesion consists of yellowish crusts inregion of ears, face or neck.
- The skin is markedly thickened and wrinkled
- Differential diagnosis from Sarcoptes is essential

HOST, LOCATION AND LIFECYCLE

- It is a minute mite
- Host: Cats occassionally rabbits
- Location: chiefly ears, back of neck, may extend to the face, foot, hind paws or even the whole body in young cats
- Burrowing mites

TREATMENT

- Malathion 0.25 -1.25 % suspensions immerse the cats for 1-2 seconds- since it is objectionable cats do not lick it.
- Tetmosol can be used as local topical medicine
- Ointment of 1-2% sulphur

Family : Dermanyssidae

***Dermanyssus gallinae* - RED MITE OF POULTRY**

- Common name: **Red mite of Poultry**
- Host: Pigeon, Cage birds, wild birds etc, also Man
- Night Feeder, hides in crevices during day

EFFECT ON THE HOST - RED MITE OF POULTRY

- The mite can multiply rapidly
- It causes severe irritation
- It sucks blood leading to anemia in birds
- It transmits ***Borrelia anserina***
- Man can be attacked
- Egg production in infested bird decreases
- It can also result in death of newly hatched chicks

- Infested chicken are unthrifty
- Increased susceptibility to diseases due to reduced vitality is also seen in affected birds

DIAGNOSIS - RED MITE OF POULTRY

- **Red coloured mite** when fed

TREATMENT - RED MITE OF POULTRY

- Apply Carbaryl 0.25% in cracks and crevices, repeat after 2-3 weeks
- Amitraz spray
- Litter treatment with 2% Chlordane, 2% Malathion and 0.5% Lindane

Family :Analgesidae

Megninia ginglymura- **FEATHER MITE OF POULTRY**

- Live chiefly between barbules of feathers /rarely enter quill in down feathers and contour feathers

Morphology

- Third pair of legs exceptionally well developed in male but not used for walking. In female, all legs are equal in size
- Undivided posterior margin
- All legs end in suckers
- Scavangers-feed on feather fragments and desquamated cells of skin

Effect on host

- Extremely heavy infestation causes irritation
- Birds go off feed
- Concentrate on preening
- So drastic reduction in egg yield in layers
- Wt loss in broilers

Control

- Dip in malathion

PSOROPTIDAE

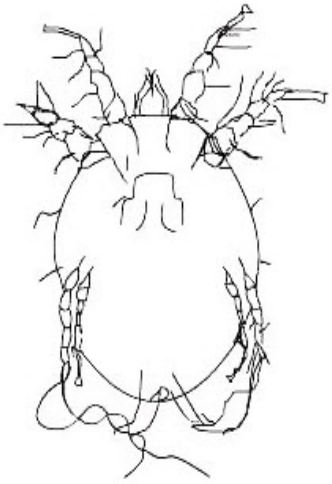
- Species are highly specific to their host unlike Sarcoptidae
- They cause a condition known as **SCAB in animals like** sheep, goat, cattle, buffalo, equines, cat, rabbit etc
- They **do not burrow into skin**
- They are parasitic on surface layer causing the formation of thick heavy scab rather than thickening of skin
- The following species are valid (Sweotman (1958) Can J Zool. 36: 905-929,
    - ***Psoroptes ovis*** *– Sheep*
    - ***Psoroptes equi*** *– Horse*
    - ***Psoroptes natalensis*** *– Indian water buffalo and cattle*
    - ***Psoroptes caniculi*** *– Rabbit, Cosmopotitan (also occur in ears of goat, sheep, horse, donkey, mule, gazelle*

PSOROPTES – MORPHOLOGY

- **Body oval, No dorsal spines**
- No vertical setae on dorsum of Propodosoma
- **Legs are longer and project beyond margin of body**

- **Bell shaped suckers (caruncles) on stalks** (pedicels) on the tarsi of fore or all thelegs
- The pedicels of tarsal suckers are long and composed of 3 segments in Psoroptes
- Aus is terminal
- Male has **adanal sucker (Copulatory discs)**
- Posterior margin of abdomen of male prolonged into lobes
- Prominent in Psoroptes and Chorioptes

Ventral view of female Psoroptes mite



PSOROPTIDAE

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    - ***Psoroptes ovis* –** Sheep
    - ***Psoroptes equi*** – Horse
    - ***Psoroptes natalensis*** – Indian water buffalo and cattle
    - ***Psoroptes cuniculi*** – Rabbit, Cosmopotitan (also occur in ears of goat, sheep, horse, donkey, mule, gazelle

MORPHOLOGY - *PSOROPTES OVIS*

- Cause of Sheep scab – an important disease
- Australia – eradicated
- Britain – 20 years back eradicated, it has now re-entered
- U.S.A – Still exists in certain states

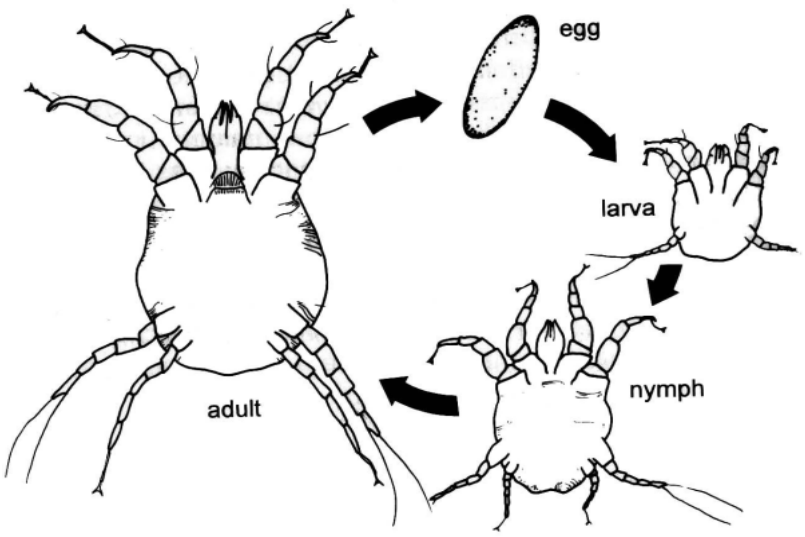
Morphology

- Male
    - A pair of copulatory suckers in ventral side
    - A pair of large terminal tubercles bearing several hairs
- Female
    - Possess suckers with jointed pedicels on **1st, 2nd and 4th pair of legs**
    - PUBESCENT female also provided with a pair of posterior copulatory tubercles which are absent in ovigerous females
    - Ovigerous female will have a genital aperture on the anterior aspect of ventral side

LIFE CYCLE - *Psoroptes ovis*

- Eggs laid on skin at the edge of lesion
- Hatch in 2-3 days
- Larvae feed for 2 – 3 days
- Moult to Nymphal stage – last 12 has is a state of lethargy
- Nyphal stage lasts 3-4 days – Before moult -lethargic period -36 hrs
- Smaller nymphs will become adult
- Pubescent female appear before males on the 5th day and the males on the 6th day-copulation takes place
- Pubescent females molt to become ovigerous
- Life cycle from egg to egg- 12 days
- Adult female live 30-40 days and each lay 90-100 eggs

LIFE CYCLE - *Psoroptes ovis*



PATHOGENESIS - *Psoroptes ovis*

- Puncture epidermis – suck lymph
- Serum excudes on to surface, coagulate and form crusts
- Wool gets loose, fall out or pulled by sheep by biting and scratching
- Bare, crusty patch unsuitable for mite to multiply
- They migrate to margin
- Wool get matted in serum that oozes out

TREATMENT - *Psoroptes ovis*

- Dipping is best
- Chlorinated hydrocarbons prohibited because of insecticide residues
- Organophosphorous compounds can be used
    - Malathion/Sumithion - 50 EC
        - 20 ml of 50 EC m/s is 1 lit.H_2O = 1.0 %
        - 20 ml of 50 EC m/s in 2 lit.H_2O = 0.5 %
    - Zolone
        - 35 EC – 5 ml is 345 ml H_2O = 5%
        - 20 EC – 5 ml is 195 ml H_2O = 5%
- Deltamethrin (Synthetic pyrethroid) – Butox- 4 ml is 1 lit H_2O = 1% solution, Residual effect- 15 days

psoroptes cuniculi (Rabbit)

- Ear canal of rabbit
- Head shaking
- Otacariases
- **Ear cankar**
- If not checked, heavy infestation to other parts of body
- Loss of balance occur
- Septic meningitis may ensue

Difference between *Sarcoptes* and *psoroptes*

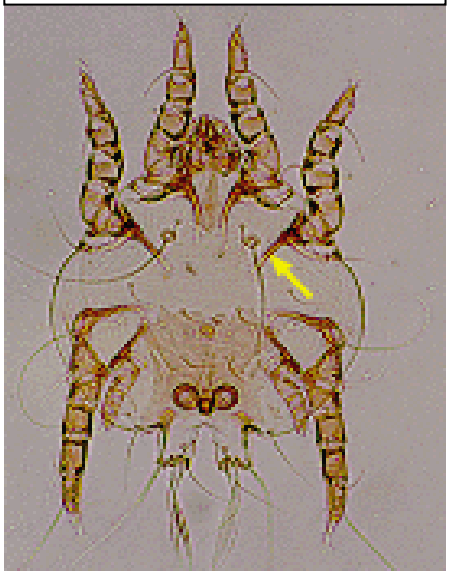
SARCOPTES SP	*PSOROPTES SP*
• Sarcoptes, causes **scabies of man** and sarcoptic mange of sheep, goats, cattle, pigs, equines, dogs, foxes, rabbit and other animals • Notoedres, causes notoedretic mange of cats, rabbits and rats • Cnemidocoptes affects fowls	• Psoroptes causes **psoroptic mange of sheep, goats, cattle, equines and horses** • Chorioptes causes chorioptic mange of equines and cattle
Morphological features	
• **Body globose (round)**	• **Body oval**
• Integument covered with scales and spines (presence of 6 dorsal conical spines)	• No dorsal spines
• **Legs are short**	• **Legs are longer and project beyond the margin of the body**
• Bell shaped suckers (caruncles) on stalks (pedicels) on the tarsi of some or all legs	• same
• Pedicels of the tarsal suckers not segmented	• Pedicels long and composed of three segments in Psoroptes, short and not segmented in Otodectes and Chorioptes
• **Legs 3 and 4 of the females alone end in bristles instead of suckers**	• **Legs 3 and 4 of females only bear terminal bristles and not suckers, while legs 4 of both Psoroptes and Chorioptes bears suckers.**

• Anus terminal	• Anus terminal
• No adanal suckers (copulatory discs) in males	• Males with adanal suckers on the posterior end of abdomen
• Posterior margin of the abdomen of male is not bi lobed	• Posterior margin of the abdomen of the male is produced into two lobes which are prominent in Psoroptes and Chorioptes but not so in Otodectes

CHORIOPTES SP.

- Named after their hosts
- ***C.equi*** – Fetlock of horse
- ***C. caprae*** – *Goats*
- ***C.cuniculi*** – *Ears of rabbit*
- ***C.bovis, C. equi, C. ovis-*** *All belong to the species of C. bovis*
- *In horse -foot mange, itchy leg on pastern*
- ***Otodectes cynotis*** **-** *Ear of dog, cat, fox*

CHORIOPTES BOVIS



THROMBIDIFORMES - DEMODICIDAE

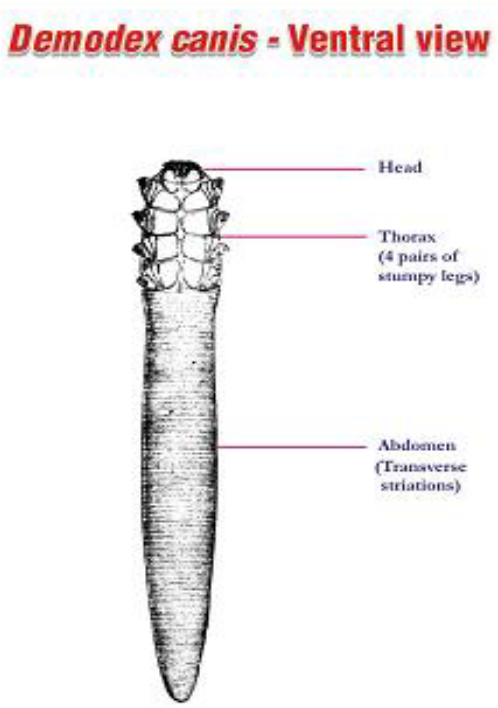
Sub Order : *Thrombidiformes*

- They have one pair of stigmata located on the gnathosome at the base of chelicerae
- Some have no stigmata or trachea eg. Demodicidae breathe through body surface
- Well developed pedipalps
- Chelicerae adapted for piercing

Super Family : Demodicoidea

Family : Demodicidae

Host : Dogs, Cattle, Goat, Sheep, Swine, Wild animals, Rabbits, Hamsters, Rats,Mice etc., Uncommon in cats and horses.



- Highly specialized skin parasites
- **Live in hair follicles and associated glands**
- **Very host specific**
- Seen in hair follicle/ dermal glands-sebaceous glands modified sebaceous glands, e.g. meibomian, caudal, preputial and vulval glands
- Also seen in modified sweat glands, submaxillary skin papillae and mixed sebaceous and sweat glands eg: perianal glands

Morphology

- 0.25 mm
- Female longer, elongate
- Cylindrical
- Body divided into head, thorax, and abdomen

Head

- Has three jointed pedipalp
- One pair chelicerae
- Single hypostome

Thorax

- Ventral side with four pairs of stumpy legs
- Each leg is three jointed, vulva in female on ventral side
- On the dorsal side in males there is a longitudinal slit which is the genital opening

Abdomen

Transversely striated

RED MANGE OF DOGS

Demodex canis* - *"Red Mange" *in dogs*

- In other animals, disease caused is termed ***"Follicular mange"* or *"Demodectic mange"***

Etiology

- ***D. caprae, D.ovis, D. phylloides*** (pigs), ***D. bovis D.folliculorum*** (man)

LIFE CYCLE - *D.CANIS*

- Completed in 3-4 weeks in dogs. 3 nymphal stages

EFFECT ON THE HOST - *D. CANIS*

- Injury to host occurs when mites puncture with their stylet like chelicerae the epithelial cells lining the hair follicles and glands to feed on the cell contents
- The host response in most cases leads to thrombosis of internal infestations
- Pustules initially seen on **abdomen, neck, legs, also feet, face and thigh** regions
- Dogs have repulsive mousy odour / rancid odour
- Itching is less
- In dogs both forms are seen
- **Clinical signs evident in dogs less than 1 year old**- presumably immuno deficient
- 1st appear as mildly erythematous patch above eyes and corners of mouth, associated typically with hair loss- then spreads to forelegs, trunk
- Most resolve without treatment

- Death occurs in severely infected animals
- In generally predisposed or immuno depressed animals and in case of secondary infection, it develops into chronically severe, moist, purulent dermatitis - *"**Pustular Demodicosis**"* - unpleasant odour - rancid/mousy
- If generalized, there is intense redness, tenderness of skin which easily bleeds- Death occurs in heavily infested animals
- Mild and moderate hypertrophy of the affected epithelia
- In some cases marked hypertrophy and cell destruction occurs
- Opening of hair follicle and ducts of glands are blocked
- Dermal papule formation and nodules
- Hair loss-secondary bacterial infection-inflammation, pruritus and pustule formation (*Staphylococcus*)
- Lesions occur on face and head and then spread-if untreated, death due to emaciation and toxaemia occurs

CLINICAL SIGNS - *D.CANIS*

Two major clinical forms

Scaly or Squamous demodicosis	Papulonodular demodicosis
• "**Red mange**" of dogs • Most common • Dry, scaly dermatitis • Itching, thickening and wrinkling of skin • Loss of hair, reddening of skin • Sec infection-rupture of follicular cells, inflammation, purulent exudates • Localized or Generalized • **Repulsive mousy odour** • Red skin-bluish green- coppery reddish colour • Skin is tender, easily bleeds	• Obstruction of hair follicles, gland ducts • Leads to palpable cyst like/nodular swellings in the skin - traps mites within. Common form in Cattle, Goats & Pigs • Lesions enlarge as the mites multiply along with cellular debris and glandular secretions • Eventually rupture -leads to secondary infections and abscesses • Can rupture internally- introduce mites into lymphatics

Demodex cati (cat) - **CAT FOLLICULAR MITE**

- Squamous form
- Associated with underlying immuno suppressive diseases

Demodex bovis **(Cattle)- CATTLE FOLLICULAR MITE**

Condition: **Papulonodular form**

- Population of 100s to 1000s mite/follicle results in dilated follicle-leads to dermal papules or cysts
- As they enlarge they can be felt beneath skin
- Lesion concentrate in anterior part of cows, notably neck, shoulders , axillary region, udder
- Papular cysts enlarge to form granulomatous nodules-when follicular opening gets blocked by mites, keratin and other debris
- Usually seen in cows stressed by pregnancy/ lactation
- Dilated nodules vary in size from a pin head to a chicken egg
- Larger modules rupture to produce suppurative sores
- The pus like exudate (consistency of tooth paste) when examined will reveal the presence of large numbers of *D. bovis*

Economic Loss

- Skin damage-defects in leather
- Tanning industry loss- due to diminished quality of processed cow hide

Demodex caprae- **GOAT FOLLICULAR MITE**

- Dermal papules and nodes
- Common in young animals, pregnant and dairy goats
- Papules on face, neck, axillary region, udder
- These later enlarge to become nodules-suppurate
- mites are transferred via exudates
- Nodule rupturing internally results in granulomas wherein phagocytic cells try to destroy mites

Anti-Tick immune-prophylaxis

` Ticks are important ectoparasites of domestic and wild animals, and tick infestations economically impact cattle production worldwide. Control of cattle tick infestations has been primarily by application of acaricides which has resulted in selection of resistant ticks and environmental pollution.

BM86-based vaccines

Tick vaccines became commercially available in the early 1990's for the control of cattle tick infestations (Willadsen et al., 1995). **TickGARD (in Australia) and Gavac (CUBA)** are both derived from *Rhipicephalus (earlier Boophilus) microplus* midgut membrane-bound recombinant protein **BM86**. Vaccine trials with BM86 resulted in a reduction in the incidence of **babesiosis**, as well as reduced **tick infestations** in vaccinated cattle herds However, because *A. marginale* is also mechanically transmitted by these ticks, BM86 antigen vaccination controlled the transmission of *A. marginale* only in regions where ticks are the main vectors (de la Fuente et al., 1998).

A BM86 ortholog of ***Hyalomma anatolicum anatolicum***, **HAA86**, was cloned and expressed by Azhahianambi et al. (2009) and Jeyabal et al. (2010) reported that vaccination of cattle with the recombinant HAA86 antigen did not only protect against homologous tick challenge but also reduced tick transmission of *Theileria annulata*, thus protecting the animals against lethal exposure.

The ***R. microplus*** **BM95** glycoprotein is a BM86 homologue that protects cattle against infestations by South American cattle tick strains not protected by BM86 vaccination (Canales et al., 2009b). Studies with BM95 have shown it protects against a broader range of tick strain infestations suggesting BM95 could be a more universal antigen against infestations by *R. microplus* strains from different geographical areas (García-García et al., 2000; de la Fuente and Kocan, 2003).

64TRP is a 15 kDa protein that resembles mammalian host skin proteins, identified in expression libraries as a putative tick cement protein involved in the attachment and feeding of ***R. appendiculatus*** (Trimnell et al., 2002).

Damages to hide and skins due to ecto-parasitic infestations

Ectoparasites generally affect the health of animals and the quality of hides and skin. The leather industries have suffered great loses over the years because of infestation of animal skin.

Loss of Hides

Valuable hides are often damaged by ectoparasites. The irritation and trauma to the skin reduce the hide quality. Some ectoparasite larvae, notably **warbles (*Hypoderma*)**, migrate through the body and eventually penetrate the skin, leaving large holes. This invasion of the body by larvae is called **myiasis**. The resultant damage to hides may render them worthless.

Skin Lesions

Arthropods damage their hosts in a variety of ways. Their feeding on the host´s skin may cause intense itching, especially characteristic of lice and mites. Damage by mites results in the skin disease called **mange,** characterised by raw, thickened skin that has lost its hair. Much of the damage is actually inflicted as a result of the cattle responding to the very **intense itching caused by mites**. Rubbing, licking, and scratching irritate the skin, which becomes raw. Fluid oozes onto the surface, coagulates, and dries to form a crust. This damaged area expands as mites travel to the edges of the lesion seeking fresh skin upon which to lay their eggs. The entire lesion is susceptible to **secondary bacterial infections** which cause even more damage to the skin. **Infestations of lice are less harmful** than are those of mites but are serious in some geographic locations.

The ticks feed by attaching to the skin of animals to **suck their blood via needle like mouthparts (hypostome)**. Most of pathogenic ticks, affecting skin and hides of domestic ruminants belong to the family Ixodidae (hard ticks). Tick bites directly damage to the skin at the site of attachment. Adverse reactions to ticks depend in part on content of salivary secretions. The severity of local cutaneous reactions varies not only with salivary, when a tick feed, a wound is created in the skin. This is usually a sterile abscess and will heal to form a small scar. The inflammatory and hypersensitive reactions at feeding site are **irritating and painful**. Ticks in large numbers on the back and flanks of cattle make many small scars in the skin, so that when the skin is processed for leather, blemishes appear that **reduce the value of the leather**.

Glossary

Acephalus larvae: Larva with reduced head or no head eg. Larvae of dipteran flies

Apodous larvae: Acephalus larvae with no thoracic and abdominal legs

Butchers jelly: Gelatinous tracks in muscle of beef due to migration of larva of Ox warble fly through subcutaneous tissue

Caudal aster: Spine like process on the last abdominal segment of pupa of horse fly

Coarctate Pupa: Pupa in which developing adult cannot be seen externally.

Combs: Spines located on the 8^{th} abdominal segment of certain species of mosquitoes

Crutching: Regular clipping of wool around tail, breech to prevent soiling of wool

Dagging: Removal of fecal soiled wool

Dichoptic eyes: Compound eyes which are placed wide apart eg. Female mosquitoes.

Ecdysis or moulting: Shedding of exoskeleton

Ecdysis/moulting: Casting off of exoskeleton

Empodium: Many insects possess a lobe or spine between the two claws at the end of the tarsus (the final segment in the leg of the insect). This lobe or spine is called an empodium.

Eucephalus larvae: Larvae with distinct head and mouth part eg. Larvae of mosquito

Exarate Pupa: Pupa in which the wings and legs of developing adult are seen externally and free from the rest of the body eg. Beetles.

False gid or sturdy: A condition seen in Sheep infected by the larva of Sheep nasal fly characterized by injury and even erosion of skull leading to neurological symptoms in sheep.

Flagellum: Remaining segments of the antenna other than 1^{st} and 2^{nd} in arthropod.

Graber's organ: Organ having respiratory and sensory function located on the penultimate segment of the larva of horse fly.

Haemocoel: Space filled with blood called haemolymph

Holoptic eyes: Compound eyes which meet at the mid line eg. Male mosquitoes

Hypopial nymph or Hypopi: Are nymphs produced by Sarcoptes to resist adverse conditions.

Imago: Adult insect inside the pupa

Licked beef: The beef affected by the migration of larva of Ox warble fly through the subcutaneous tissue characterized by production of greenish yellow tracts with eosinophilic infiltrations.

Metamorphosis: Change in form of the arthropod associated with ecdysis or moulting.

Miliary dermatitis: A condition seen in cats by flea bite, characterized by small papules and pruritis.

Mules operation: Surgical removal of breech folds.

Obtectate Pupa: Pupa in which the wings and legs of developing adult are seen externally and bound to the body by moulting fluid.

Oligopod larvae: Eucephalus larvae having only thoracic legs.

Ornithophilic: Opportunistic feeder either human or animals

Ostia: Openings on the wall of heart of arthropods

Pecten: Row of spines on the ventral aspect of the siphon tube in mosquito

Pedicel: Second antennal segment in arthropods

Pizzle strike: Strike by myiasis fly in the penile sheath of ram and withers.

Pleuron: Lateral plate between Tergum and Sternum

Podomeres: Jointed legs of arthropods

Poll stike: Strike by myiasis fly on rams head or near horns.

Polypod larvae: Eucephalus larvae having both thoracic and abdominal legs

Proctodaeum: Posterior part of alimentary canal in arthropods

Queens land itch, sweet itch, sweat itch or summer dermatitis: Allergic dermatitis caused by Culicoides.

Respiratory fossa: Stigmal opening located at the junction of 8^{th} and 9^{th} abdominal segments of anopheline mosquito

Scape: First antennal segment in arthropods

Scleritis: Chitinous plates in exoskeleton of arthropods

Sheep cockle or rib cockle: Allergic condition seen in sheep skin characterized by brown nodules and vertical ridges on skin heavily infested by sheep ked.

Siphon tube: Tube covering the respiratory fossa in Culicine mosquito

Snotty nose: A condition characterized by nasal discharge and irritation in the sheep caused by the larva of Sheep nasal fly.

Solenophage: Pipe feeding in mosquito

Sternum: Ventral sclerite in arthropods

Stomodaeum: Anterior part of alimentary tract in arthropods

Tagmata: The tendency to form tagma/regions in arthropods

Tergum: Dorsal sclerite in arthropods

Wrigglers: Larva of mosquito