

PARASITOLOGY

BENCH AIDS

PARASITOLOGY BENCH AIDS

Topic	Page
1. Intestinal Nematodes	03
2. Cestodes	08
3. Arthropodes	16
4. Malaria	45
5. Haemoflagellates	57
6. Mosquitoes	62
7. Protozoa	82
8. Snakes	89
9. Tissue nematodes	101
10. Trematodes	106
11. Toxoplasma & Trichomonas	114

Intestinal Nematodes

***Ascaris lumbricoides* (Round worm) - Adults**

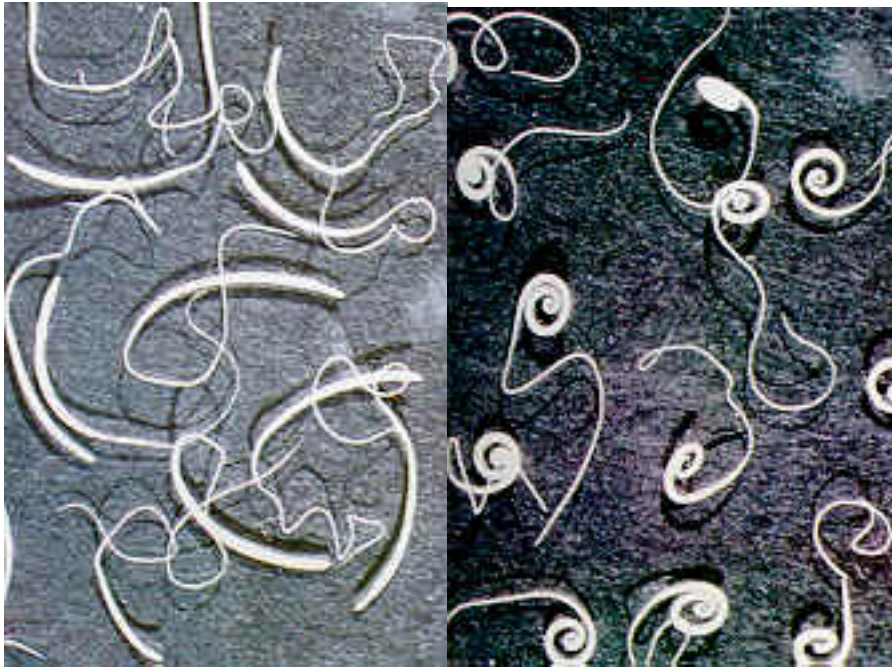


Note:

- Large, cream coloured worm.
- Male: 15-30 cm.
- Female: 20-40 cm.
- Conical anterior and posterior ends.
Male: Posterior end is ventrally curved and has two(2) retractable spicules.(May or may not be seen)
Female: Tapering posterior end.

xx

***Trichuris trichiura* (Whip worm) - Adults**



Females

Males

Note:

- Greyish white in colour.
- 3-5 cm in length.
- Thinner anterior 3/5th.
- Thicker posterior 2/5th.
- Tail end of the male is curved.
- Single spicule in a sheath.

***Ascaris lumbricoides* (Round worm)**

Unfertilised / Fertilised egg.

Unfertilised egg**Note :**

- **Size :** 40-90 mm
- **Shape :** Irregular in shape, longer and narrower than fertilised eggs.
- **Shell :** outer - brown with irregular mammillations
Inner - Thin transparent shell.
- **Content :** Large roundish refractile granules.

Fertilised egg



Necator americanus (Hook worm) - Ova

Note :

- **Size :** About 35-65 μ m.
- **Shape :** Oval with flattened poles (Barrel shaped).
- **Shell :** Thin hyaline shell appears as a black line.
Has a clear space between shell and the blastomere.
- **Content :** In fresh stools - 4 to 16 grey granular cells , in few hours old stools - a uniform mass of small grey granular cells.
In 12 to 48 hours old stools - The whole egg is filled by a small larva (Egg is embryonated).



Trichuris trichiura (Whip worm) - Egg



Note :

- **Size :** about 22-50 mm.
- **Shape :** Oval in shape - Like a paddy seed .
Two mucus plugs in each ends.
- **Shell :** Fairly thick , smooth , has two layers
- **Colour :** Brownish in colour.
- **Content :** Unsegmented embryo - single cell appears as a uniform granular mass.

Enterobius vermicularis (Pin worm) - Egg

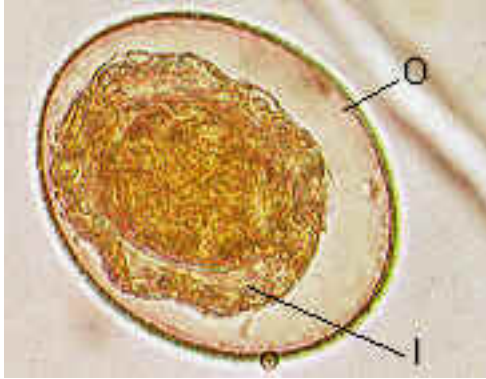


Note :

- **Size :** Length about 25-50 mm.
- **Shape :** Planoconvex in shape (D shape).
- **Shell :** Thin , transparent , colourless , double walled.
- **Content :** Fully developed larva or a small granular mass seen inside.

Cestodes

Hymenolepis diminuta - Egg



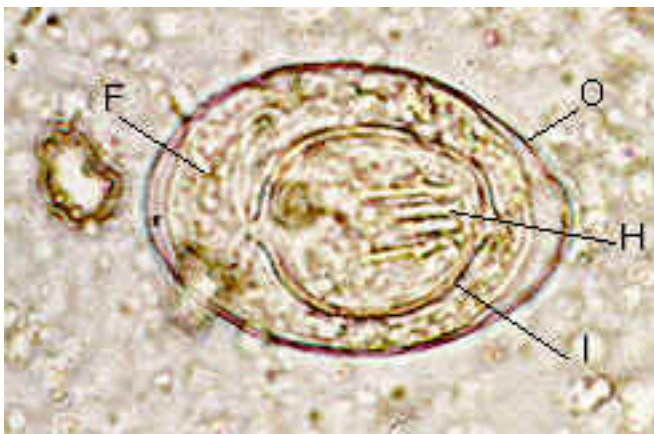
O - Outer shell

I- Inner shell

Note:

- **Size** : 70 - 80um (**much larger than the *H. nana***)
- **Shape** : Round.
- **Colour** : Transparent or pale yellow.
- **Shell** : Has two components.
Thick brown outer shell.
Thin embryophore (inner shell).
- **Content** : A rounded embryo containing 6 hooklets arranged in fan shape (Hexacanth embryo).
Bigger than the eggs of *H.nana*. No polar thickening or polar filaments.

Hymenolepis nana - Egg



Note:

- **Size** : 40 -45um. (**Smaller than *H. diminuta* egg.**)
- **Shape** : Oval, almost round.
- **Colour** : Very pale grey.
- **Shell** : External membrane thin and transparent.
Internal membrane has two polar thickening with filaments coming out of them.
- **Content** : Rounded mass (embryo) with 6 refractile hooklets arranged in fan shape

and some well defined granules in the centre.

O - Outer shell

I - Inner shell

H - Hooklets

F - Filaments

Echinococcus granulosus - Adult worm



Note :

- Very small worm (less than 1 cm in length).
- Has only three (3) to Five (5) proglottides.
- Scolex consists of Four (4) suckers and Two (2) rows of hooklets.

E - Eggs

G -Gravid segments

H - Hooklets

S - Suckers

Hymenolepis nana - Scolex and proglottids



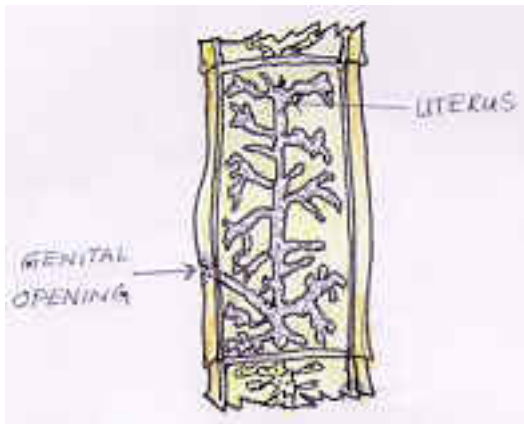
Note :

- One row of hooklets - rostellum.
- **Four (4) suckers.**
- **Segment wider than its length .**

H - Hooklets

S - Suckers

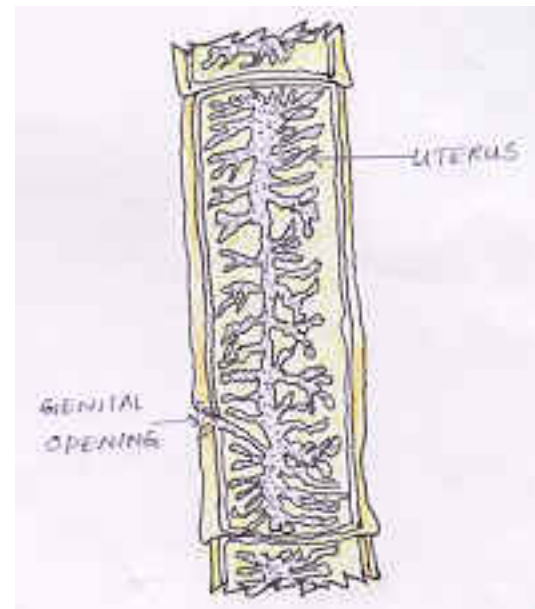
Taenia spp. - gravid proglottids



T.solium :

- Length : breadth ratio 2 : 1.
- Lateral branches 7 - 13.

Injected with India ink to show lateral branches of uterus .



T.saginata :

- Length : breadth ratio 4 : 1.
- Lateral branches 15 - 32.

Taenia saginata - Scolex



Note :

- Pyriform in shape.
- Size 1-2 mm in diameter.
- **Four (4) prominent hemispherical suckers present.**
- **No hooks or a well developed rostellum.**

S - Suckers

Taenia solium - Scolex



S - Suckers

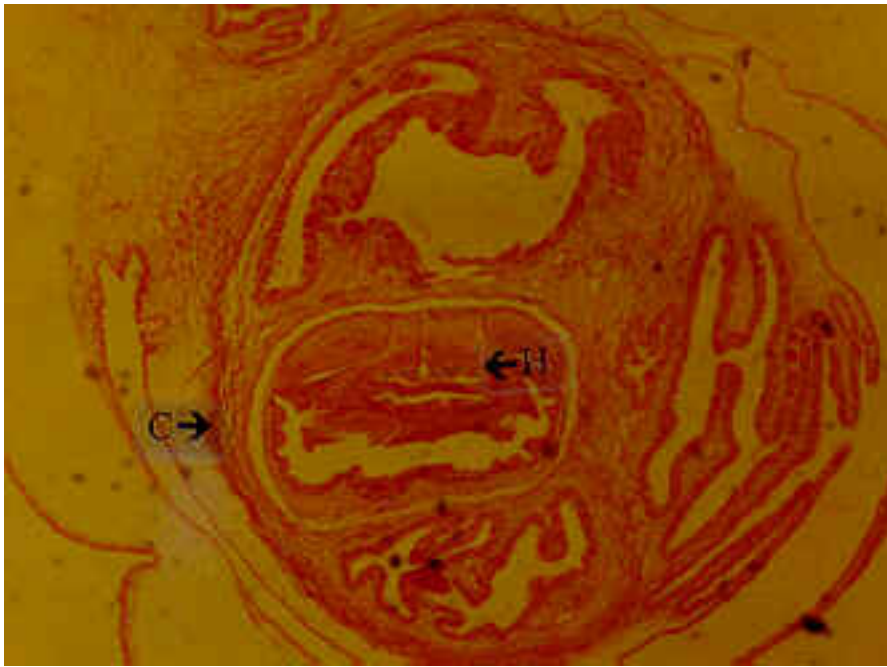
H - Hooks

R - Rostellum

Note :

- Globular in shape.
- Size 1mm in diameter.
- **Four (4) cup shaped suckers & rostellum with two rows of hooks present.**

Cysticercus cellulosae - Tissue section



C - Tissue capsule

H - Hooks

Note:

- Oval in shape.
- Translucent cyst.
- Invaginated scolex with four (4) suckers and a circle of hooks. (Suckers are not visible on the photograph.)
- Enclosed in host tissue capsule.

***Echinococcus granulosus* - Hydatid cyst-Tissue section**



Note:

- Cyst wall consists of three (3) layers.
- (a) Brood capsules bud off from innermost **germinal layer**.
- (b) **Laminated layer** consists of several layers of parasite origin.
- (c) Outermost part is a **fibrous tissue layer** of host origin.
- Cyst cavity is filled with highly allergenic “hydatid fluid”.

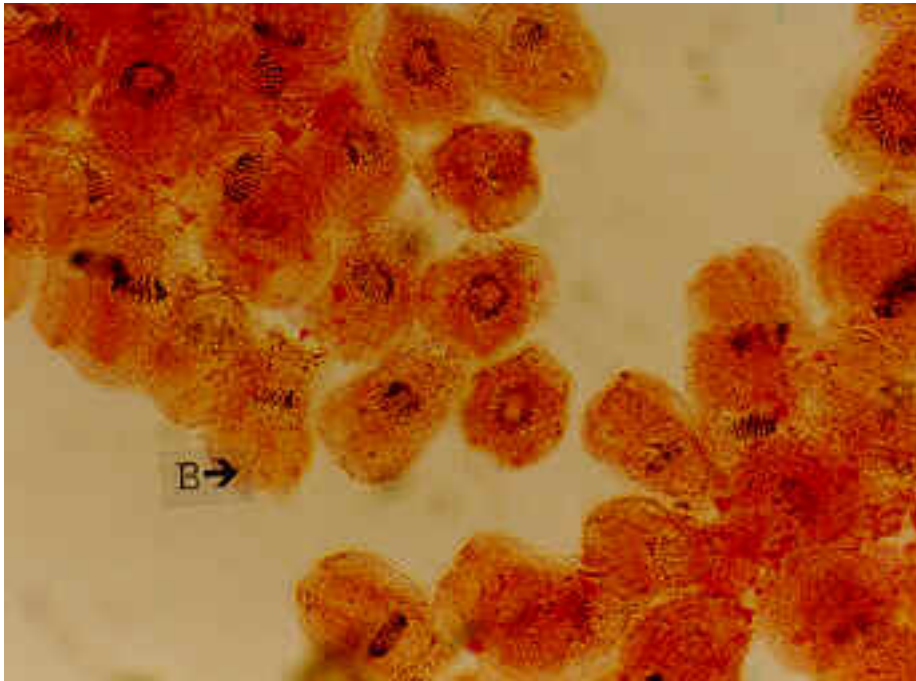
G- Germinal layer

L-Laminated layer

F-Fibrous layer

B-Brood capsule.

Echinococcus granulosus - Hydatid sand



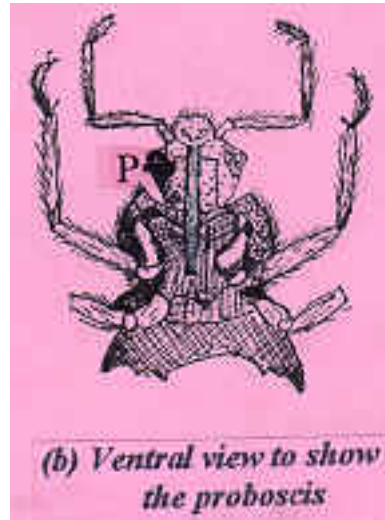
Note:

- Brood capsules liberated from the germinal layer epithelium are called “**Hydatid sand**”.
- Hydatid sand floating freely in the fluid filled cavity of hydatid cyst.

B - Brood capsule

Arthropodes

***Cimex lectularis* - Bed bug**



Note :

- **Head :** Short and broad with prominent eyes.
Four (4) segmented, laterally placed antennae.
Proboscis held closely appressed along the ventral surface of the head.
- **Body :** 4-5 mm long, oval wingless insect.
Flattened dorsoventrally.
- **Wings :** Two (2) rudimentary non functional wings termed "**Hemelytra**".
- **Legs :** Three (3) pairs of slender, well developed legs.

A - Antennae

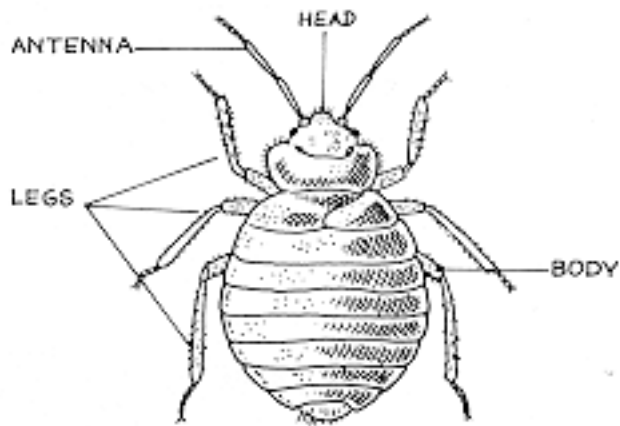
H - Hemelytra

P - Proboscis

***Cimex lectularis* (BEDBUG)**

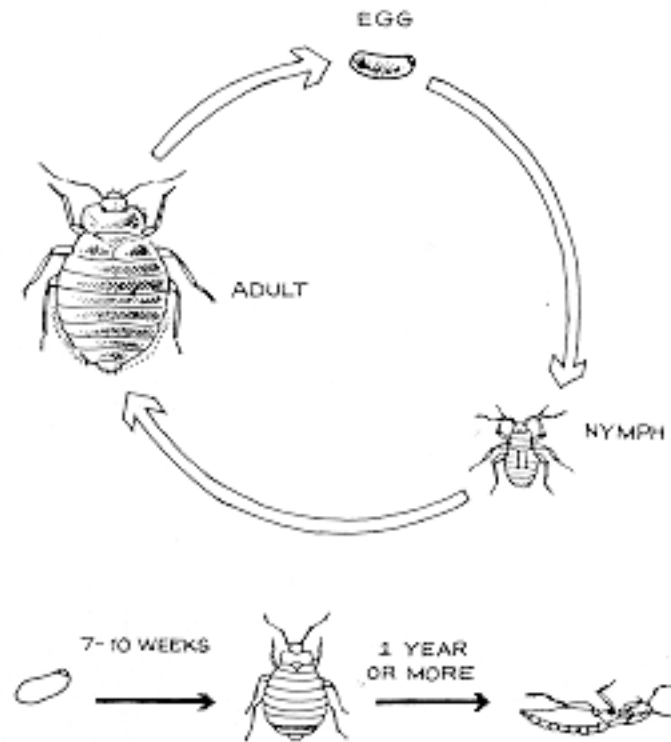
APPEARANCE

- 6-7 mm long.
- Reddish brown colour.
- Flat, oval, hairy body.
- 2 antennae.
- 3 pairs of legs.
- Head attached to thorax with no neck.



LIFE CYCLE

- Life cycle has 3 stages - egg, nymph and adult; can be completed in 7-10 weeks under favourable conditions.
- Eggs are pearly white and oval, 1 mm in length.
- Nymph moults 5 times; a blood meal is required before each moult.
- Adult lives for several months to 1 year or more; female may lay 75-500 eggs at the rate of 2-3 eggs a day.
- Bedbug can remain in the egg or nymph stage for an indefinite period if food is not available.



HABITAT & BEHAVIOUR

- Lives in cracks and crevices in walls and floors, furniture, bedsteads, mattresses, picture frames, wallpaper, books and papers, boxes, etc.
- Avoids light and is active during night.
- Spoils woodwork, pictures and furniture by depositing eggs and excreta.

PUBLIC HEALTH IMPORTANCE

- Bites and sucks blood.
- Biting causes itching, swelling and inflammation.
- Emits foul smell.
- Interferes with sleep.

THINGS NEEDED FOR CONTROL

- Hangers or nails for clothing.
- Clothes-line to put bedding outside for spraying or beating.
- Paint for walls.
- Plaster to fill in cracks and cervices.
- Candles.

- Heating stove.
- Adhesive tape for sealing skirting, picture rails, windows, etc.

PREVENT ACCESS

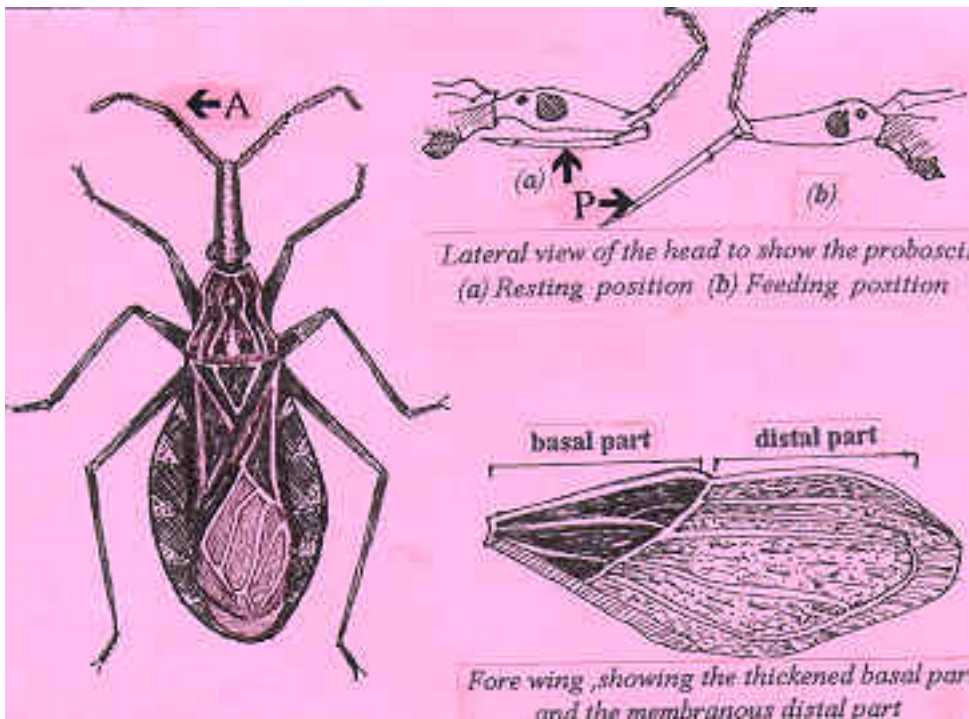
- Prevent passive entry into the house on clothes, suitcases, cardboard boxes, furniture, etc.
- Do not share clothing or bedding with other people.

REDUCE INFESTATION

- Take furniture and bedding away from the house and beat to dislodge bugs.
- Pour boiling water over bed frames.
- Pass lighted candle under bedsprings.

Adult Reduviid/Triatomine/Cone-Nosed bug

Note:



- **Head :** Long snout like head. Prominent dark coloured eyes. Pair of laterally placed long thin antennae.
- **Body :** 2-3 cm long, narrow, flattened body. Dark brown with red and yellow markings on thorax, wings and sides of abdomen.
- **Wings :** Two (2) pairs of wings; fore wings and hind wings.
Fore wings - Basal part thickened and relatively hard. Distal part is membranous.
Hind wings - Entirely membranous.
- **Legs :** Three (3) pairs of thin elongated legs.

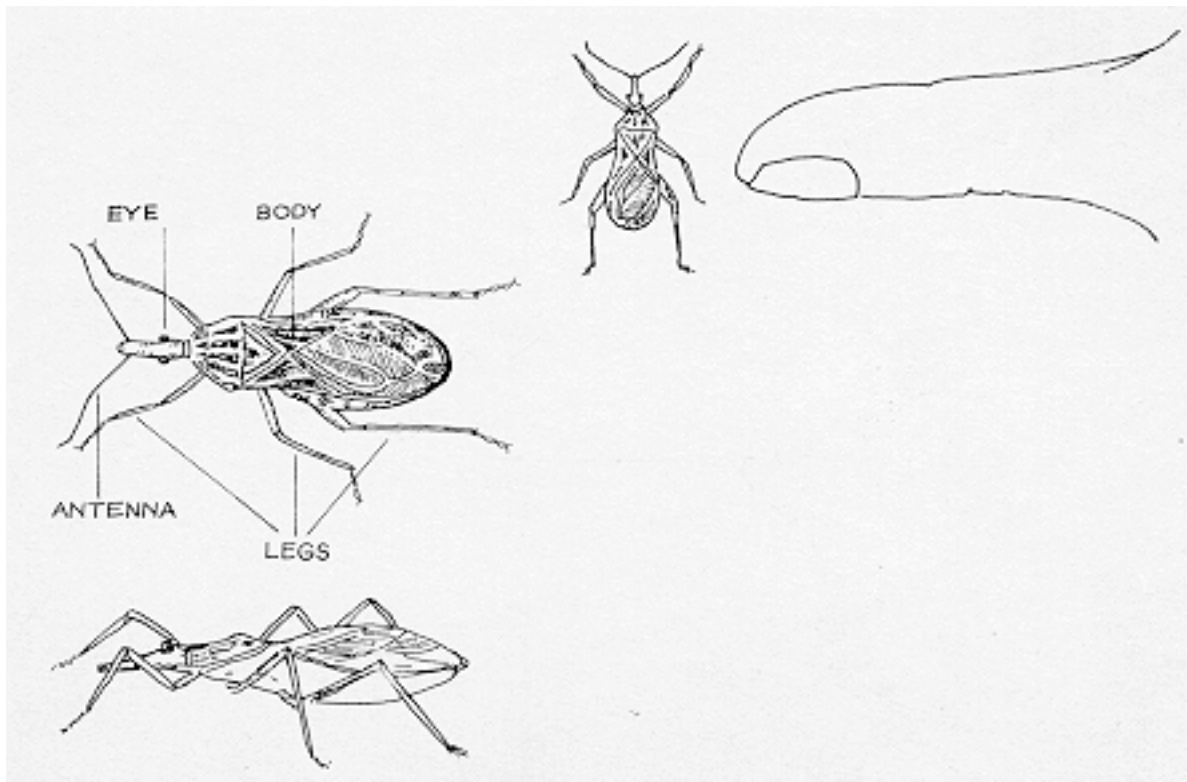
A - Antennae

P - Proboscis

Rhodnius prolixus (ASSASSIN BUG)

APPEARANCE

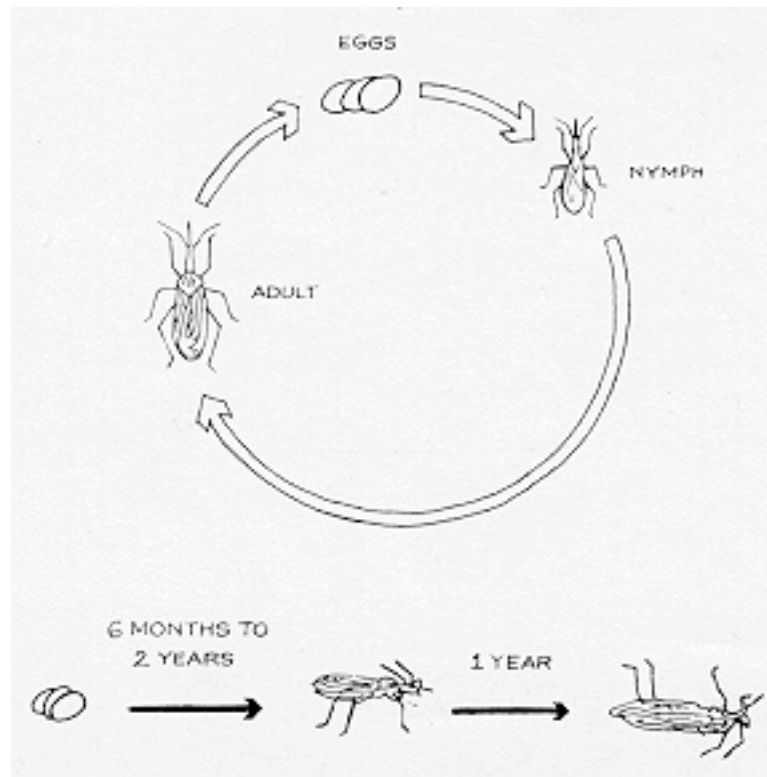
- 2-3 cm long.
- Body brightly coloured with black & brown stripes.
- Antennae inserted on sides of long, roughly conical head near apex.
- Large eyes placed laterally.
- Proboscis kept folded under the head like a knife blade.
- Wings held folded on back.
- Legs well developed.



LIFE CYCLE

- Life cycle has three stages-egg, nymph and adult; can be completed in 6 months to 2 years.
- Eggs are oval and white in colour and turn pink before hatching.
- Nymph moults 5 times; each moult requires a blood meal.
- Adults mate 7-10 days after a blood meal; female lays about 300 eggs in a life time.

- Adult can live for 3-4 months without food.



HABITAT & BEHAVIOUR

- Found predominantly in mud walled houses with thatched roofs.
- Lives in cracks and fissures in the walls and roofs, behind pictures on walls, under mattresses or objects accumulated under beds, in debris and on animals' coats.
- Emerges at dusk to feed on sleeping victims; also feeds on excreta of other bugs.
- Avoids light and is an active runner

PUBLIC HEALTH IMPORTANCE

- Bites and sucks blood from the exposed parts of the body, usually the face.
- Defaecates while sucking blood, and may transmit Chagas disease by contamination of the bite wound with the faeces.
- Bites cause swelling and severe pain.

THINGS NEEDED

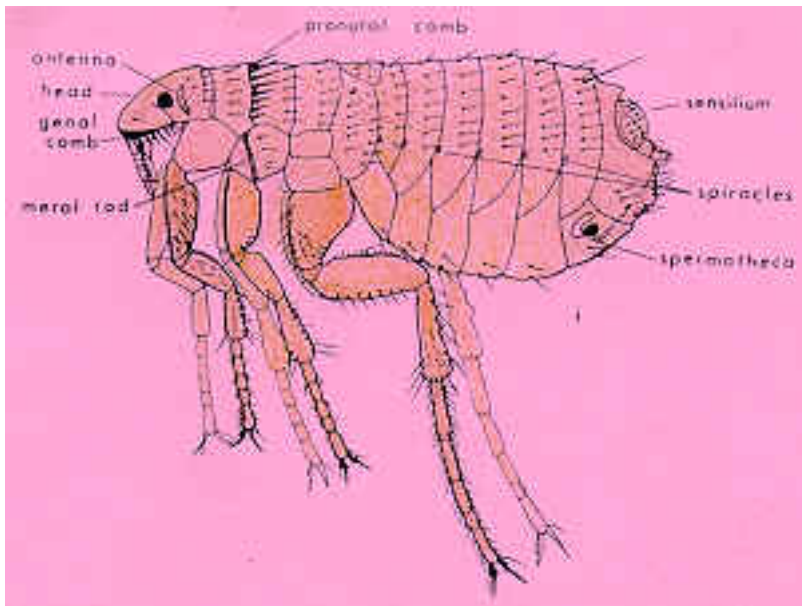
- Screening for doors and windows.
- Insect repellent.
- Hand spray-gun for repellent
- Hangers for clothing.
- Plaster to fill cracks and fissures.

PREVENT ACCESS

- Use mosquito net.
- Keep beds away from walls and posts.
- Segregate eating and sleeping areas.
- Keep pets and other animals out of the house.

Fleas - General features

Note:



- Body is laterally compressed.
- Light to dark brown in colour.
- Wingless insects.
- Three (3) pairs of powerful and well developed legs.
- Hind pair of legs are specialized for jumping.
- Legs and body are covered with bristles and small spines.
- **Female flea** - Abdomen is rounded in shape.
 - Distinct brownish spermatheca on position 6-8th abdominal segments.
- **Male flea** - Abdomen upturned appearance.

Ctenocephalides spp.



G - Genal comb

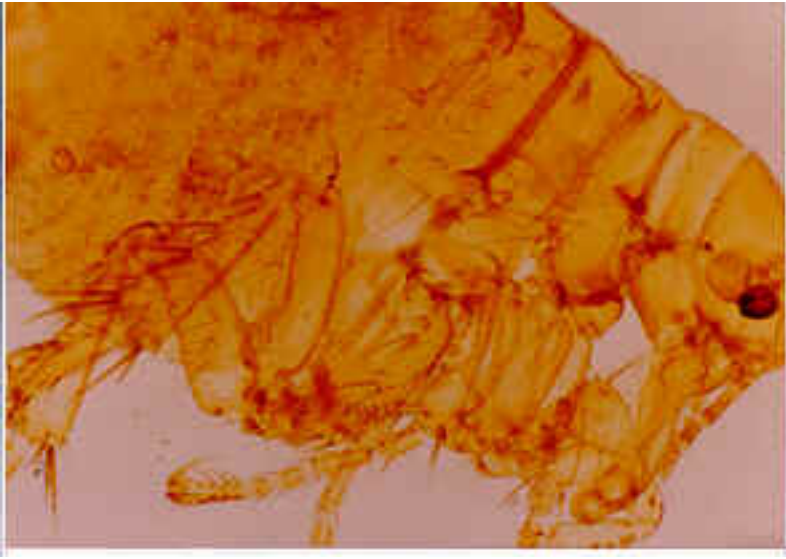
M - Meral rod

P - Pronotal comb.

Note :

- Presence of both genal and pronotal combs.
- Presence of a meral rod.

Pulex irritans - (Human flea)



Note :

- Combless fleas.
- No meral rod.

***Xenopsylla cheopis* - (Rat flea - Female)**



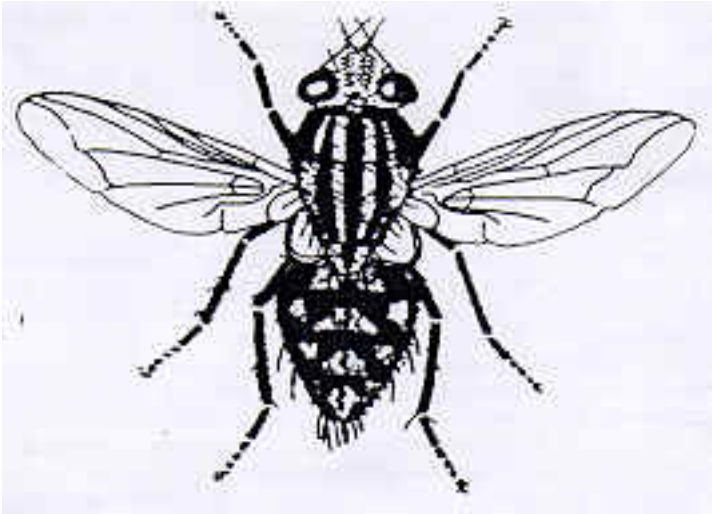
Note :

- Absence of both genal and pronotal combs.
- Presence of a meral rod.
- 'C' shaped spermatheca. (**In female *Xenopsylla*)**
- Rounded posterior end. (**In female *Xenopsylla*)**

M - Meral rod

S - Spermatheca

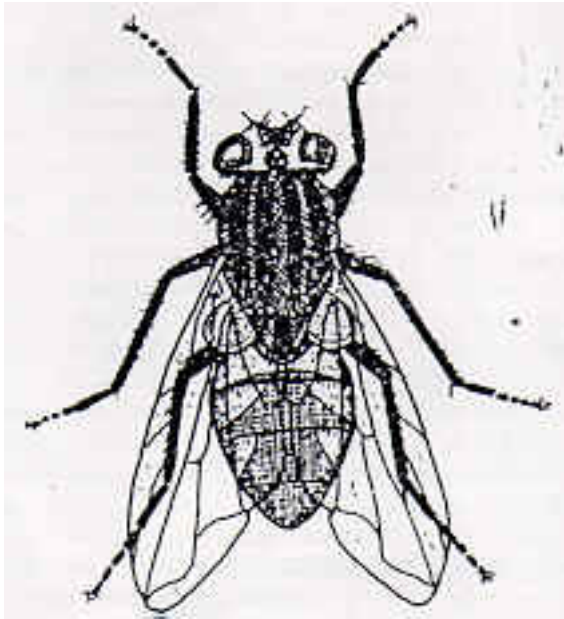
Sarcophaga spp. - (Common flesh fly)



Morphology :

- 10-14 mm in length.
- Grey in colour.
- Eyes brick red.
- Abdomen chequered.

Musca domestica (Common house fly) - Adult



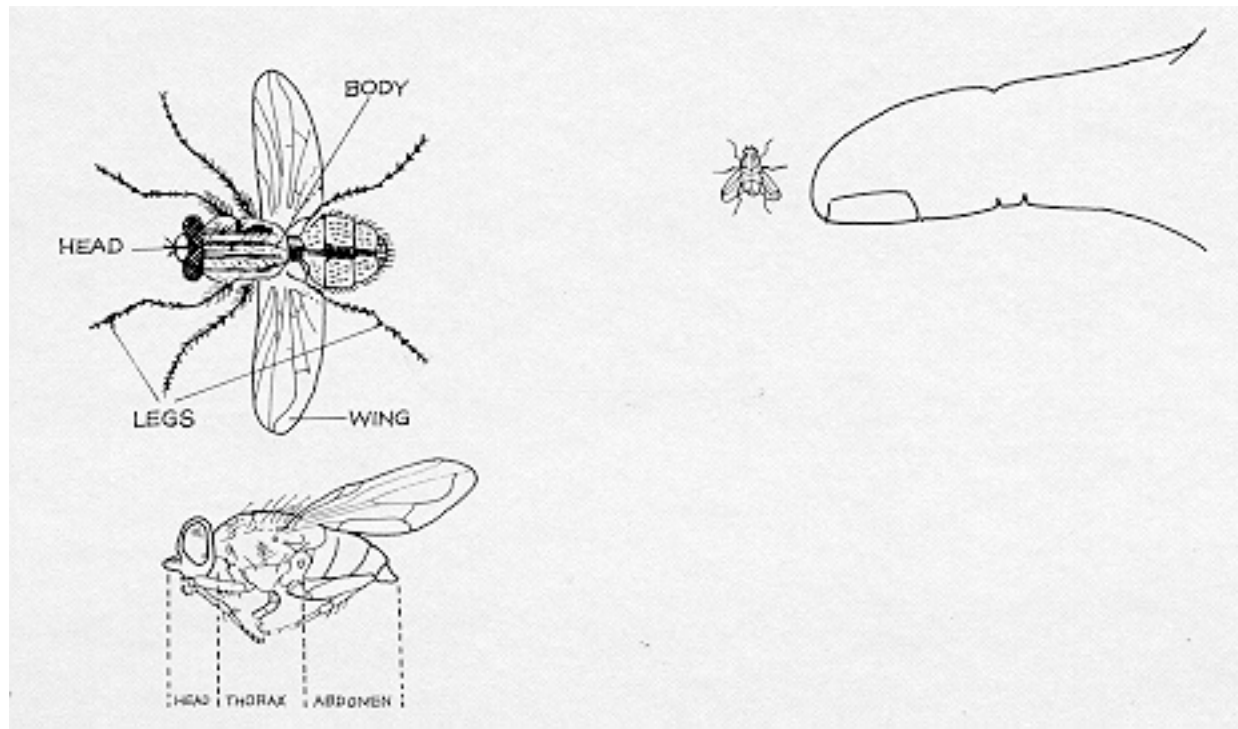
Morphology :

- Body length - **male** 5.8-6.5 mm / **female** 6.5-7.5 mm
- Four (4) longitudinal stripes on thorax.
- Five (5) segmented tarsi.

***Musca domestica* (HOUSEFLY)**

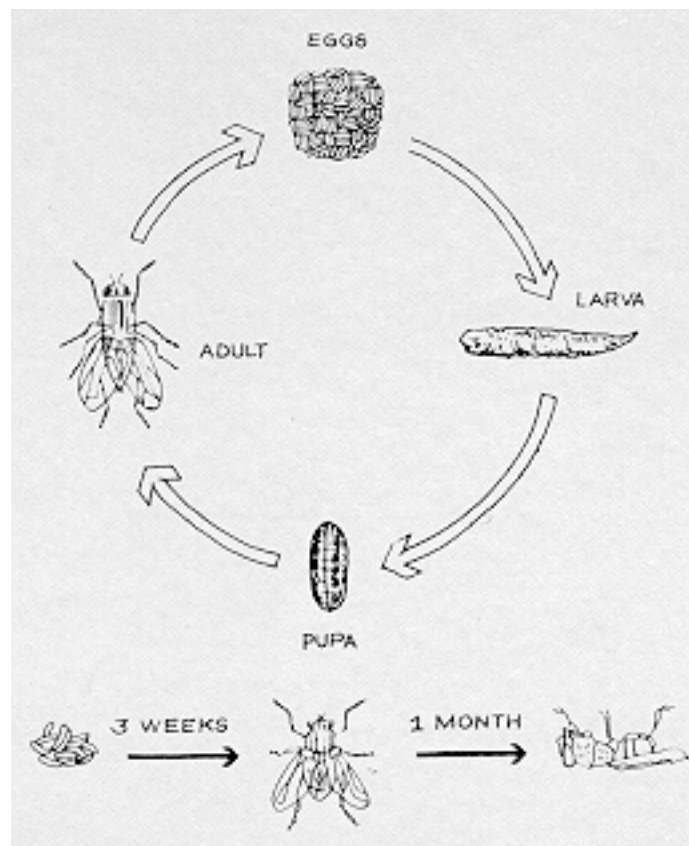
APPEARANCE

- 6-9 mm long.
- Dull grey colour.
- Large eyes.
- 2 small antennae (Feelers).
- Thorax with four narrow stripes.
- Yellow abdomen.
- 2 wings without scales.
- 3 pairs of legs.



LIFE CYCLE

- Life cycle has 4 stages - egg, larva, pupa and adult; can be completed in about 3 weeks under favourable conditions.
- Egg is oval, white and 1 mm in length.
- Larva is cylindrical, cone-shaped at one end and white in colour; there are 3 larval stages.
- Pupa is a resting stage.
- Adult mates 2-20 days after emerging and can live for about 1 month; female adult lays a total of about 500 eggs in 2-7 batches; eggs are laid 4 days after mating.



HABITAT & BEHAVIOUR

- Breeds in animal dung, human excreta, garbage, sewage, plant debris and other decaying organic matter.
- Found during day near food sources and breeding places.
- Rests at night on ceilings, tops of walls, wires, cords, edges and rough surfaces.
- Feeds on human food, garbage, excreta and decayed plant and animal matter.
- Feeding places 100-500 m from breeding place.

PUBLIC HEALTH IMPORTANCE

- Mechanically transmits dysentery, diarrhoea, typhoid, cholera, leprosy, poliomyelitis and parasitic worms; may also cause skin infections.
- Leaves droppings on food and dishes which may lead to contamination of food.

THINGS NEEDED FOR CONTROL

- Food and garbage containers with lids.
- Fly-swatter.
- Sticky fly-paper.
- Fly curtains, e.g., stripes of beads or plastic.
- Window/door screens.

- Nets for beds and cribs.
- Repellent.

IN THE HOUSE

- Screen doors, windows and ventilators.
- Use antily curtains e.g., strips of beads, plastic, etc., in doorways.
- Use nets over beds and cribs.
- Kill flies with fly-swatters or catch on sticky fly-paper.
- Keep toilet clean and slab hole covered after use.
- Store garbage in closed containers.
- Keep food covered or store it in closed containers.

IN THE COMMUNITY

- Keep shops and food establishments clean; do not leave food exposed.
- Provide sanitary latrines to avoid defaecation in open spaces.
- Arrange for street sweeping and garbage collection at least every other day, and dispose of garbage by sanitary methods.
- Arrange for effective wastewater removal and disposal.

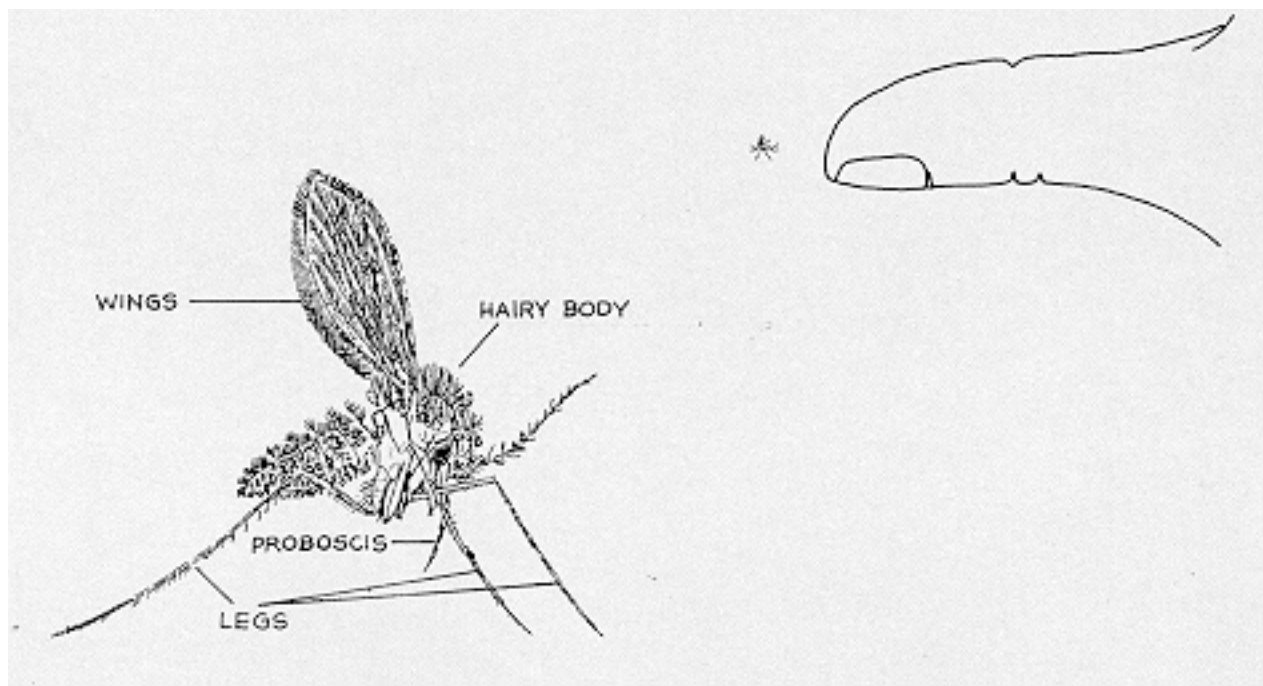
Phlebotomus spp. - Adult sand fly

Note:

- **Vector of human leishmaniasis.**
- **Size :** 1.5-3.0 mm.
- **Colour :** Yellowish or light brown coloured.
- **Other features :** -Hairy appearance - Whole body and wings
 - Large black eyes.
 - Head bent at an acute angle.
 - Long stilt like legs.
 - Oval hairy wings devoid of scales. (Not visible in this photograph)
 - Mouth parts are small and have blade like cutting organs. (not clear in this photograph)
- **At rest wings are held erect over the body.**

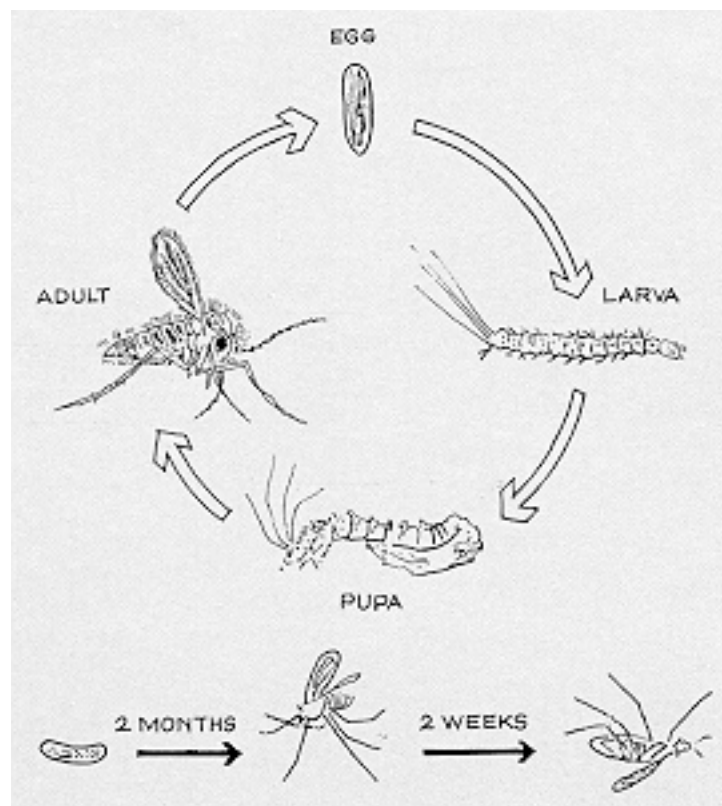
Phlebotomus papatasi* (SANDFLY)*APPEARANCE**

- About 2.5 mm long.
- Pale yellowish grey or buff coloured.
- Body hairy and moth-like.
- Long slender antennae.
- Narrow hairy veined wings.
- Very long, thin lanky legs.
- Proboscis longer than head.



LIFE CYCLE

- Life cycle has 4 stages - egg, larva, pupa and adult; can be completed in about 2 months under favourable conditions.
- Eggs are elongated and shiny brown in colour.
- Larva is a tiny caterpillar-like creature, 0.5 mm in length.
- Pupa is buff coloured with old larval skin attached to the tip of the abdomen.
 - Adult is short lived and seldom survives more than 2 weeks; female lays 40-60 eggs.



HABITAT & BEHAVIOUR

- Breeds in damp and sheltered sandy soil, bases of walls, crumbling masonry, damp cracks, soil contaminated by animals, etc.
- Seeks shelter in dark, cool rooms and animal houses.
- Active towards evening and at night.
- Stays away from breezes and light.
- Flies only short distances and appears to hop; seldom rises to upper floors of buildings.
- Feeding places within 50 m of breeding places.

PUBLIC HEALTH IMPORTANCE

- Female bites and sucks blood of people as well as animals.
- Biting causes irritation and itching.
- May transmit kala azar, oriental sore, espundia and sandfly fever.

THINGS NEEDED FOR CONTROL

- insect repellent.
- Hand spray-gun for repellent.
- Mosquito net sprayed with repellent.

IN THE HOUSE

- Use mosquito net.
- Use insect repellent on person, clothing and mosquito net.
- Sleep on upper floor or build sleeping area 4-7 m above ground.
- Close windows and doors for an hour at dusk.
- Plug cracks and cervices and level walls.
- Ensure adequate ventilation and air circulation.

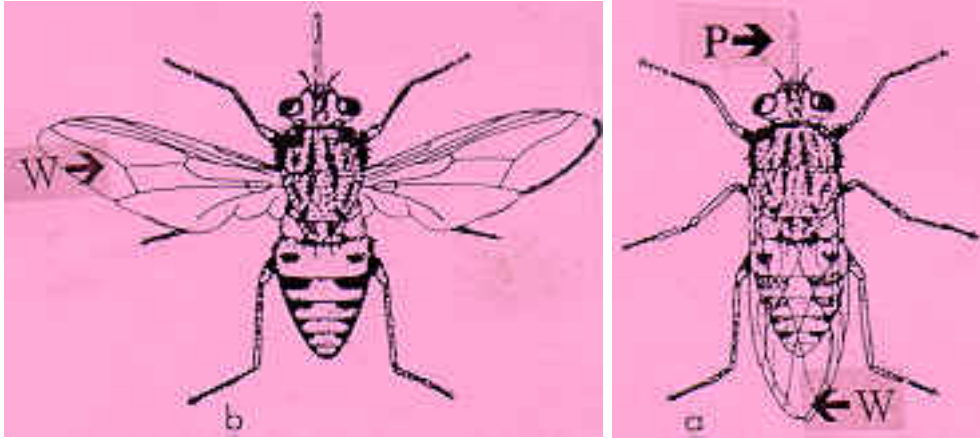
AROUND THE HOUSE

- Remove animal dung, plant debris and other refuse from vicinity of house.
- Remove crumbling masonry, building material rubble, old foundations, etc.
- Avoid defaecation in open spaces around house.

Glossina spp. - Adult Tsetse fly

Note :

- **Vector of African trypanosomiasis.**
- Yellowish/Brownish black in colour.
- Little larger than the house fly.
- Combination of a rigid and forwardly projecting proboscis.
- At rest the wings are placed over the abdomen like the closed blades of a pair of scissors.



P - Proboscis

W - Wings

Musca domestica (House fly) - Egg

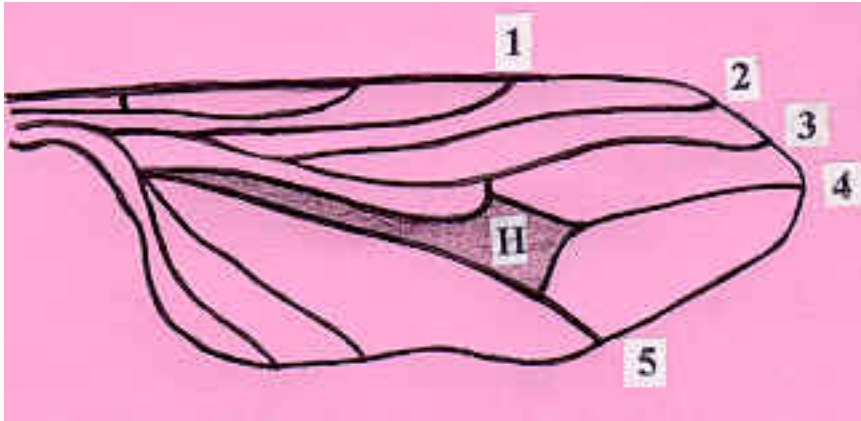
**Note :**

- Creamy white in colour.
- Distinctly concave dorsally giving them a banana shaped appearance.

Musca domestica (House fly) - Wing**Note :**

- Vein 4 bending up sharply to join the costa close to vein 3.
- This is an important character which can help to distinguish *Musca* spp. From other rather similar spp.

Glossina spp. - Tsetse fly Wing



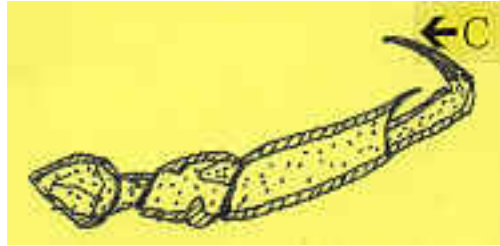
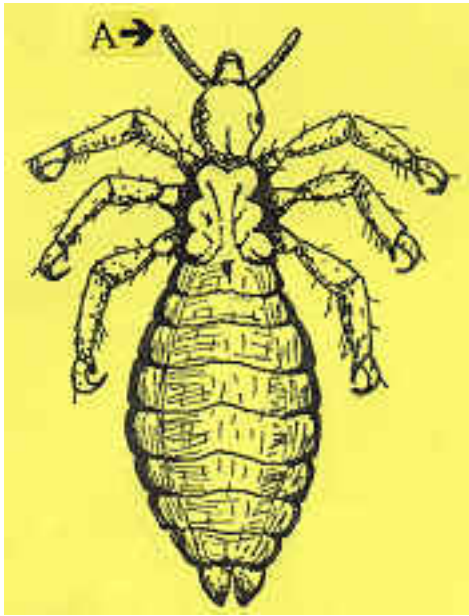
Note :

- "**Hatchet cell**" between 4th and 5th vein is the characteristic feature.

H - hatchet cell

Pediculus humanus humanus(Body louse)

Pediculus humanus capitis(Head louse)

Note:

- **General features:** 2-4 mm in length.
Wingless insects.
Flattened dorsoventrally.
- **Head:** Pair of five jointed antennae.
Pair of simple lateral eyes.
- **Thorax:** Chitinous thorax.
- **Abdomen:** Nine segmented abdomen with darker sclerotised lateral margins.
- **Leg:** three pairs of legs ending with an apical claw and a spine.

A-Antennae

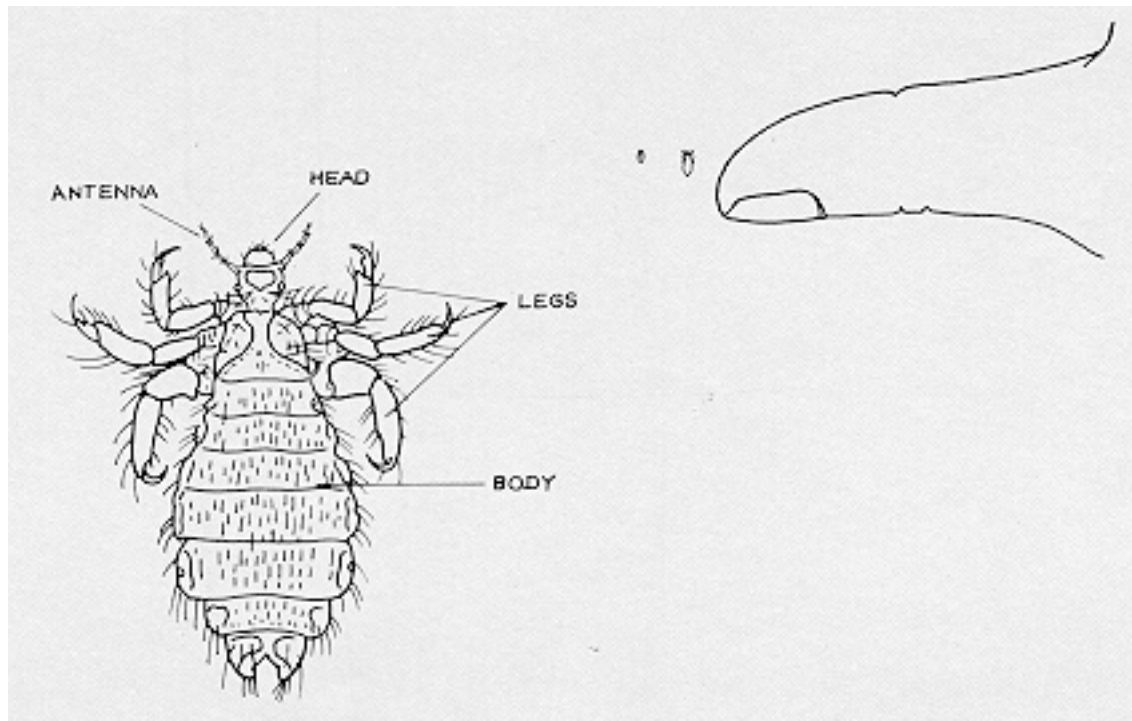
C-Claw

Pediculus humanus capitis, Pediculus humanus humanus (LOUSE)

APPEARANCE

GENERAL

- Flat body.
- Mouth parts that pierce and suck blood.
- 2 antennae.
- 3 pairs of short legs with claws.



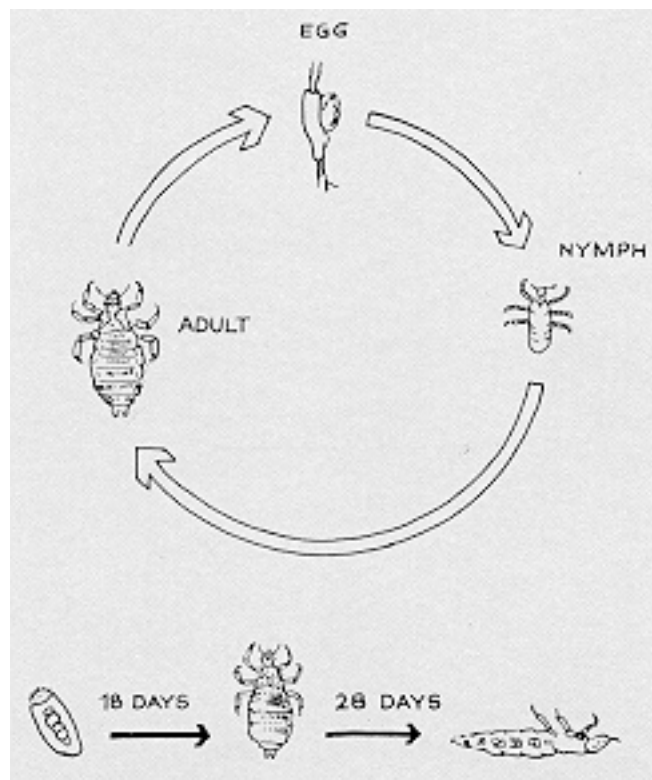
DISTINGUISHING FEATURES

· *P.h.capitis* (Head louse)

- 1-2 mm long.
- Dirty white to greyish black colour.
- Thick antennae.

LIFE CYCLE

- Life cycle has 3 stages - egg, nymph and adult; can be completed in 18 days under favourable conditions.
- Eggs are elongate oval and whitish in colour.
- Nymph moults three times and is similar to adult except in size.
- Females lay average of 8-10 eggs a day until 50-100 eggs have been laid by the head louse and 200-300 by the body louse.



HABITAT & BEHAVIOUR

- *P.h.capitis* (Head louse)
 - Inhabits scalp, mostly behind ears and back of head.
 - Glues eggs to hair near the scalp.
- *P.h.humanus* (Body louse)
 - Lives in clothing and places where clothing touches body, e.g. armpits, crotch, waistline, neck, shoulder, etc.
 - Glues eggs to fibres in seams of clothing.

PUBLIC HEALTH IMPORTANCE

- Lice bite and suck blood.
- Biting causes irritation and itching.
- Itching may cause skin infections, such as impetigo, furunculosis and eczema.
- Body lice may transmit typhus, trench fever and relapsing fever.

THINGS NEEDED FOR CONTROL

- Soap for washing and bathing.
- Brush or comb for each person in the house.

PREVENT LOUSE INFESTATION

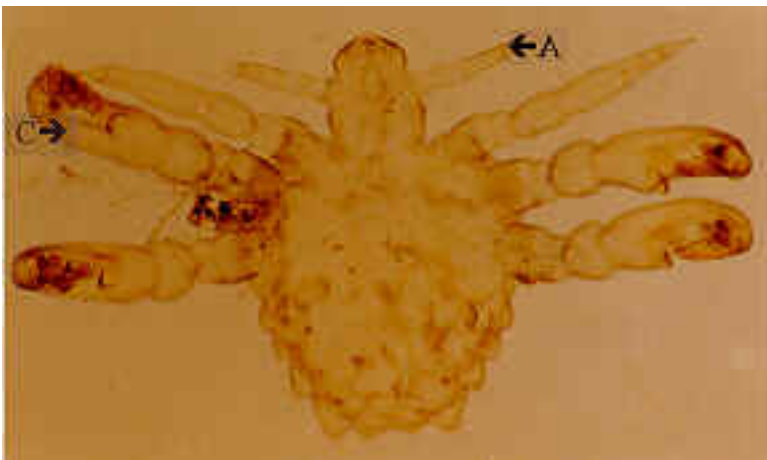
- **In hair:**
 - Wash hair regularly.
 - Keep hairbrush, comb, cap, etc. clean and do not share with others.
- **On body**
 - Keep clean.
 - Bath regularly and change into clean clothes.
 - Wash bedclothes regularly.
 - Do not share clothing and bedding with others.

GET RID OF INFESTATION

- **In hair**
 - Use fine comb or hand to remove and crush nits, nymphs and adults.
 - Apply kerosene and vegetable oil mixture (1:1) to hair, tie up in a towel for an hour and wash.
- **On body**
 - Boil clothing and bedding with soap and water.
 - Leave infected clothing and bedding unused for a month; lice will die without food.
 - Disinfect clothes by heating in air at 700 C.
 - Do not crush body lice; crushing may spread disease.

***Pthirus pubis* (Crab louse)**

Note:

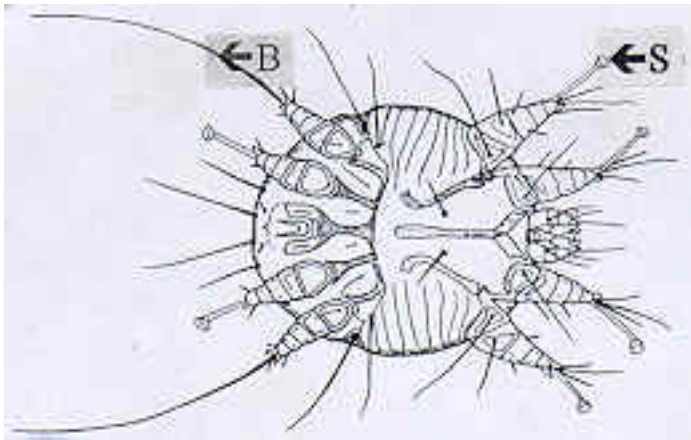


- **General features:** 0.8-1.2 mm in length.
Crab like appearance.
Oblong turtle shaped body.
- **Head:** Rectangular shaped.
Pair of five(5) jointed antennae.
Pair of simple lateral eyes.
- **Legs:** Three (3) pairs of legs.
1st pair is not well developed.
Last two pairs are provided with well developed heavy claws.

A-Antennae

C-Claws

Sarcoptes scabiei - Male



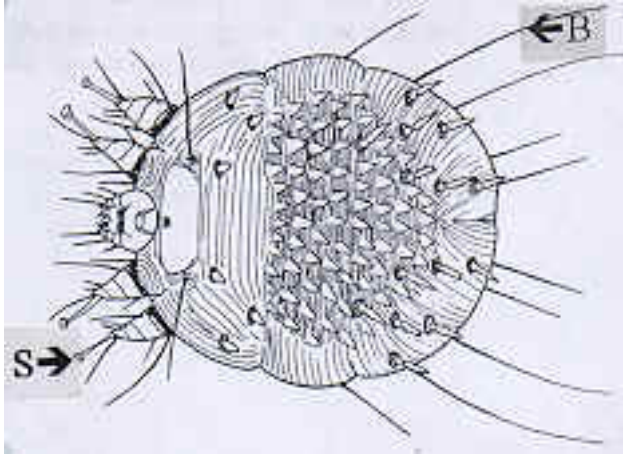
S - Suckers

B - Bristles

Note :

- **Smaller than the female.**
- Four pairs of short stumpy legs.
- First, second and fourth pairs end in suckers.
- Third pair ends in bristles.

***Sarcoptes scabiei* - Female**



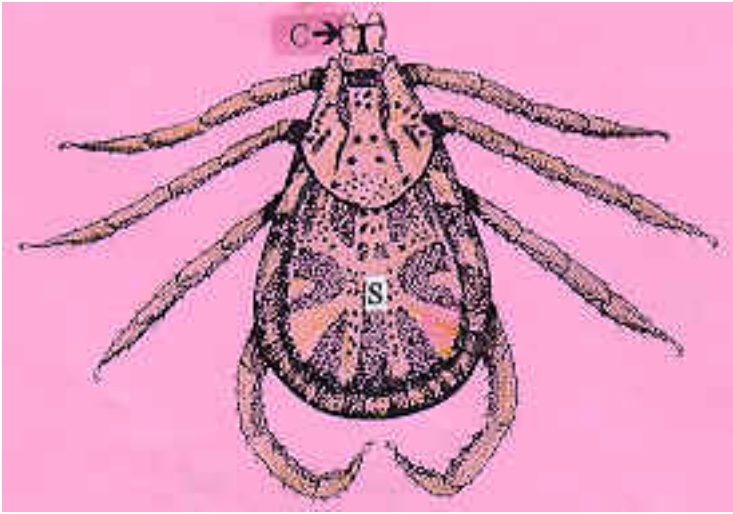
S - suckers

B - bristles

Note :

- **Larger than the male.** (Just visible without the aid of a hand lens.)
- Four pairs of short stumpy legs.
- Anterior two pairs end in suckers.
- Posterior two pairs end in bristles.

***Ixodes dammini* - (Hard tick) - Adult male**



C - Capitulum

S - Scutum

Note:

- **Body** : Oval, flattened dorso-ventrally and smaller than the female hard tick.
- **Capitulum (Mouth parts)** : Projects anteriorly and dorsally visible.
- **Scutum/Shield (Dorsal plate)** : Large, covers the entire dorsum.
- **Legs** : Four pairs.

Ixodes dammini - (Hard tick) - Adult female



Note:

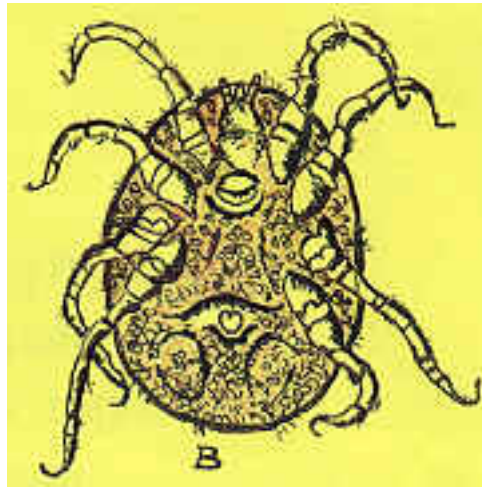
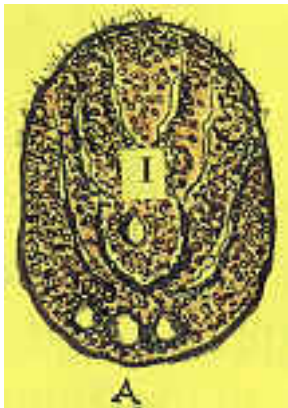
- **Body** : Oval, flattened dorso-ventrally. Larger than the male hard tick.
- **Capitulum (Mouth parts)** : Projects anteriorly and dorsally visible.
- **Scutum/Shield (Dorsal plate)** : Small, restricted to the anterior part.
- **Legs** : Four pairs.

C - Capitulum

S - Scutum

Argas persicus (Soft tick)

Note:



- **Body** : Oval, flattened dorso-ventrally.
- **Capitulum (Mouth parts)** : Situated ventrally thus not visible dorsally.
- **Integument** : Tough, leathery and wrinkled which has fine granulations/tubercles.
- **Legs** : Four pairs.
- No scutum.
- **Male and female ticks are similar in their external appearance.**

I - Integument

A - Dorsal view, female

B - Ventral view, female

Malaria

DRUG RESISTANCE IN MALARIA

Largely a problem with *Plasmodium falciparum*

In vivo resistance has been reported to all antimalarials except artemisinin and its derivatives.

Definition of drug resistance

The ability of a parasite strain to survive and / or multiply despite the administration and absorption of a drug in doses equal to or higher than those usually recommended, but within the limits of tolerance of the subject.

Measuring drug resistance

May be done *in vitro* or *in vivo*

In vitro tests

Rieckmann's microtechnique measures the ability of malaria parasites to grow to mature schizonts *in vitro* in the presence of standard drug dilutions and controls, over a period of 24-26 hrs.

In vivo tests

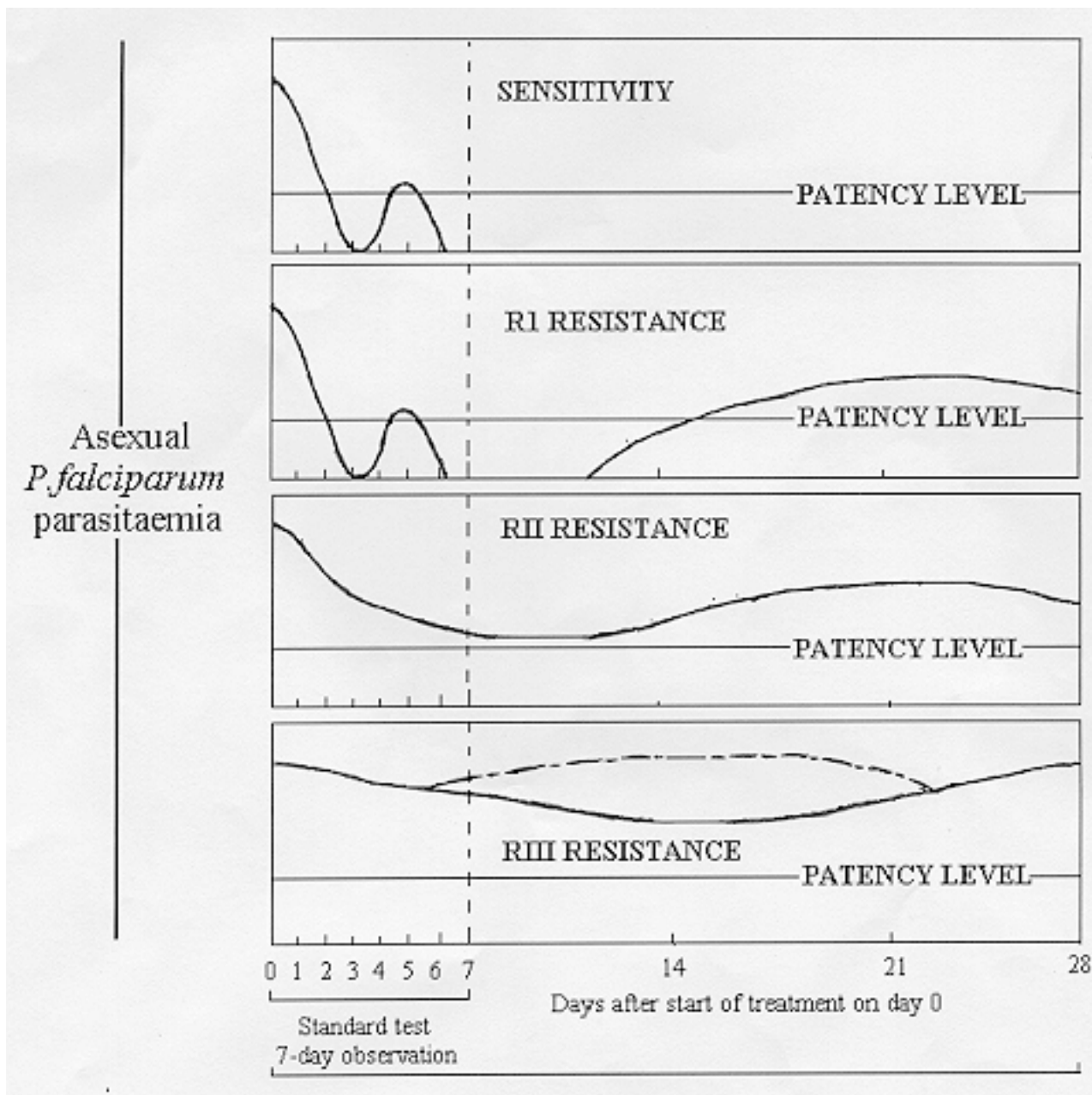
Involve the administration of standard treatment to a patient followed by assessment of parasitaemia in repeated blood smears over a period of 7 days (WHO standard field test) or 28 days (WHO extended field test). These tests allow identification of the grade of drug resistance.

Asexual stages of sensitive strains are generally cleared from the blood by 3 days after the initiation of treatment and definitely by 6 or 7 days.

RI resistance: Recrudescence of the infection between 7 and 28 days of completing treatment following initial resolution of symptoms and parasite clearance.

RII resistance: Reduction of parasitaemia by >75% at 48 hrs but failure to clear parasites within 7 days.

RIII resistance: Parasitaemia does not fall by >75% within 48 hrs.



The short test allows detection of RII or RIII resistance, but not RI resistance. The extended test distinguishes sensitive strains from those with RI resistance (assuming that the patient is not a risk of re-infection during the period of assessment).

Possible mechanisms of changes in drug sensitivity in malaria parasites

- 1 . Physiological adaptations in the parasite due to non-genetic changes.
- 2 . Selection of previously existing drug-resistant cells from a mixed population under drug pressure.
- 3 . Spontaneous mutations.
- 4 . Mutation of extra-nuclear genes.
- 5 . Existence of plasmid-like factors.

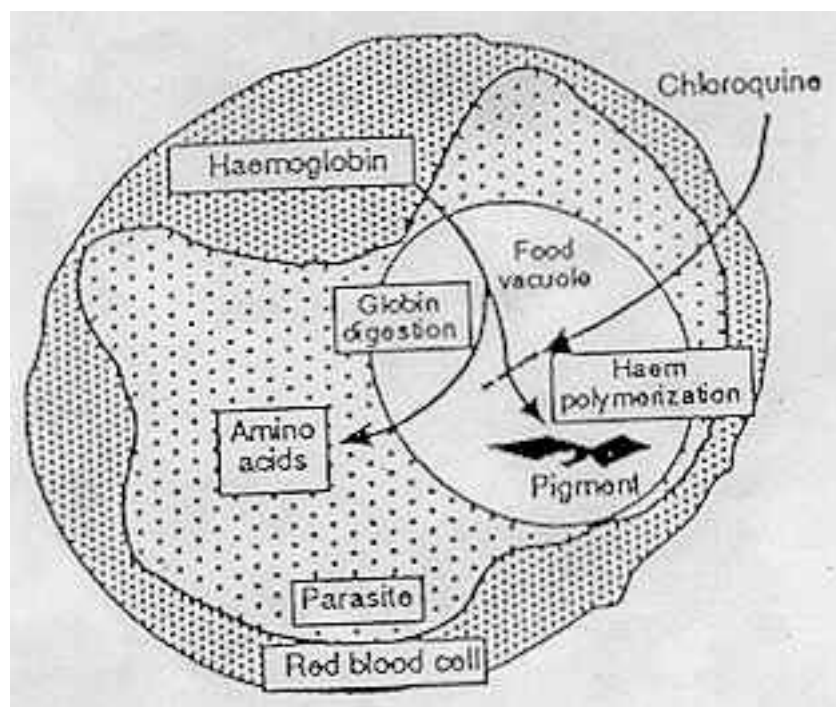
Evolution of chloroquine resistance in *P. falciparum*

Emergence of chloroquine resistance in *P. falciparum* is largely due to selection of resistant mutants by the indiscriminate use of the drug, especially in subtherapeutic doses.

Uncontrolled and irresponsible prophylaxis and treatment leads to subcurative plasma levels of drugs, which kill the more sensitive strains but select the less sensitive ones. Spontaneous mutations in these forms further reduce the drug sensitivity.

Physiological mechanisms for chloroquine resistance

The erythrocytic stages of the malaria parasite ingest haemoglobin into food vacuoles. Here various enzymes break down the Hb into its protein component and ferriprotoporphyrin IX (FPIX). FPIX has a membrane lytic action. The malaria parasite detoxifies this cytotoxic molecule by binding it to a protein produced by the parasite, leading to the formation of haemozoin (malaria pigment).

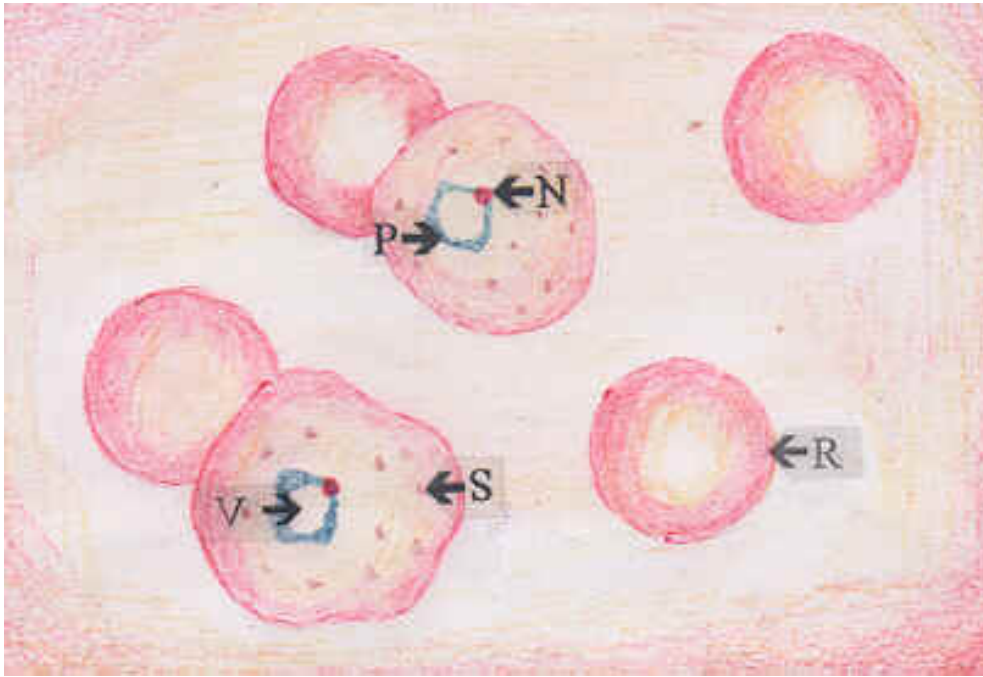


In chloroquine sensitive malaria parasites, the drug is taken up into the food vacuole, and it appears to act by interfering with the detoxification of FPIX.

Chloroquine resistant malaria parasites seem to be able to keep down the concentration of drug in the food vacuole by a rapid efflux mechanism which releases chloroquine from resistant parasites 40-50 times faster than from sensitive parasites.

It has also been suggested that chloroquine resistant malaria parasites can somehow make FPIX available to the host cell haemoxygenase system for elimination.

Plasmodium vivax - Ring trophozoite



N- Nucleus / chromatin

R - Normal RBC

V- Vacuole

P- Parasitic cytoplasm.

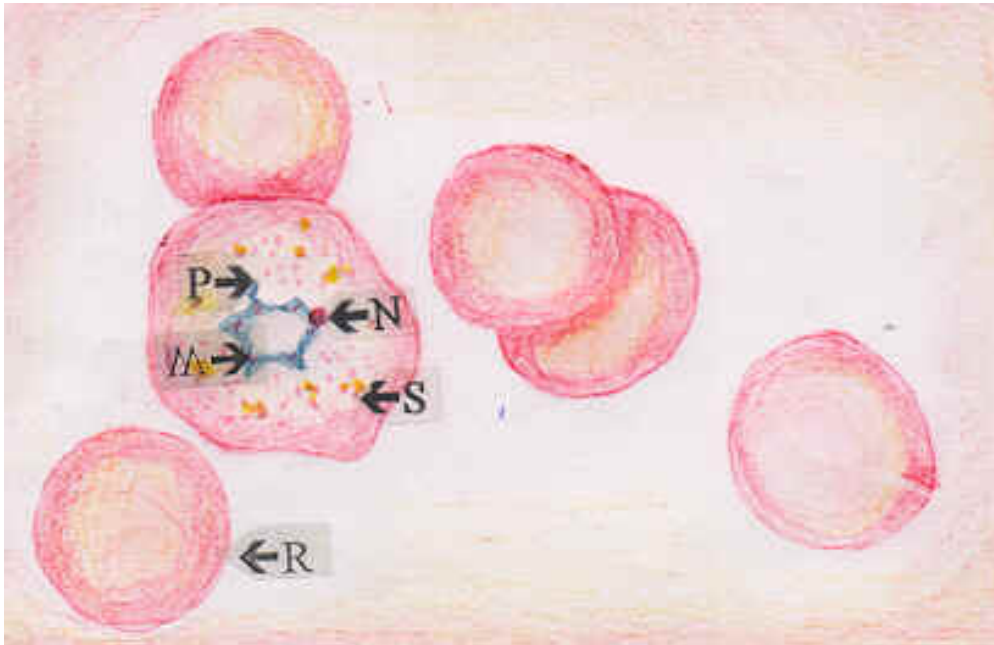
S- Schuffner's dots.

Note:

- Red cell is enlarged.
- Stippling (Schuffner's dots) in the RBC cytoplasm.
- Signet ring appearance (Ring is coarse and large).

Except in the cases of hyperinfection multiple invasion (polyparasitism), Accole form (applique forms) and double nuclear phenomenon are usually not found in *P.vivax*.

Plasmodium vivax - Amoeboid trophozoite



N- Nucleus

M- Malaria pigment

S - Schuffner's dots

P- Pseudopodia

R- Normal RBC

Note:

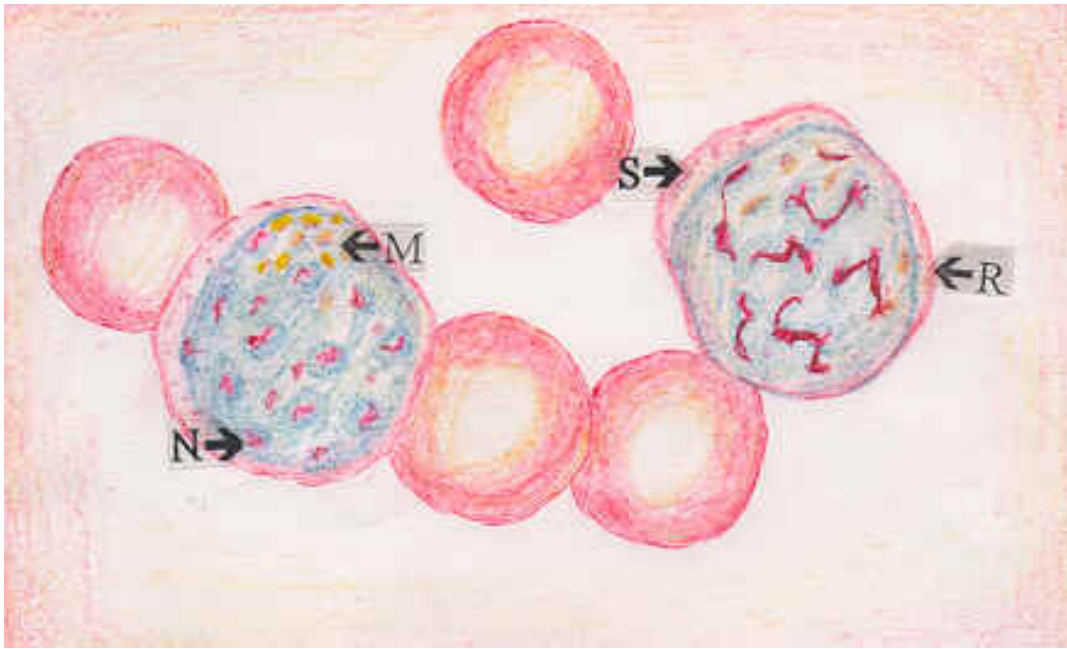
- RBC enlarged, stippling more marked.
- Vacuole starts disappearing.
- Parasite nucleus is **NOT** divided.
- Parasite cytoplasm develops pseudopodia.
- (Parasite looks like an amoeba)
- Few granules of malaria pigment may be present.

In *P.falciparum* at this stage the parasite is compact, no pseudopodia seen & usually not found in the peripheral circulation. The malaria pigment is jet black in colour compared to *P. vivax*.

Plasmodium vivax - Immature schizont

Note :

- RBC is enlarged.
- Schuffner's dots are



N - Nuclear fragments.

R - RBC cytoplasm.

M - Malaria pigment

S - Schuffner's dots.

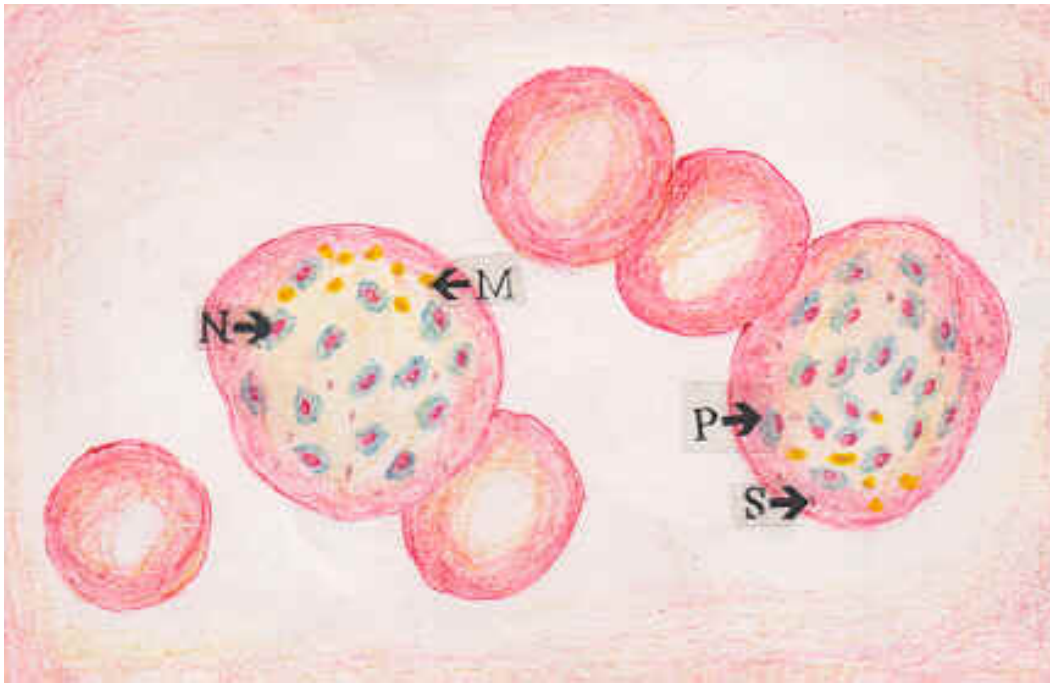
more
marked.

- Parasitic nuclear fragments are still dividing.
- Malaria pigment ++

Plasmodium vivax - Mature schizont

Note:

- RBC is enlarged.
- Schuffner's dots are more marked.
- Parasitic nucleus is divided into 12-24 segments.
- Parasitic



cytoplasm is compact and collected around nuclear fragments. (Pink / red)

- Malaria pigment +++

N - Daughter nuclei

P - Parasitic cytoplasm

M - Malaria pigment.

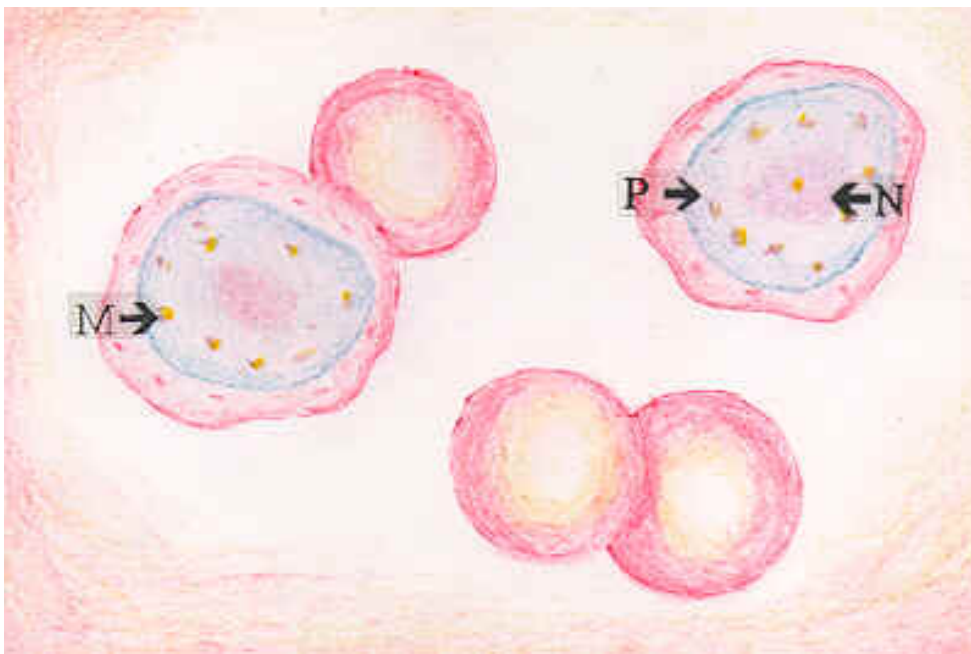
S - Schuffner's dots

In *P.falciparum* , schizont stage is not found in peripheral blood except in heavy infections and the malaria pigment is jet black in colour compared to *P.vivax*

Plasmodium vivax - Male gametocyte / Microgametocyte

Note :

- RBC is enlarged.
- Gametocyte is large, round and entirely fills the RBC.
- Parasitic nucleus is not distinct but dispersed and



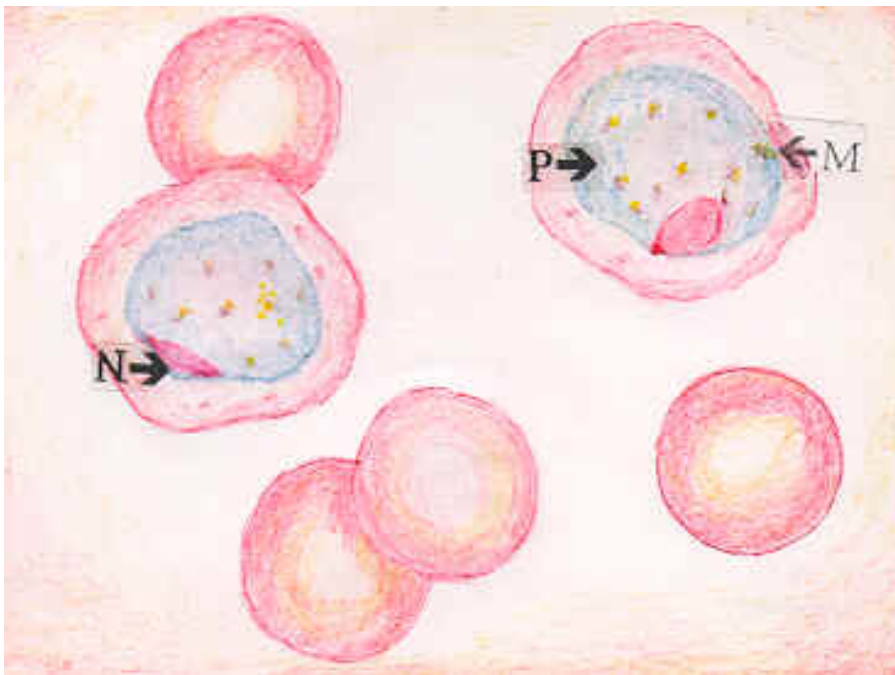
N - Nucleus

P - Parasitic cytoplasm

M - Malaria pigment

- located centrally.
- Parasitic cytoplasm is pinkish in colour. (Due to dispersed nucleus).
- Malaria pigment (Yellowish brown)) is prominent.
- Stippling is visible.
- No vacuole.

Plasmodium vivax - Female gametocyte / Macrogametocyte



Note :

- RBC is enlarged.
- Gametocyte is large, round in shape and entirely fills the RBC.
- Parasitic nucleus is very distinct and pushed to a side.
- Parasitic cytoplasm is bluish in colour.
- Malaria pigment - Yellowish brown is prominent.
- Stippling is visible.

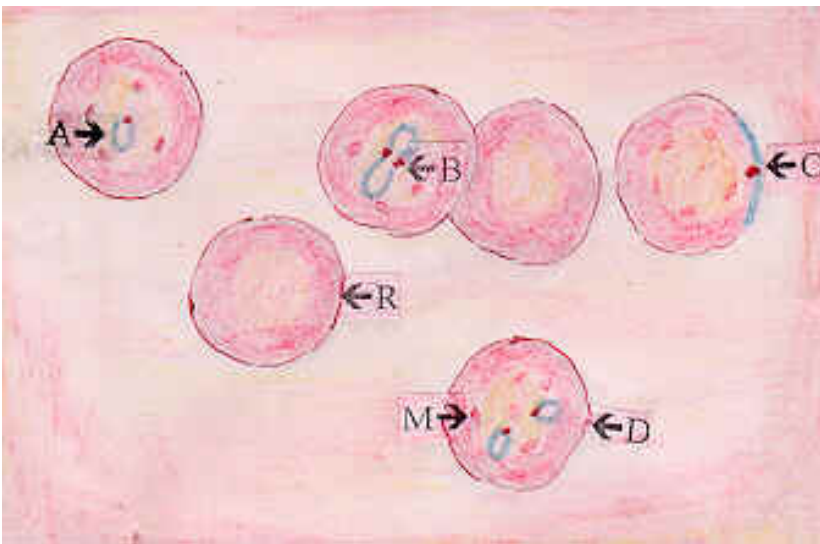
P - Parasitic cytoplasm.

M - Malaria pigment

N - Nucleus

Plasmodium falciparum - Ring trophozoite

Note :



- Red cell is **NOT** enlarged.
- Stippling is seen as coarse Maurer's dots or clefts in the RBC cytoplasm. (Few dots compared to *P.vivax*).
- Ring is very delicate & small.
- Multiple invasion (Polyparasitism) .
- Double nuclear phenomenon.
- Applique form (Accole form) - chromatin and cytoplasm of parasite is applied to the membrane of the RBC .

A - Ring stage

B - Double nuclear phenomenon

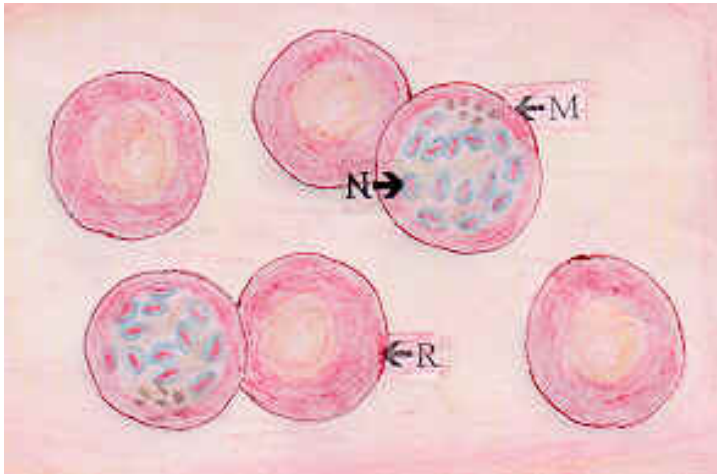
C - Applique form

D - Multiple invasion

M - Maurer's dots

R - Normal RBC

Plasmodium falciparum - Mature schizont



N - Daughter nuclei

R - Normal RBC

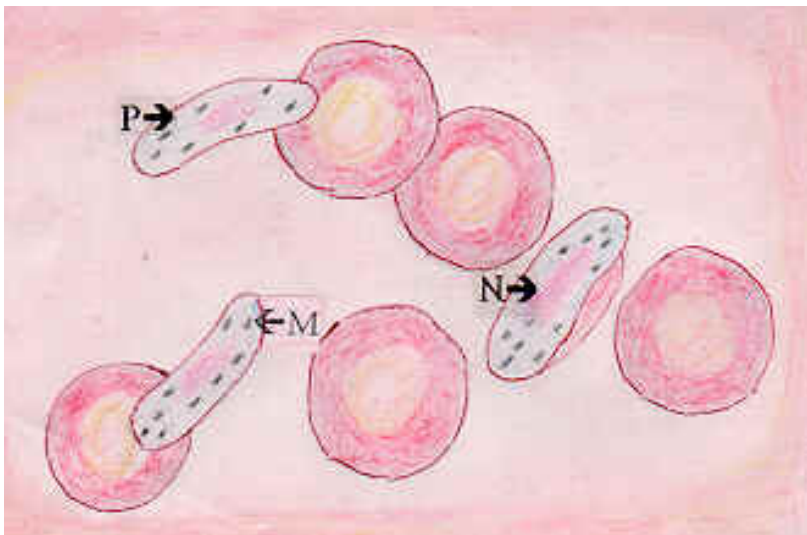
M - Malaria pigment

Note :

- Infected red cell is not enlarged.
- No stippling.
- Parasitic nucleus is divided.
- Parasitic cytoplasm is compact & collected around nuclear fragments.
- Malaria pigment appears inside the RBC as a clumped black body.

In *P.falciparum*, schizont stage is **NOT** usually found in peripheral blood except in heavy infections.

Plasmodium falciparum - Male gametocyte



N - Nucleus

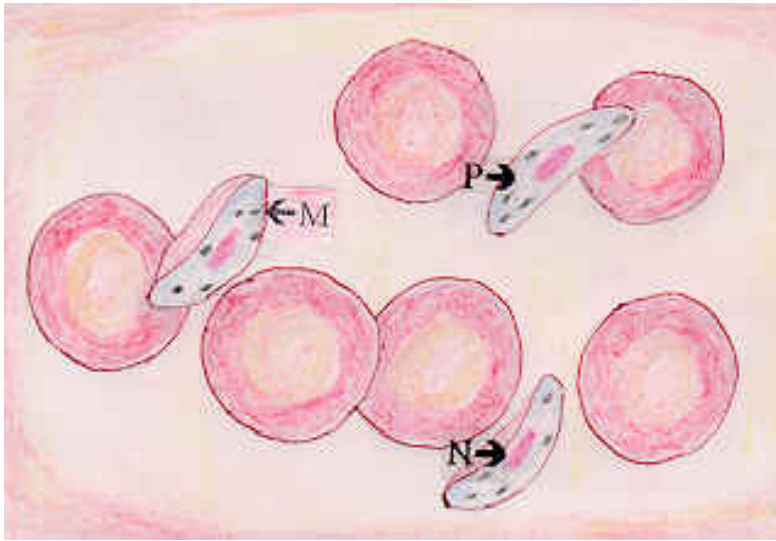
P - Parasitic cytoplasm

M - Malaria pigment

Note :

- Gametocyte is sausage shaped with blunt rounded ends
- Parasitic nucleus (pink / red) is not distinct but diffused.
- Parasitic cytoplasm is pinkish in colour.(Due to diffused nucleus).
- Malaria pigment (jet black) is scattered inside.
- No vacuole .

Plasmodium falciparum - Female gametocyte



Note :

- Found inside RBC .
- Gametocyte is crescentic in shape with pointed ends.
- Parasitic nucleus (pink /red) is distinct, well defined and located at the centre.
- Parasitic cytoplasm is bluish in colour.
- Malaria pigment (jet black) is scattered inside.
- No vacuole.

N - Nucleus

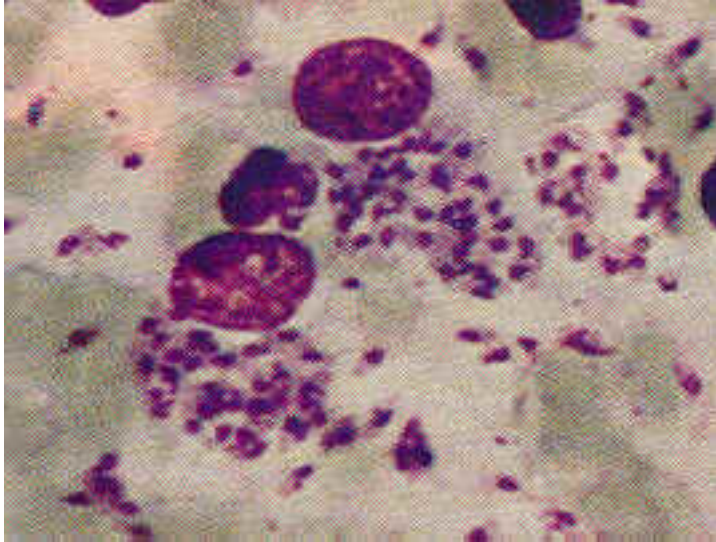
P - Parasitic cytoplasm

M - Malaria pigment

Haemoflagellates

Leishmania Amastigote stage - [Leishman - Donovan (LD) bodies]

Note:



- **Found within phagocytic vacuoles of macrophages and other mononuclear phagocytes.**
- **Size :** 2-5um x 1-3um.
- **Shape :** Oval or rounded.
- **Other features :** Parasitic nuclei and kinetoplasts are arranged to give the “**Dot and Dash**” appearance.
Demarcation of each amastigote is not apparent.
No external flagellum.

Leishmania Promastigote stage



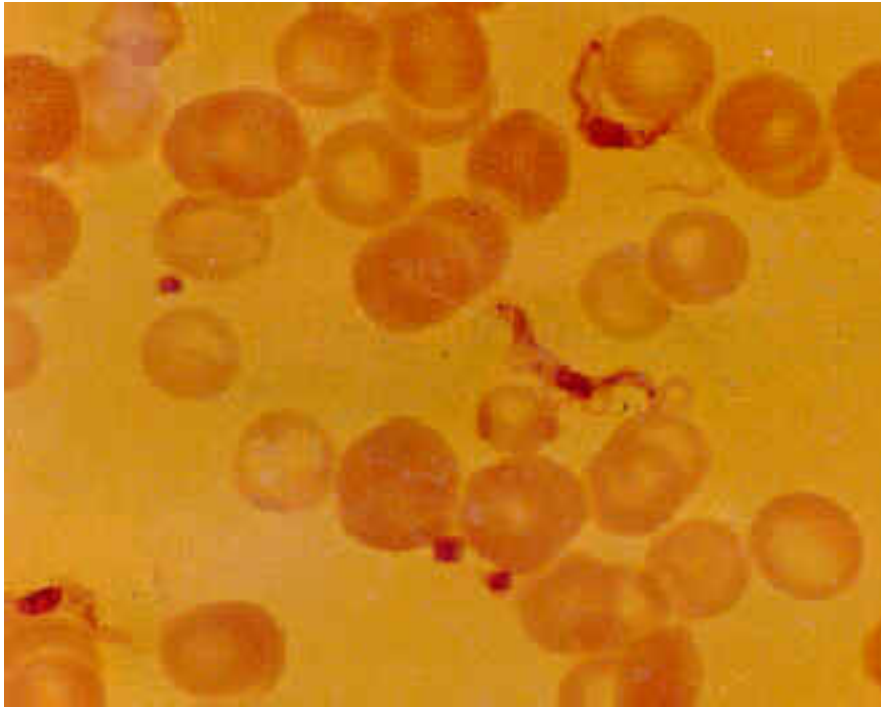
Note:

- **Found both in midgut and pharynx of sandfly vector and in culture media.**
- **Size :** 15-20um in length, 1.5-4.0um in width.
- **Shape :** varies from pyriform to long slender spindle shape.
- **Kinetoplast :** Placed anterior to the nucleus.
- **Flagellum :** Arises at the anterior end.
- **No undulating membrane.**

***Trypanosoma brucei* - Trypomastigote stage**

Note:

- **Size :** 15-35um x 1.5-4.0um.
- **Shape :** Fusiform protozoa, flattened from side to side.
Pleomorphic with long and slender to short and stumpy forms.

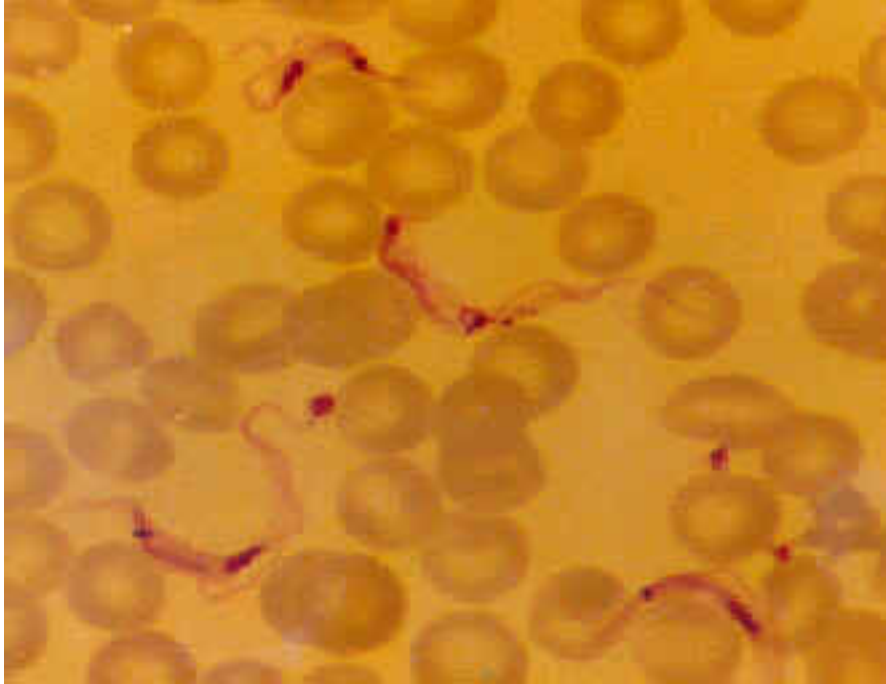


Tapering anterior end and blunt posterior end.

- **Nucleus** : Pleomorphic, varies with regard to size and position.
- **Kinetoplast** : Not prominent.
- **Flagellum** : Free flagellum, can vary in size.

***Trypanosoma cruzi* - Trypomastigote stage**

Note:



- **Size** : 17-30um in length.
- **Shape** : Fusiform slender protozoa, flattened from side to side. Typically 'C' shaped. Tapering anterior end and short pointed posterior end.
- **Nucleus** : Deeply staining, centrally placed, oval shaped nucleus.
- **Kinetoplast** : Large and prominent. Situated at the posterior end (Terminal).
- **Flagellum** : Projects from the anterior end, after passing along the undulating membrane.
- **Free flagellum about 1/3 rd of the body length.**

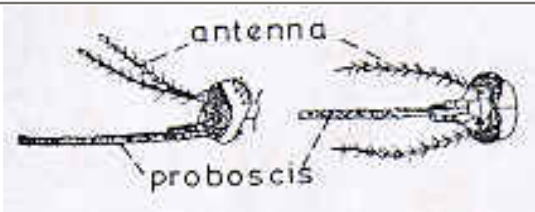
Mosquitoes

IDENTIFICATION OF GENERA OF MOSQUITOES OF MEDICAL IMPORTANCE

STEP 1

The recognition of mosquitoes of medical importance is simple if the following procedure is adopted. If the examination is not carried out in the following order or any steps omitted, the resulting identification may be incorrect.

1. IS IT A MOSQUITO



Long biting proboscis clearly visible from a dorsal or lateral position, long filiform antennae

= MOSQUITO



Otherwise reject

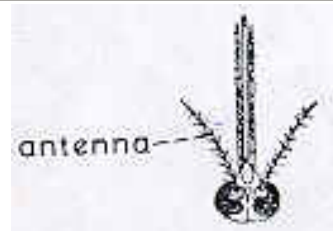
. = non-biting fly

2. IS IT A MALE OR A FEMALE MOSQUITO ?



Plumose antennae (many hairs)

= MALE



Pilose antennae (few hairs)

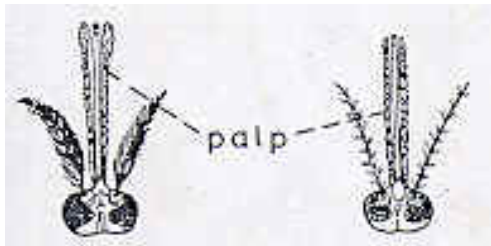
= FEMALE

N. B. It is essential to establish this point first otherwise confusion will arise in subsequently placing the mosquito in the correct group.

3. IS IT AN ANOPHELINE OR A CULICINE ?

ANOPHELINE

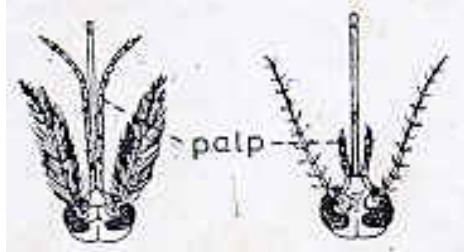
CULICINE



Male : Palps long and clubbed.

Female : Palps long.

=*Anopheles* spp.



Male : Palps long.

Female : Palps short.

It is necessary to further characterise the culicine as belonging to one of three (3) genera.

Notice that if the mosquito is not first sexed correctly a male culicine could be confused with a female anopheline.

IDENTIFICATION OF GENERA OF MOSQUITOES OF MEDICAL IMPORTANCE

STEP 2

CULICINES

(Following descriptions apply to both sexes)

<p>Wings with light coloured, narrow scales not forming conspicuous spots</p> <p>=<i>Aedes</i> or <i>culex</i></p>	<p>Wings with groups of light and dark coloured, Broad scales giving a speckled appearance</p> <p>Scales heart - shaped.</p> <p>= <i>Mansonia</i> spp.</p>
<p>Conspicuous black and white scales forming patterns on thorax and giving legs a banded appearance</p> <p>= <i>Aedes</i> spp.</p>	<p>Dull brown mosquitoes lacking prominent banding on legs or conspicuous thoracic markings.</p> <p>= <i>Culex</i> spp.</p>

Genera of culicines

A) *Culex* spp.

- Dull brown without any markings on the thorax, wings, legs.

1). *Culex quinquefasciatus*.

B) *Aedes* spp.

- Medium size.
- Black with silvery scales.
- Legs banded.

1). *Aedes aegypti*.

2). *Aedes albopictus*.

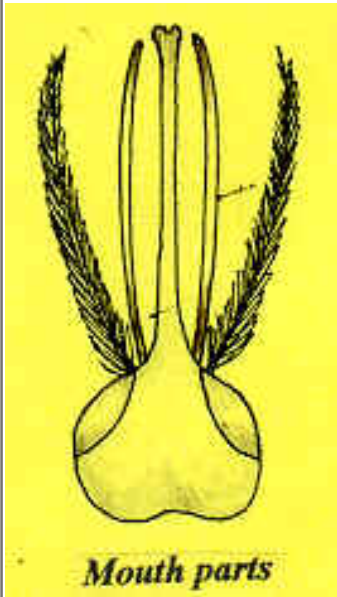





C) *Mansonia* spp.

- Brown mosquito with banded abdomen and legs.
- Wings - "salt and pepper" appearance.

1). *Mansonia uniformis*.

2). *Mansonia annulifera*.

Aedes aegypti

Male		Female	
 <p>Mouth parts</p>	 <p>Thorax</p>	 <p>(a)</p>	 <p>(c)</p>
	 <p>Leg</p>	 <p>(b)</p>	

A - Antennae

P - palps

A - Antennae

P - Palps

a - Thorax

b - Leg

c - Adult (mouth parts)

Characteristic features :

- **Mouth parts :** Feathery antennae.
Long palps.
- **Thorax :** Two (2) curved white lines. (Lyre shape) on sides of thorax.
- **Legs :** Black and white bands on legs.

Characteristic features :

- **Mouth parts :** Pilose antennae.
Short palps.
- **Thorax :** Two (2) curved white lines
(Lyre shape) on sides of thorax.
- **Legs :** Black and white bands on legs.

Aedes albopictus - Female



Characteristic features :

- **Mouth parts :** Pilose antennae.
Short palps.
- **Thorax :** Single white line on back of thorax.
- **Legs :** Black and white bands on legs.



A - Antennae

P - palps

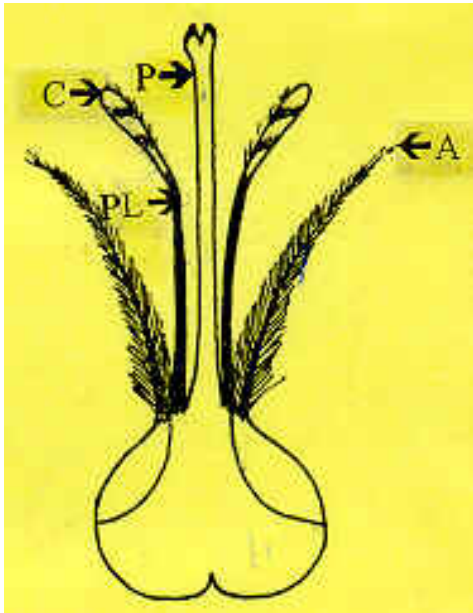
a - Thorax

b - Leg

c - Adult (mouth parts)

Anopheles spp.

Male	Female



A - Antennae

C - Clubbed tips

PL - Palps

P - Proboscis

Characteristic features :

- **Mouth parts :** Plumose antennae.
Long and clubbed palps.
- **Wings :** Light and dark bands are present.

PL - Palps.

P - Proboscis A - Antennae

Characteristic features :

- **Mouth parts :** Pilose (less hairy) antennae.
Long palps.
- **Wings :** Have light and dark bands on the edge.

Culex spp.

Male

Female



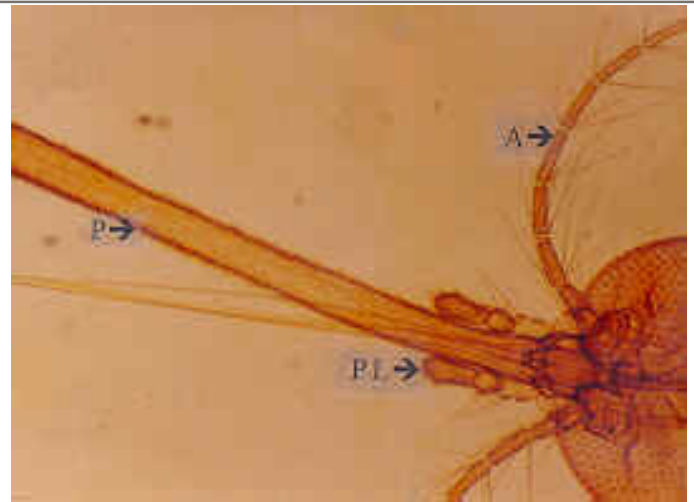
PL - Palps

P - Proboscis

A - Antennae.

Characteristic features :

- **Mouth parts :** Feathery (plumose) antennae. Long palps.
- **Thorax :** No markings on back of thorax.



PL - Palps

P - Proboscis

A - Antennae

Characteristic features :

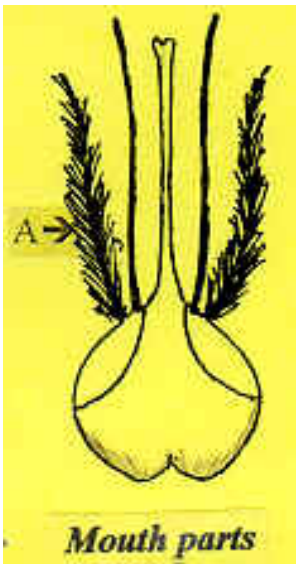
- **Mouth parts :** Pilose (less hairy) antennae. Short palps.
- **Thorax :** Dull brown in colour. No markings on thorax, legs and wings.

Mansonia spp. - Male



Characteristic features :

- **Mouth parts :** Plumose antennae. Long palps.
- **Wings :** Broad scales with "salt and pepper" appearance.

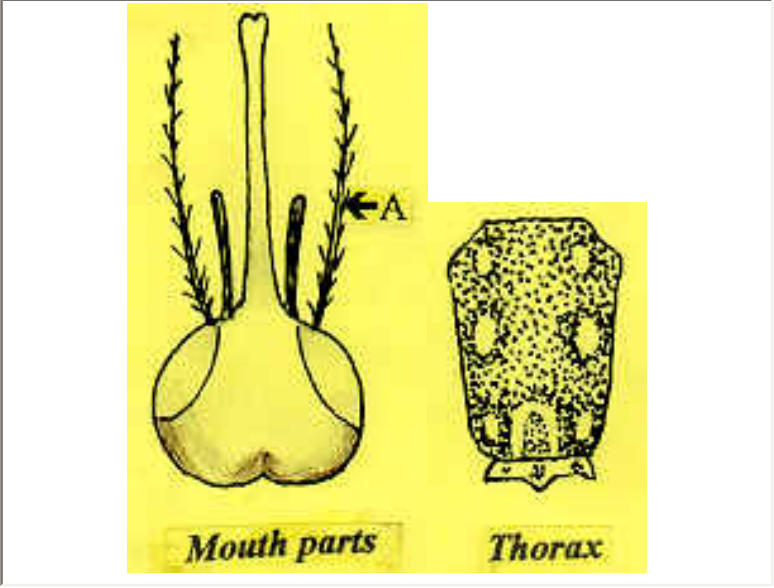


- **Legs :** Brown and white bands on legs.

A - Antennae

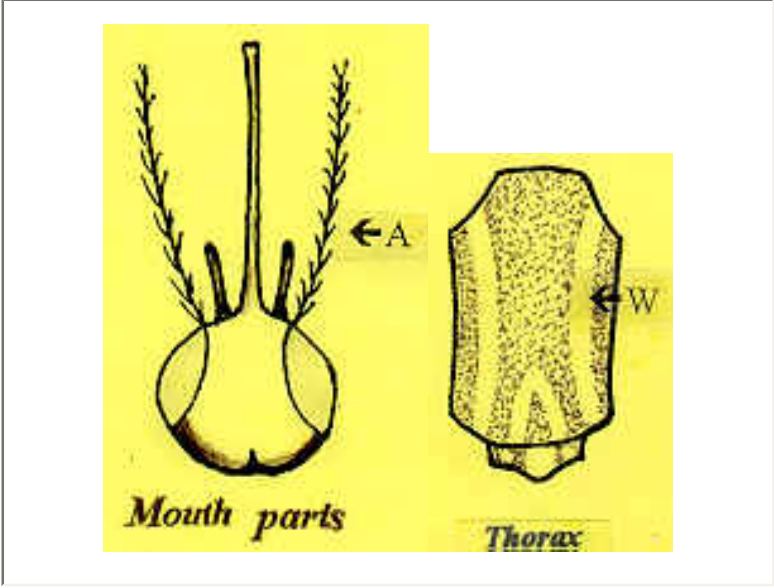
P - Palps

***Mansonia annulifera* - Female**



A - Antennae.

***Mansonia uniformis* - Female**



A - Antennae
W - Mark

Characteristic features :

- **Mouth parts :** Pilose antennae.
Short palps.
- **Thorax :** Light brown with six (6) white dots arranged in two (2) rows.

Characteristic features :

- **Mouth parts :** Pilose antennae.
Short palps.
- **Thorax :** Dark brown with pale greenish white ‘W’ marking on dorsum of thorax.

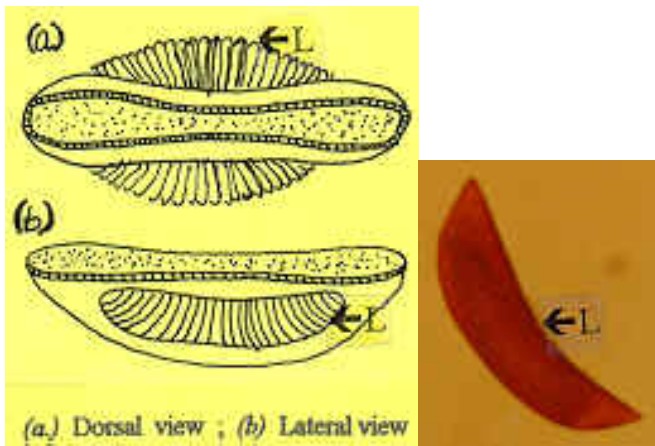
Aedes spp. - Egg



Note :

- Laid singly.
- No lateral floats.

Anopheles spp. - Egg



L - Lateral floats

Note :

- Single, boat-shaped eggs.
- Lateral floats. (Not clearly visible in this photograph)

Culex spp. - Eggs



Note :

- Eggs are stuck together forming a raft.

Mansonia spp. - Eggs



TF - Terminal filament

Note :

- Drawn out into a terminal filament.
- In the form of a cluster. (Sticky mass)

Posterior end of *Aedes* larva



Note :

- Short and broad siphon tube.
- Single sub ventral tuft.

S - Siphon

T - Tuft

Posterior end of *Anopheles* larva



Note :

- No siphon tube.

Posterior end of *Culex* larva



Note :

- Thin and long siphon tube is at the posterior end.
- Three (3) sub ventral tufts.

S - Siphon

Posterior end of *Mansonia* larva

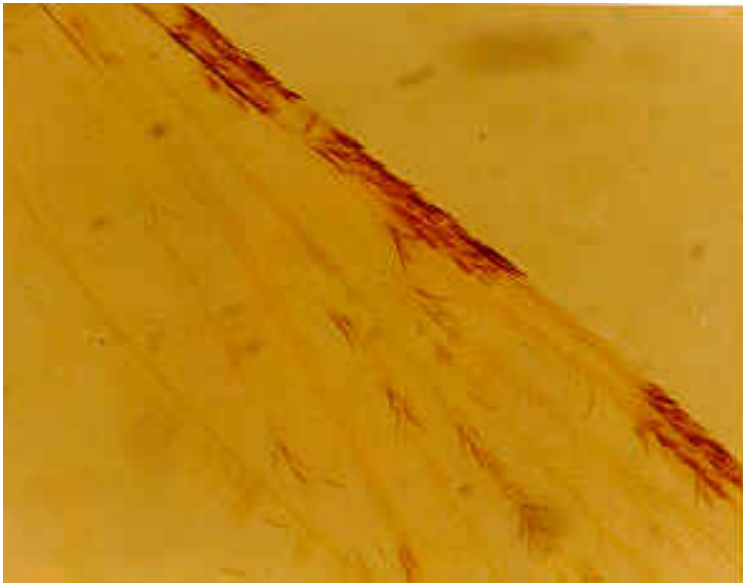


S - Siphon

Note :

- Chitinized, "**saw-like**" (Serrated) siphon.

Anopheles spp. - Wings



Note :

- Four (4) sharply defined pale areas on its anterior border and a fifth one on the wing tip.

Mansonia spp. - Wing



Note :

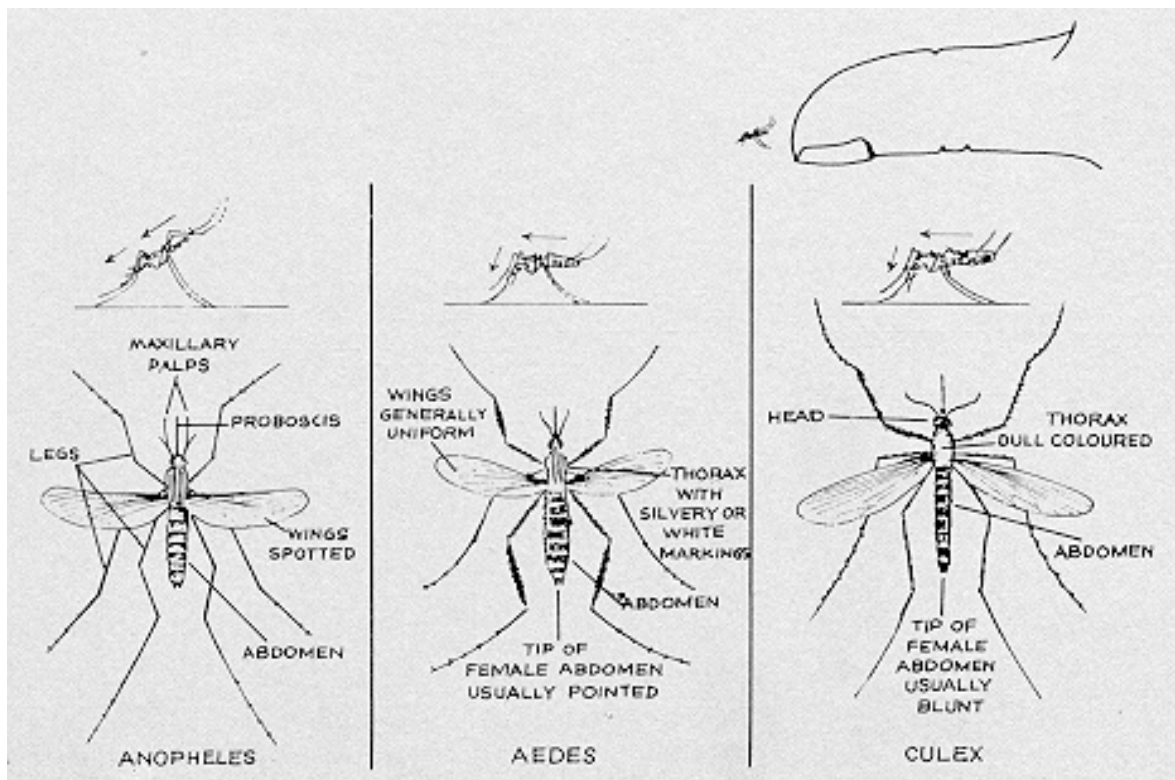
- Broad scales with "salt and pepper" appearance.

MOSQUITO

(*Anopheles culicifacies*, *Aedes aegypti*, *Aedes albopictus*, *Culex pipiens quinquefasciatus*)

APPEARANCE

- 3.5-5 mm long body covered with scales.
- 2 antennae.
- 2 wings.
- 3 pairs of legs.
- A proboscis which is used for biting and sucking blood.



LIFE CYCLE

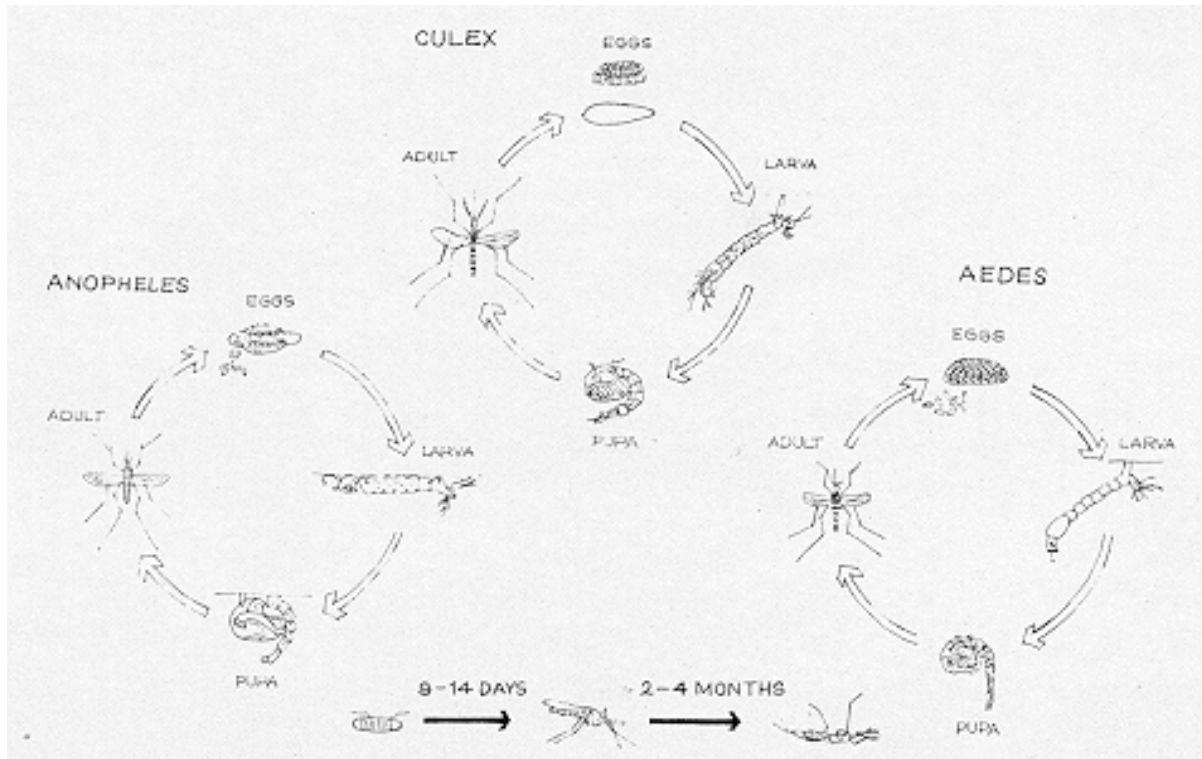
- Life cycle has four stages - egg, larva, pupa and adult.
- *Anopheles*
 - Eggs laid singly and have floats.
 - larvae rest parallel to water surface and have only rudimentary breathing tube.
 - Life cycle can be completed in 9-14 days under favourable conditions.

- ***Aedes***

- Eggs laid singly and do not have floats.
- Larvae rest at an angle to water surface and have short, stout breathing tube.
- Life cycle can be completed in 11 days under favourable conditions.

- ***Culex***

- Eggs laid in boat-shaped rafts and do not have floats.
- Larvae rest at an angle to water surface and have long, slender breathing tube.
- Life cycle can be completed in 9-13 days under favourable conditions.



HABITAT & BEHAVIOUR

- **Breeding places:**

- Primary breeding habitat of mosquito is water.
- *Anopheles* breeds in fresh as well as polluted water; particularly in marshes, water filled depressions, overhead tanks, ponds and puddles; also breeds in cisterns, pots and other receptacles.
- *Aedes* breeds in anything holding clean or fairly clean water, e.g., domestic water storage containers, flower vases, tree holes, roof gutters, old tyres and other discarded containers.
- *Culex* breeds in polluted water, e.g., in drains cesspits, pit latrines, and sometimes in rainwater collected in discarded containers and roadside ditches.

- **Resting places**

- Dark, cool, humid places.
- Resting places inside dwellings include hanging furnishings and clothing, under furniture, on walls, ceilings etc.
- Resting places around dwellings include clumps of vegetation, tree holes, drainage pipes, etc.

PUBLIC HEALTH IMPORTANCE

- Female mosquito bites and sucks blood.
- Mosquito bites cause itching and may spread disease.
- *An.culicifacies* spreads malaria.
- *Ae. aegypti* and *Ae. albopictus* spread viral diseases, e.g., dengue, and yellow fever.
- *C.p. quinquefasciatus* spreads bancroftian filariasis.
- Various species spread filariasis, which can lead to elephantiasis.

THINGS NEEDED FOR CONTROL

- Window screening.
- Mosquito net.
- Mosquito eating fish.
- Paraffin oil.
- Mosquito repellent.
- Hand spray-gun for repellent.

IN THE HOUSE

- **Eliminate breeding places:**
 - Cover water storage containers.
 - Get rid of unwanted standing water; invert container if possible.
 - Clean roof gutters.
 - Replace water in flower vases, animal drinking pans, etc. every day.
- **Prevent access:**
 - Use mosquito net.
 - Use insect repellent.
 - Screen doors, windows, ventilators and beds.
 - Cover water surface of pit latrines with paraffin oil or polystyrene balls.

AROUND THE HOUSE

- Cut open cans and crush; turn over pans and trays; cut waste tyres and turn over; fill in tree holes.
- Remove waste articles that may catch rain water.
- Cover cisterns and open tanks with screens.
- Introduce mosquito eating fish such as *Gambusia affinis* into wells and other fresh water sources.
- Pour paraffin over- or use polystyrene balls to cover - standing water that cannot be drained.
- Replace cesspits by soakpits.
- Seal septic tanks and fit vent pipes with screens.

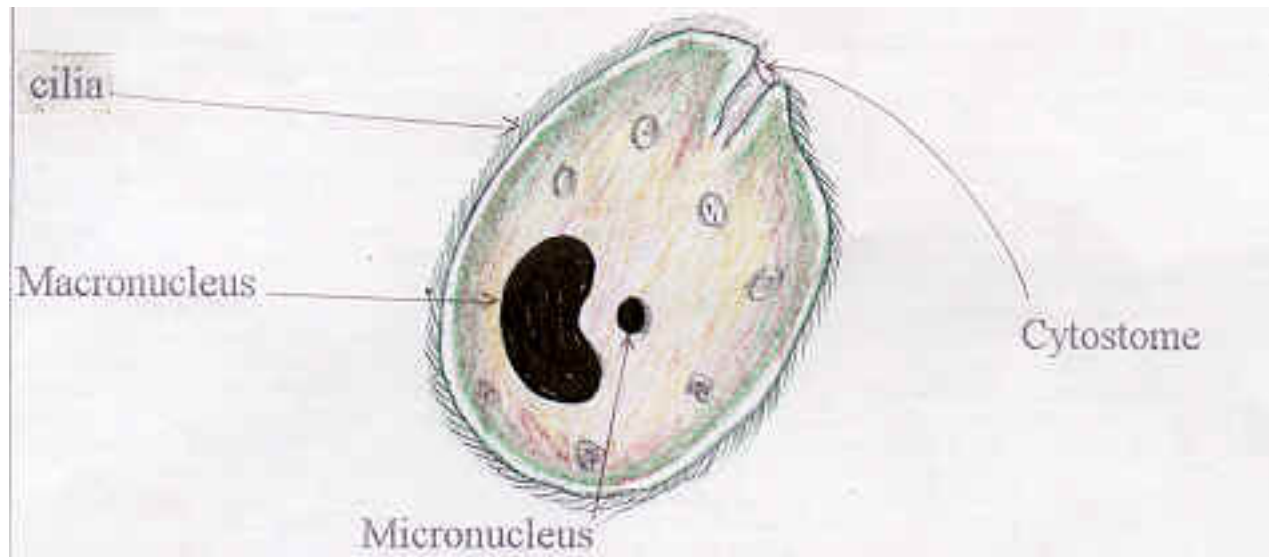
IN THE COMMUNITY

- Drain or fill marshes, swamps, puddles, etc.

- Introduce natural predators such as dragonflies, lizards and toads into mosquito habitat.
- Prevent water spillage around community water-supply sources.
- For large bodies of water, construct public irrigation works that allow control of water level and shore conditions.

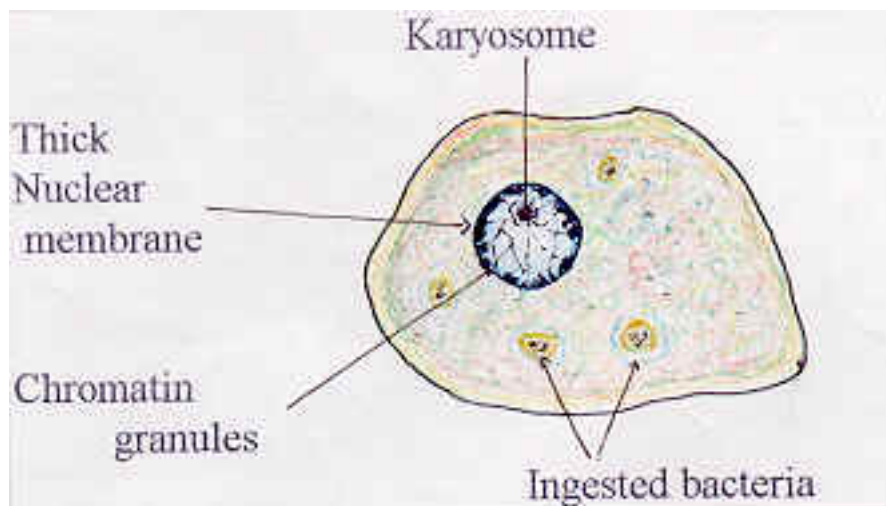
Protozoa

***Balantidium coli* - Trophozoite**



- **Size :** Very large 45-60 μm . (Often as big as or bigger than round worm egg).
- **Shape :** Oval with one pole more rounded than the other. (shaped like a sac)
- **Cilia :** Small cilia visible on surface.
- **Content :** Large kidney shaped macronucleus and a small round micronucleus. Cytostome ("mouth") visible at the top of the organism.
- **Cytoplasm :** Granular and numerous vacuoles present.

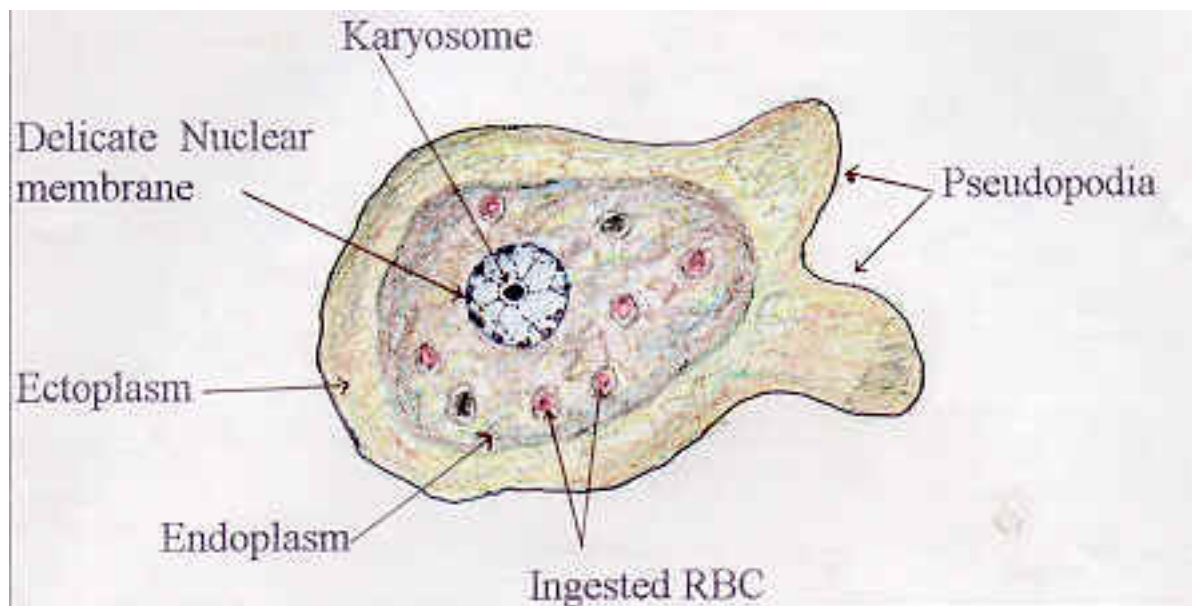
***Entamoeba coli* - Trophozoite**



- Unicellular.
- No definite shape.

- single nucleus.
- Demarcation between ectoplasm & endoplasm is not very clear, ectoplasm is only a thin rim of cytoplasm.
- Pseudopodia are broader & blunter (usually granular).
- Endoplasm coarsely granular, usually contains ingested Bacteria - numerous vacuoles (No RBC).
- Karyosome large, eccentrically located inside the nucleus.
- Nuclear membrane is thick, lined irregularly with coarse granules of chromatin.
- Size range 15-50 μm
- **(Fresh specimen will show sluggish movement)**.

***Entamoeba histolytica* - Trophozoite**

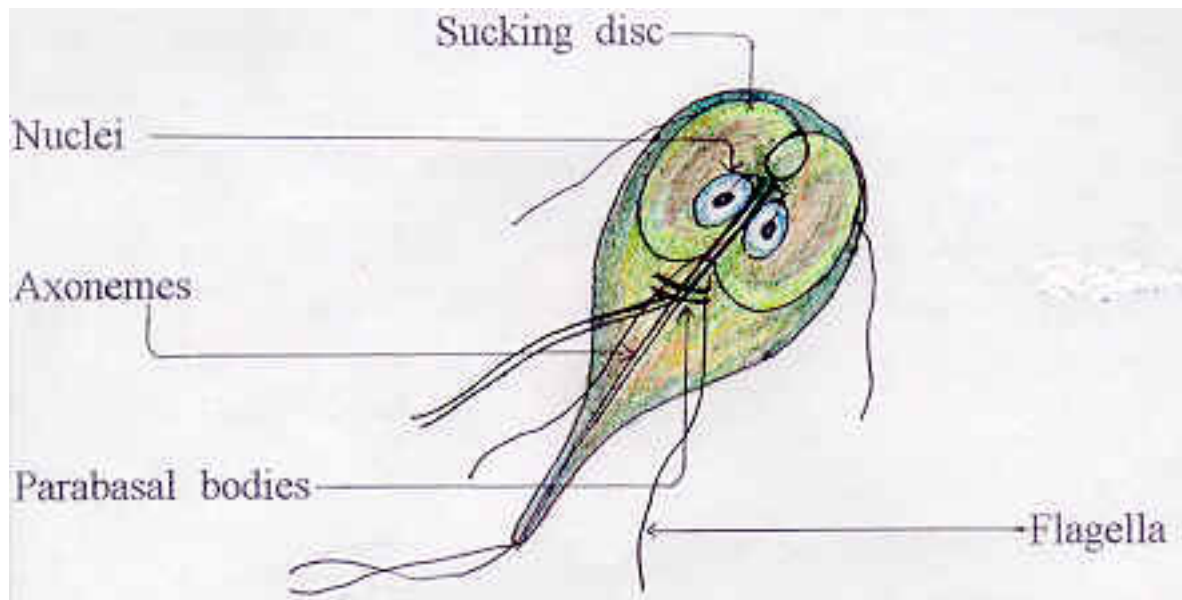


- Unicellular.
- No definite shape.
- Single nucleus.
- Cytoplasm is divided into - clear hyaline -**ectoplasm**.
finely granular -**endoplasm**.
- Thin finger like ectoplasmic pseudopodia.
- Endoplasm usually contains ingested RBC(Reddish yellow or Yellowish green in saline preparation), **No Bacteria**.
- Karyosome is small dot like, central in position and surrounded by a clear halo

inside the nucleus.

- Nuclear membrane is delicate, lined regularly with single layer of fine granules of chromatin.
- Size range 15-60 μm .
- **(Fresh specimen will show characteristic active progressive movement in definite direction).**

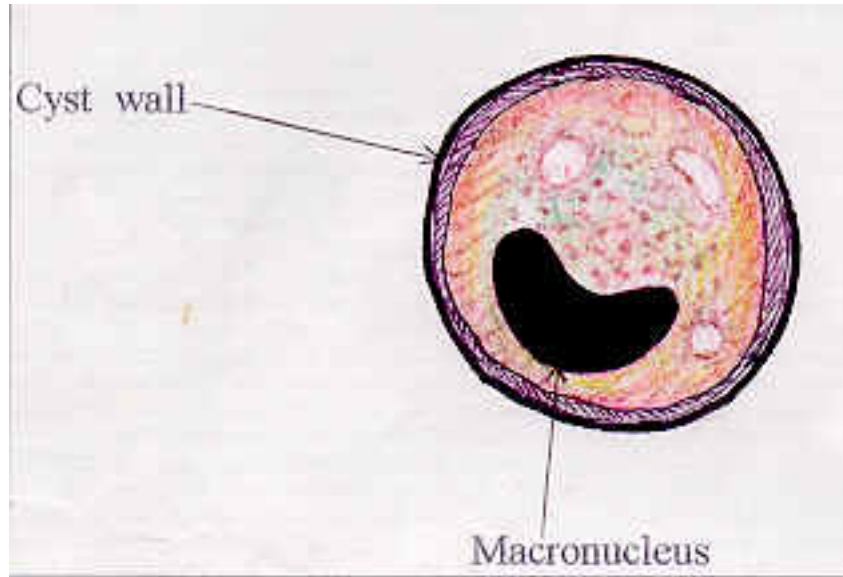
***Giardia intestinalis* - Trophozoite** **(*Giardia lamblia* / *duodenalis*)**



- **Size :** 10-18 μm (size of 2 RBC s)
- **Shape :** Bilaterally symmetrical.
Front view - pear shaped, broad anterior & tapering posterior end.
Side view - spoon shaped.
- **Content :** An ovoid, concave sucking disc (occupies 3/4th of ventral surface.)
 2 nuclei with large central karyosomes.
 2 axonemes.
 2 blepharoplasts.
 2 parabasal bodies (deeply staining).
 4 pairs of flagella.
 (No undulating membrane or axosytle).
- **Motility :** Moves forward with rapid, jerky , twisting motion. **(seen in fresh**

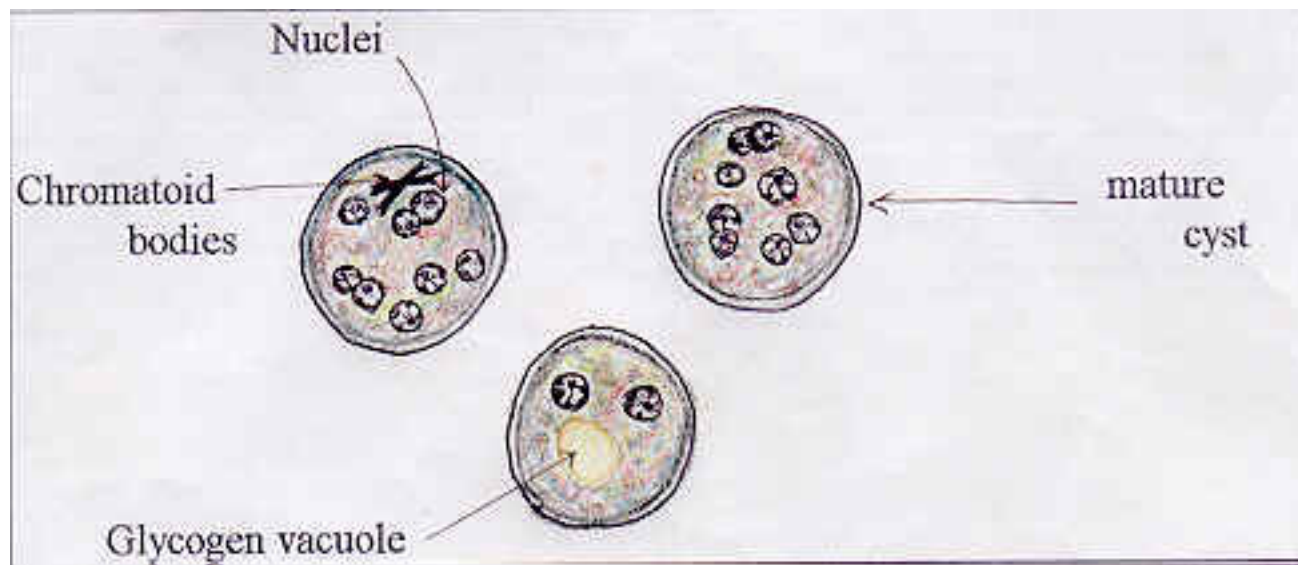
specimens).

Balantidium coli - Cyst Stage



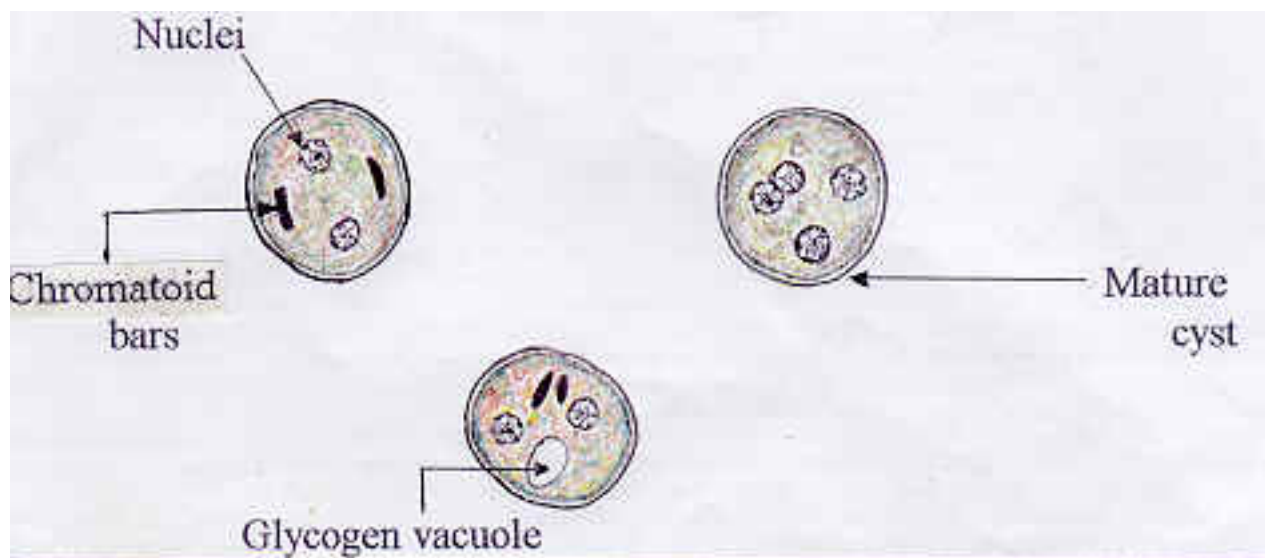
- **Size :** Very large cyst 45-65 μm . (Size of a round worm egg).
 - **Shape :** Round. (sometimes oval).
 - **Shell :** Thin, double walled.
 - **Nuclei :** Usually only the large kidney shaped macronucleus is visible.
 - **Cytoplasm :** Granular, filled with inclusion bodies.
-

Entamoeba coli - Cyst Stage



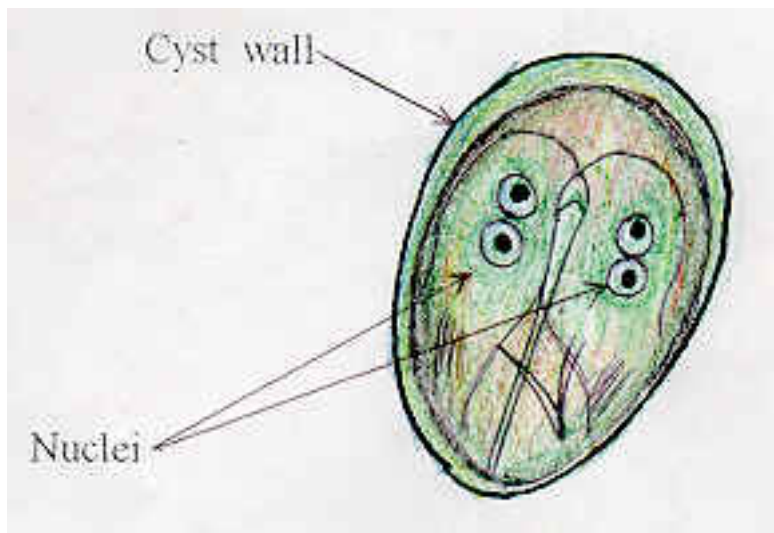
- Round in shape.
- Surrounded by a highly refractile membrane -Cyst wall.
- Mature cysts contain **EIGHT (8)** nuclei.
- Cytoplasm is clear & hyaline.
- Nuclei retain characteristics of trophozoite nuclei (Coarse chromatin granules, Eccentric karyosome).
- Chromatoid bodies if present are in the form of slender filaments or pointed threads.
- Glycogen vacuole large, diffuse, visible in binucleate stage (Not found in mature cyst).
- Size range 15-20 μm (**Larger compared to *E.histolytica***)

***Entamoeba histolytica* - Cyst Stage**



- Round in shape.
- Surrounded by a highly refractile membrane -Cyst wall .
- Mature cyst contains **FOUR (4)** nuclei.
- Cytoplasm clear & hyaline.
- Nuclei retain characteristics of trophozoite nuclei (Fine chromatin granules, Central karyosome).
- Chromatoid bars are seen as refractile rods with rounded ends (sausage shape) in normal saline.(Stains Black with iron haematoxylin, Do not stain with iodine.)
- Glycogen vacuole diffuse, stains mahogany brown with iodine (visible in uninucleate stage).
- Size range 10-15 μ (smaller compared to *E.coli*).

***Giardia intestinalis* - Cyst Stage** **(*Giardia lamblia* / *duodenalis*)**



- **Size** : 8-10 μ m.
- **Shape** : Oval, one pole more rounded than the other.
- **Shell** : Smooth, well defined wall (appears to be double walled but the second wall is the membrane of the cytoplasm)..
- **Nuclei** : Two (2) to Four (4) in number.Very fine nuclear membrane.. Karyosome small, central, faintly coloured.
- **Cytoplasm** : Clear, refractile, contains many of the structures of the trophozoite.

Snakes

CLASSIFICATION OF SNAKES

LAND SNAKES		
• Earth snakes	Non poisonous.	
• Constrictors	Non poisonous	Eg: Python
• Colubrids	a). Non poisonous b). Feebly poisonous	Eg: Rat snake Eg: Ceylon wolf snake
• Elapids	a). Highly poisonous and deadly b). Poisonous	Eg: Cobra /Ceylon krait Common krait Eg: Coral snake
• Vipers	a). True vipers b). Pit vipers	Eg: Russell's viper /Saw-scaled viper Eg: Green pit viper /Hump nosed viper.
SEA SNAKES	Highly poisonous.	

STEP 1

IDENTIFICATION OF SNAKES

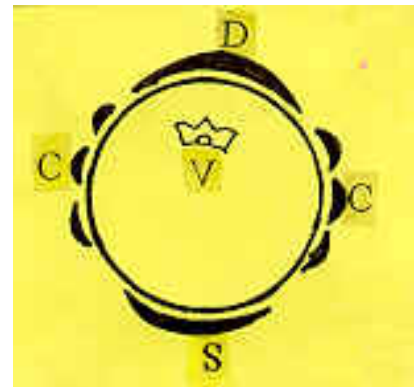
A) Arrangement of scales

V-Vertebral column

**D-Dorsals or
vertebrals**

C-Costals

**S-Sub caudals/
ventrals**



B) Body markings

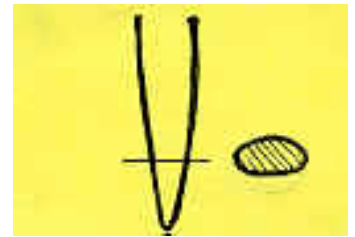
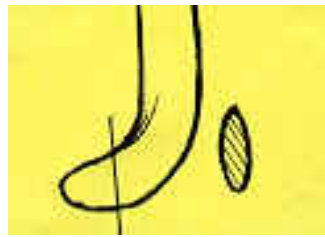
**Eg:Python-
characteristic
irregular, brown
quadrate markings
along the body.**



C) Tail-Laterally compressed or not

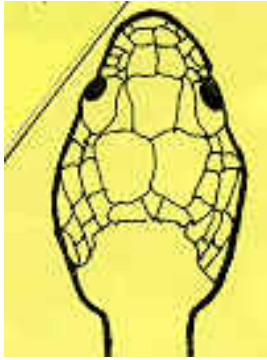
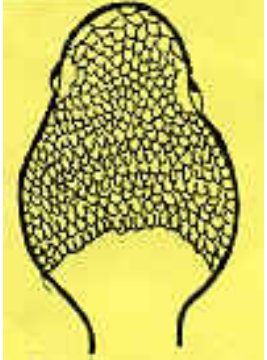
Eg: a)Sea snakes - Laterally compressed tail

b)Land snakes - Rounded in cross section.



STEP 2

DIFFERENTIATION BETWEEN COLUBRIDS AND ELAPIDS FROM VIPERS

Body parts	Colubrids/Elapids		Vipers	
Head	<ul style="list-style-type: none"> •Oval or spatula shape. • Has large scales 		<ul style="list-style-type: none"> •Triangular shape. • Has small scales. <p>(Exception- Hump nosed viper has large head scales)</p>	

Body and Tail

- Long and cylindrical body.
- Long and pointed tail



- Short and stout body.
- Short tail.



STEP 3

DIFFERENTIATION BETWEEN COLUBRIDS AND ELAPIDS

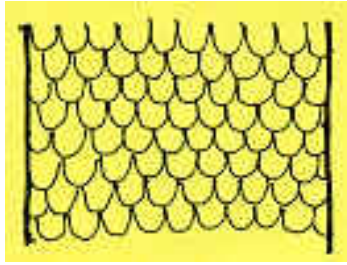
Scales

Colubrids

Elapids

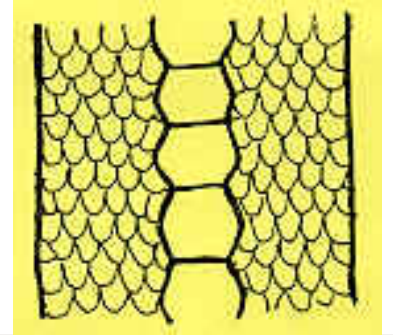
Vertebrals

• **Vertebrals are not enlarged**



• **Enlarged vertebrals**

(Exception - cobra)

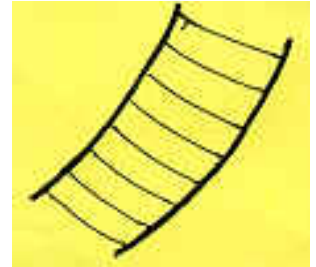
**Subcaudals**

• **Double or biserial subcaudals**

(Exception- Ceylon wolf snake)



• **Single or uniserial subcaudals**



Naja naja naja (Cobra)

S- (Nagaya, Naya)/ T-(Nalla paambu)



Habitat: All over Sri Lanka.

Characteristic features:

- Largest elapid in Sri Lanka (Upto 1m)
- Dark brown, black and olive in colour.
- "Hood" on head with "**spectacle marking**" on dorsal surface and two (2) black spots on ventral surface are clearly seen when the hood is spread out.
- Dark brown bands extend ventrally behind the hood.
- **Highly poisonous.**

Bungarus ceylonicus (Ceylon krait)

S- (Dunu karawala, Polon karawala)/ T - (Yettadi virian, yennai virian)



Habitat: Wet and Intermediate zones.

Characteristic features:

- Length upto 1m.
- Dorsal surface is black in colour with single white bands that continue onto the ventral surface.
- **Highly poisonous.**

Bungarus caeruleus (Common /Indian krait)

S-(Thel karawala, Magamaruwa) / T - (Yettadi virian, yennai virian)



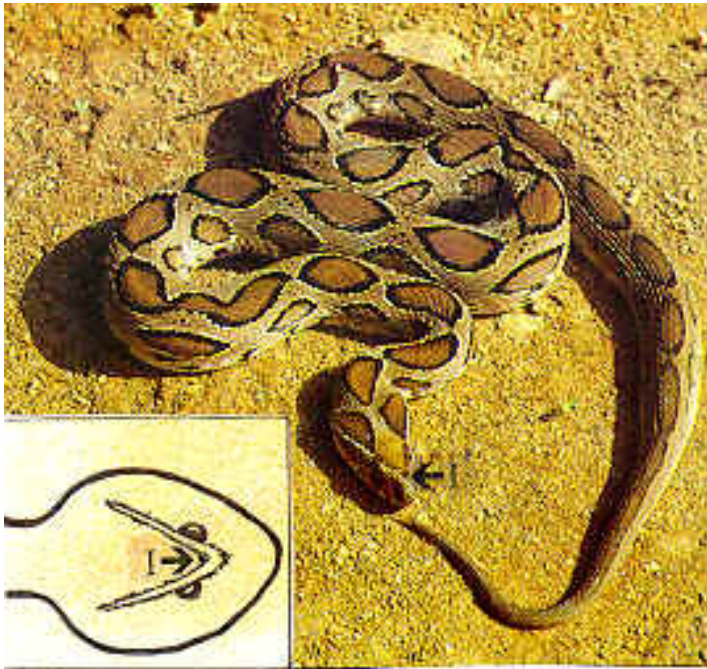
Habitat: Usually in dry zone of North and North Western provinces.

Characteristic features:

- Length upto 140 cm.
- Dorsal surface is shiny bluish - black with narrow, white double bands.
- Ventral surface is clear white and no bands.
- **Highly poisonous.**

Daboia russellii (Russell's viper)

S- (Tith polonga,Dhara polonga)/ T- (Kannadi virian)



Habitat: All over Sri Lanka.

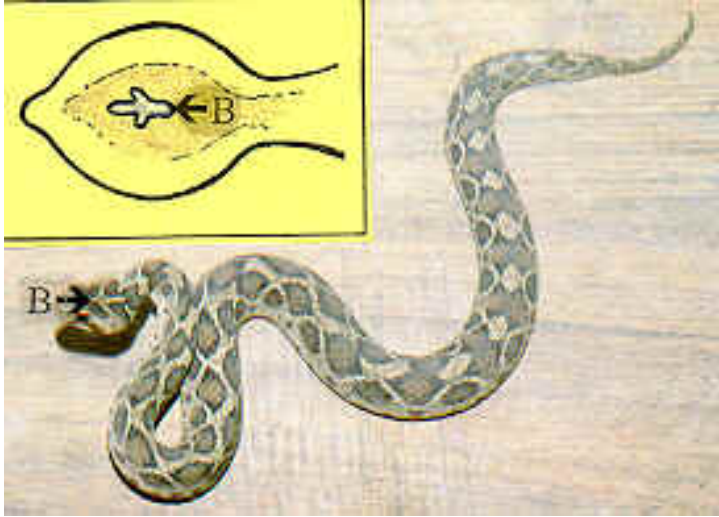
Characteristic features:

- Largest viper in Sri Lanka. (Upto 1.5 m)
- Colour varies from greyish to reddish brown.
- Has a marked neck.
- Three (3) rows of chain-like markings along the length of the body.
- **Inverted "V" mark on dorsum of head.**
- **Highly poisonous.**

I - Inverted 'V' mark

***Echis carinatus* (Saw-scaled viper)**

S- (Vali polonga)/ T-(Surattai paambu)



B - 'Birds foot' mark

Habitat: Sandy, coastal areas in the Northern and Eastern provinces.

Characteristic features:

- Length upto 50 cm.
- Dark brown in colour.
- Has a marked neck.
- **"Birds foot" ("Cross") mark on dorsal surface of head.**
- "Saw-scales" on sides of body produce a continuous hissing noise as the snake moves.
- **Highly poisonous.**

***Hypnale hypnale* (Hump-nosed viper)**

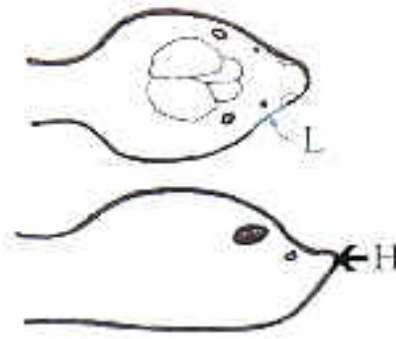
S- (Polon thelissa, Kunakatuwa)/ T- (Kulal-mooku-pudayan)

Habitat: All over Sri Lanka but commoner in plantations and in Wet zone.

Characteristic features:

H- Hump nose
L - Loreal pits

- Smaller in size (30-40 cm).
- Dark brown patches on side of body.
- Has a marked



neck.

- Nose is highly pointed and turned up (hump-nose).
- Presence of loreal pits on head.
- **Poisonous but fatal bites are uncommon.**

Trimeresurus trigonocephalus (Green pit viper)

S- (Pala polonga)/ T-(Kopi virian, patchai virian)



Habitat: All parts of Sri Lanka and especially in plantations.

Characteristic features:

- Length upto 130 cm.
- Bluish-green in colour, with black markings from head to tail.
- Large broad, flat head is triangular in shape.
- **Poisonous but fatal cases are rare in Sri Lanka.**

Sea snake (Hydrophiidae)

S-(Muhudu naya)



Characteristic features:

- The tail is laterally compressed.
- **Highly poisonous.**

Boiga spp. (Cat snake)

S- (Mapila)/ T- (Chingihalu)



Characteristic features:

- Triangular head with distinct, constricted neck.
- Head scales are enlarged.
- Light-reddish brown in colour.
- Resembles hump-nosed viper but has no loreal pit or humpon nose.
- **Mildly poisonous.**

When bitten by a venomous snake:



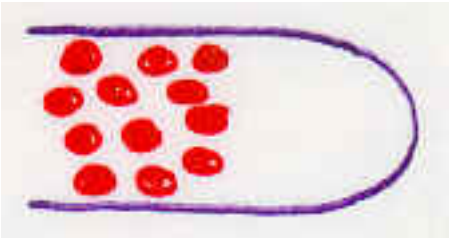

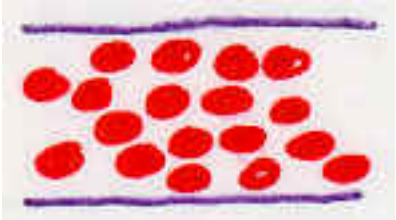
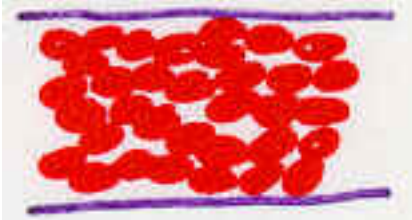


- **Do not panic.**
- **Keep the victim calm and still.**
- **Do not cut or incise the bite wound.**
- **Do not take any drug which has alcohol or aspirin**
- **Rush the patient to a hospital.**

(If you could take the snake to the doctor, it would help in the treatment)

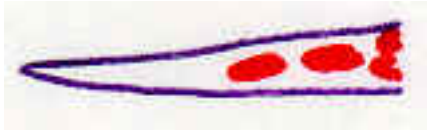
Tissue Nematodes

Comparison of microfilariae

Species	<i>W.bancrofti</i>	<i>B.malayi</i>
Sheath	+	+
Length	250-300um	175-230um
	Graceful, sweeping curves.	Irregular, kinky curves.
Appearance	 <p>Length = breadth (Square in shape.)</p>	 <p>Length = 2x breadth (Rectangular in shape)</p>
Cephalic space	 <p>Discrete, round nuclei can be counted.</p>	 <p>Nuclei blurred, cannot be counted easily.</p>
Nuclear column		

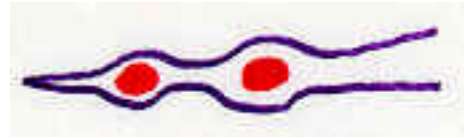
Pointed, free of nuclei.

Tail tip

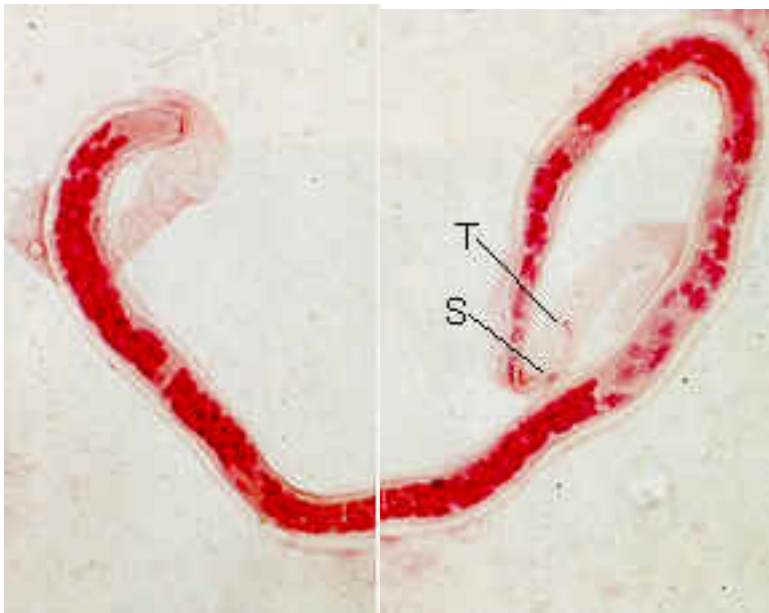


Two (2) distinct nuclei

(Terminal + Subterminal)



***Brugia malayi* - Microfilaria**



Note:

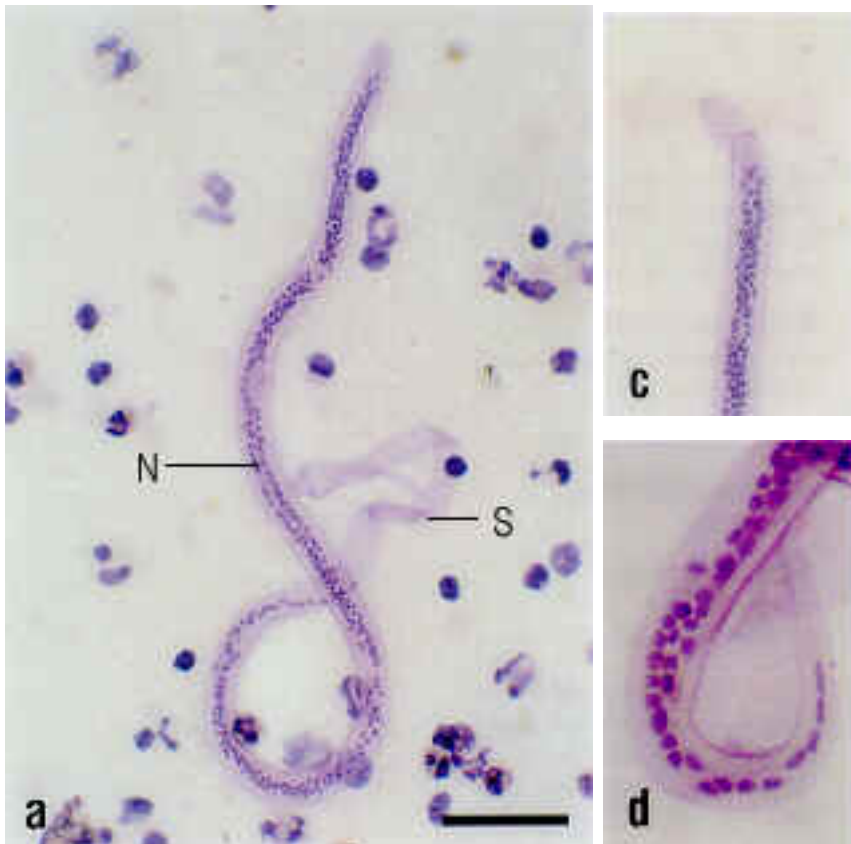
- **Length** : 175 - 230um.
- **Curves** : Irregular and kinky.
- **Sheath** : May or may not be seen.
- **Cephalic space** : Rectangular in shape, length about twice the breadth.
- **Nuclei** : Blurred, cannot be counted easily.
- **Tail** : Two distinct nuclei can be seen.

T - Terminal nucleus

S - Subterminal nucleus

SH- Sheath

Wuchereria bancrofti - Microfilaria



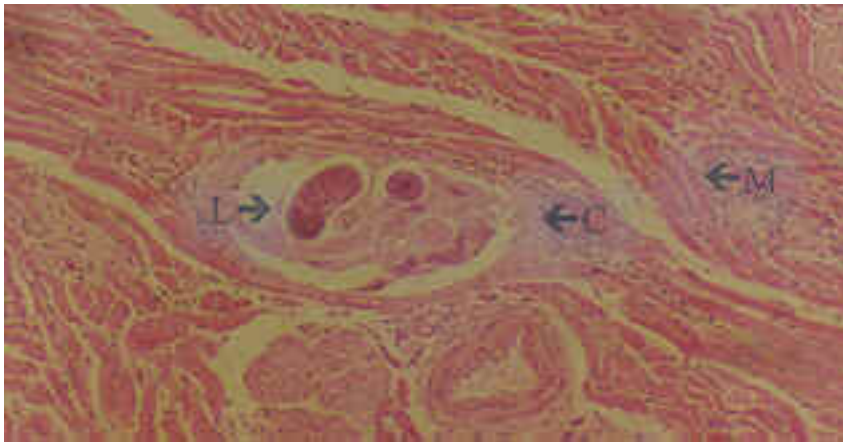
Note:

- **Length** : 250-300um.
- **Curves** : Graceful and sweeping.
- **Sheath** : Can be seen.
- **Cephalic space** : Square in shape.
- **Nuclei** : Discrete, round and can be counted easily.
- **Tail** : Pointed and free of nuclei .

N - Nuclei

S - Sheath

Trichinella spiralis - Encysted larva in muscle



Note:

- Spiral shape of the larva.
- Capsule made out of host tissue.
- Surrounding striated muscle.

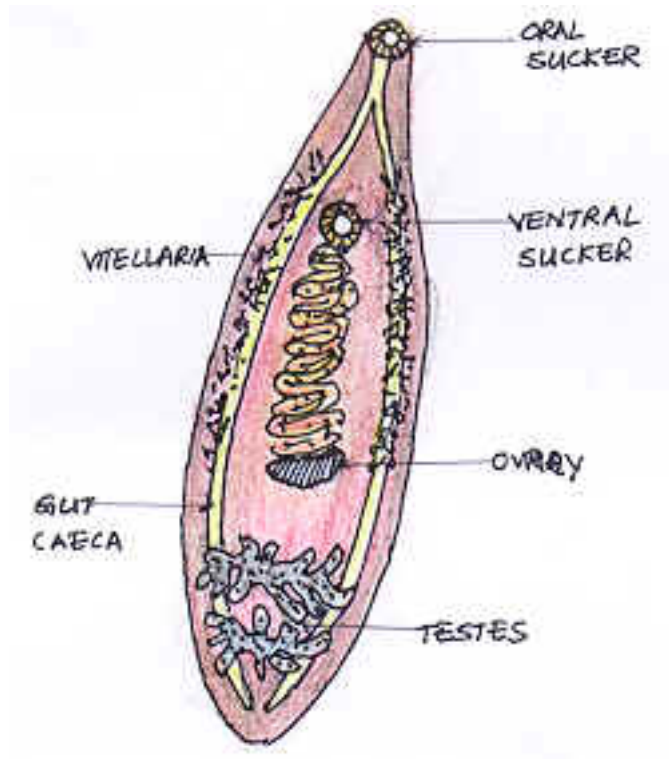
L - Larva

C - Cyst

M - Striated muscle

Trematodes

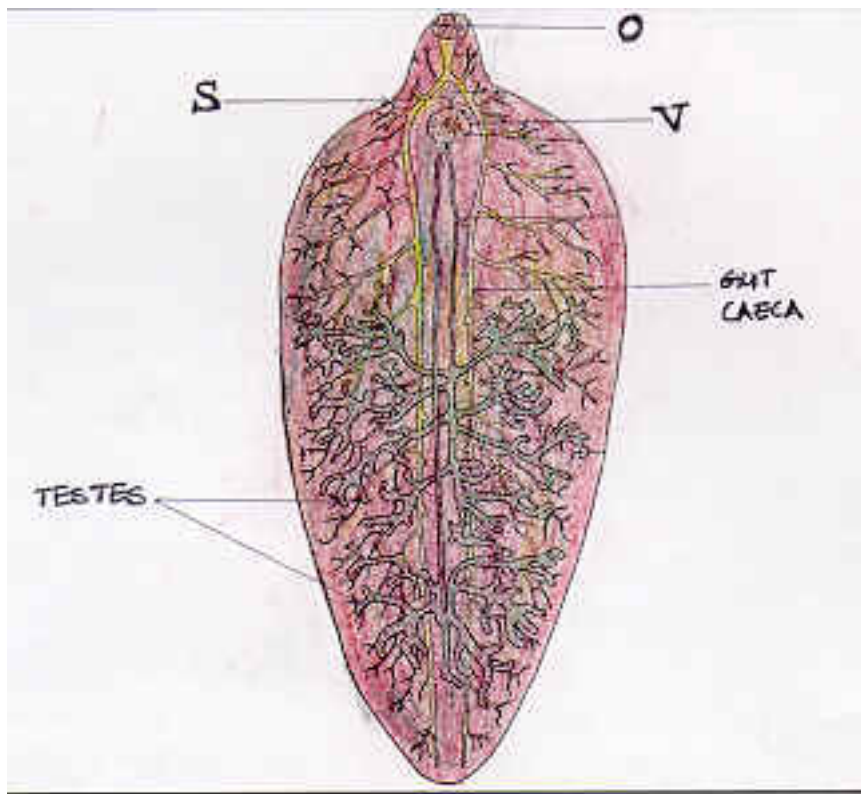
***Clonorchis sinensis* - (Oriental liver fluke) - (Stained adult worm)**



Note:

- **Size:** 6-20mm.
- **Shape:** Elongated leaf shaped.
- **Oral sucker:** Terminal.
- **Ventral sucker:** Lying about 1/4 the length of the body from anterior end.
- **Gut caeca:** Extend to the posterior end.
- **Testes:** Deeply lobed, lie one behind the other in posterior 1/2 of the body.
- **Ovary:** Small, anterior to the testes in the midline.
- **Vitellaria:** Confined to the lateral mid position of the body.

***Fasciola hepatica* (Sheep liver fluke) - Adult**

**Note:**

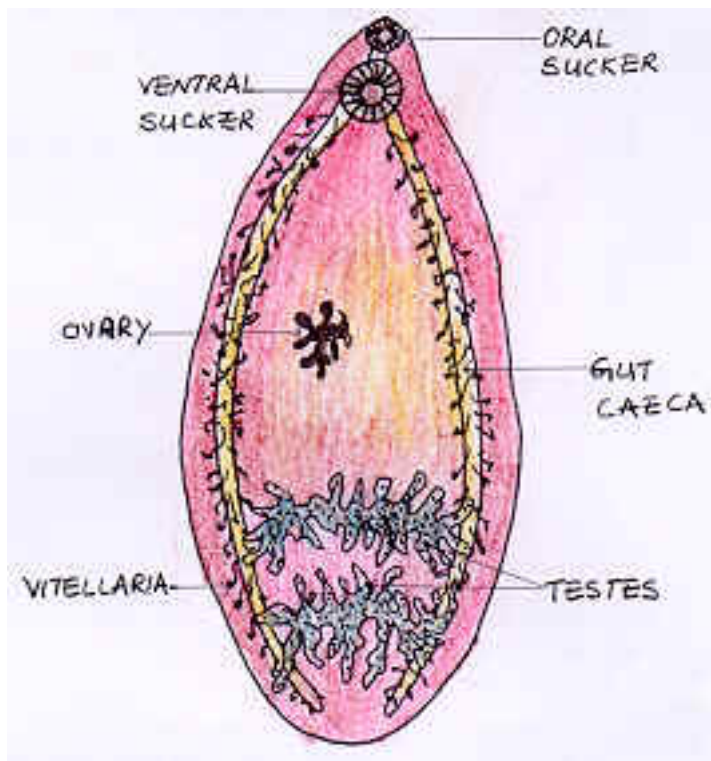
- **Size** : 20-30mm x 8-13mm.
- **Shape** : Flat leaf shaped with shouldered appearance from conical anterior projection (cephalic cone).
- **Oral sucker** : Terminal, on the cephalic cone.
Same size of ventral sucker.
- **Ventral sucker** : Within anterior 1/3 of body.
Same size of oral sucker.
- **Gut caecae** : Highly branched, end blindly.
- **Testes** : Highly branched, placed one behind the other.

O - Oral sucker

V - Ventral sucker

S - Shouldered appearance.

***Fasciolopsis buski* (Giant intestinal fluke) - Stained adult worm**

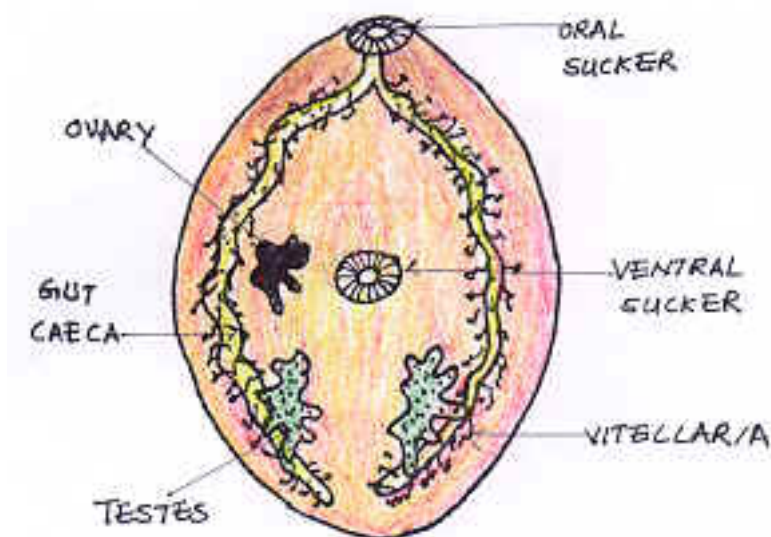


Note:

- Ovoid large worm, length 20-75mm.
- Oral and ventral suckers lie close together in anterior third of the body.
- Oral sucker is about 1/4th the size of ventral sucker.
- **Gut caeca** : Simple, unbranched.
- **Testes** : Highly branched, lie in one behind the other in posterior half of the body.
- **Ovary** : Single, highly branched, lies in the middle of the body, to the right of the midline.
- **Vitellaria** : Extend from anterior to posterior end of the body.

***Paragonimus westermani* - (Stained adult worm)**

Note:



- **Size**: About 12mm in length.
- **Shape**: Oval, coffee-bean shaped.
- **Oral sucker**: Terminal.
- **Ventral sucker**: In the middle of the body.
- **Gut caeca**: Wavy, not branched (simple) and end blindly.
- **Testes**: Lobed and lie side by side in posterior 1/3 of the body.
- **Ovary**: Lobed, anterior to testes on right side opposite to closely coiled uterus.
- **Vitellaria**: Extend from anterior to posterior end.

Clonorchis sinensis (Liver fluke) - Egg

Note:



- **Size :** 25 -30um.
- **Shell :** Smooth, Fine and Thick(Can see double lines).
A small knob at the wide end of the egg.
- **Operculum:** Easily visible at the narrow end of the egg, fitting into a thickened rim of the shell.
- **Content :** A well organised ciliated embryo.
- **Colour :** Shell - Yellowis brown.
- **Contents :** Pale yellow.

Paragonimus westermani - Lung fluke - Egg

Note:

- **Size:** 100 mm (smaller than the egg of giant liver fluke)
- **Shape:** Oval with a slight flattening in one pole.
- **Shell:** Has a distinct thickening at opposite end to the operculum.
- **Operculum:** Quite distinct, with an obvious ring.
- **Content:** Clear central space surrounded by squarish cells.
- **Colour:** Golden brown.

O - Operculum

T - thickening of the shell

Schistosoma haematobium - Egg

Note:

- **Size :** 120 -150um.
- **Shape :** Oval with one well rounded pole.
- **Spine :** Terminal.
- **Shell :** Smooth, very thin.
- **Content :** A well formed ciliated embryo surrounded by a internal shell.
- **Colour :** Grey or pale yellow.

Schistosoma japonicum - Egg



S -Spine

Note:

- **Size :** 70 - 80 um.
- **Shape :** Oval, almost rounded.
- **Spine :** Difficult to see, lateral and very small.
May be hidden by small granules often found on the surface of the egg.
- **Content :** A broad ciliated embryo.
- **Colour :** Transparent or pale yellow.

Schistosoma mansoni - Egg



Note:

- **Size :** 150um.
- **Shape :** Oval with one well rounded pole and a one conical pole.
- **Shell :** Smooth and very thin.
- **Spine :** Lateral near the rounded pole, large and triangular.
- **Content :** A ciliated embryo surrounded by an internal shell.

Toxoplasma
&
Trichomonas

Trichomonas vaginalis - Trophozoite

Morphology:



- **Size :** 27 x 18µm.
- **Shape :** Pear shaped.
- **Nucleus :** Prominent, spherical, at the anterior end.
- **Flagellae :** Five(5) in number, Four (4) anterior flagellae and one (1) posterior flagellum which extends posteriorly along the undulating membrane.
- **Axostyle :** Runs down the middle of the body.
- **Undulating membrane:** Conspicuous, extends along approximately half the length of the body.

A-axostyle

N-Nucleus

AF-Anterior flagellae

PF-Posterior flagellum

U-Undulating membrane

Toxoplasma gondii - Pseudocyst & released Endozoites/ Tachyzoites



Note:

- Endozoites/Tachyzoites within the macrophage = **Pseudocyst**
- Some of the pseudocysts are ruptured releasing endozoites.

Tachyzoites/Endozoites

- Crescent or curved in shape .
- 4-6 x 2-3um in size.
- One end rounded and other end pointed

P-Pseudocyst

E - Endozoites

W - White cells