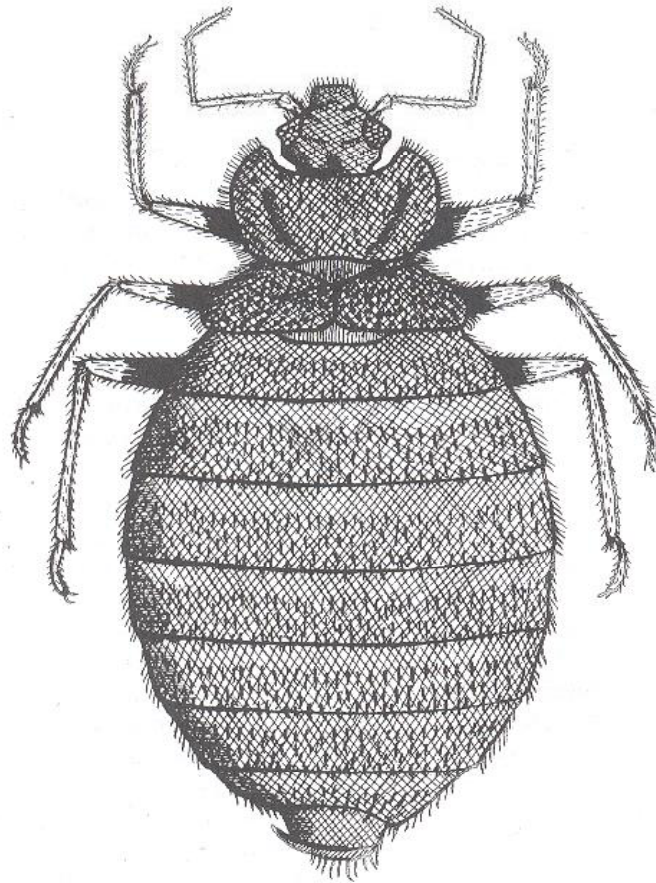


The family Cimicidae (Bedbugs)



- There are two species of bed bugs, of which both feed on humans.
- *Cimex lectularius*, which has a wide distribution in tropical and non tropical countries.
- *C. hemipterus*, commonly called the tropical bedbugs and also occur in some areas of some non-tropical countries such as Florida, USA.

- It's not often easy to separate these two bedbugs; *C. lectularius* the prothorax is generally 2.5 times as wide as long, whereas in *C. hemipterus* it is only twice as wide as long.
- Also in *C. hemipterus* the abdomen the abdomen is not as rounded as in *C. lectularius*.
- A third species *Leptocimex boueti*, found only in west Africa, bites bats and also human but it's of much less importance than *Cimex species*.

External morphology

- Bedbugs are oval, wingless insects which are flattened dorsoventrally
- They are about 4-7mm long and when unfed pale yellow or brown colour, but after a full blood meal they become characteristically darker brown (mahogany).

- The head is short and broad and has a pair of prominent compound eyes, in front which have a pair of segmented antennae.
- The prothorax is much larger than mesothorax and metathorax and has distinct wind-like expansion.

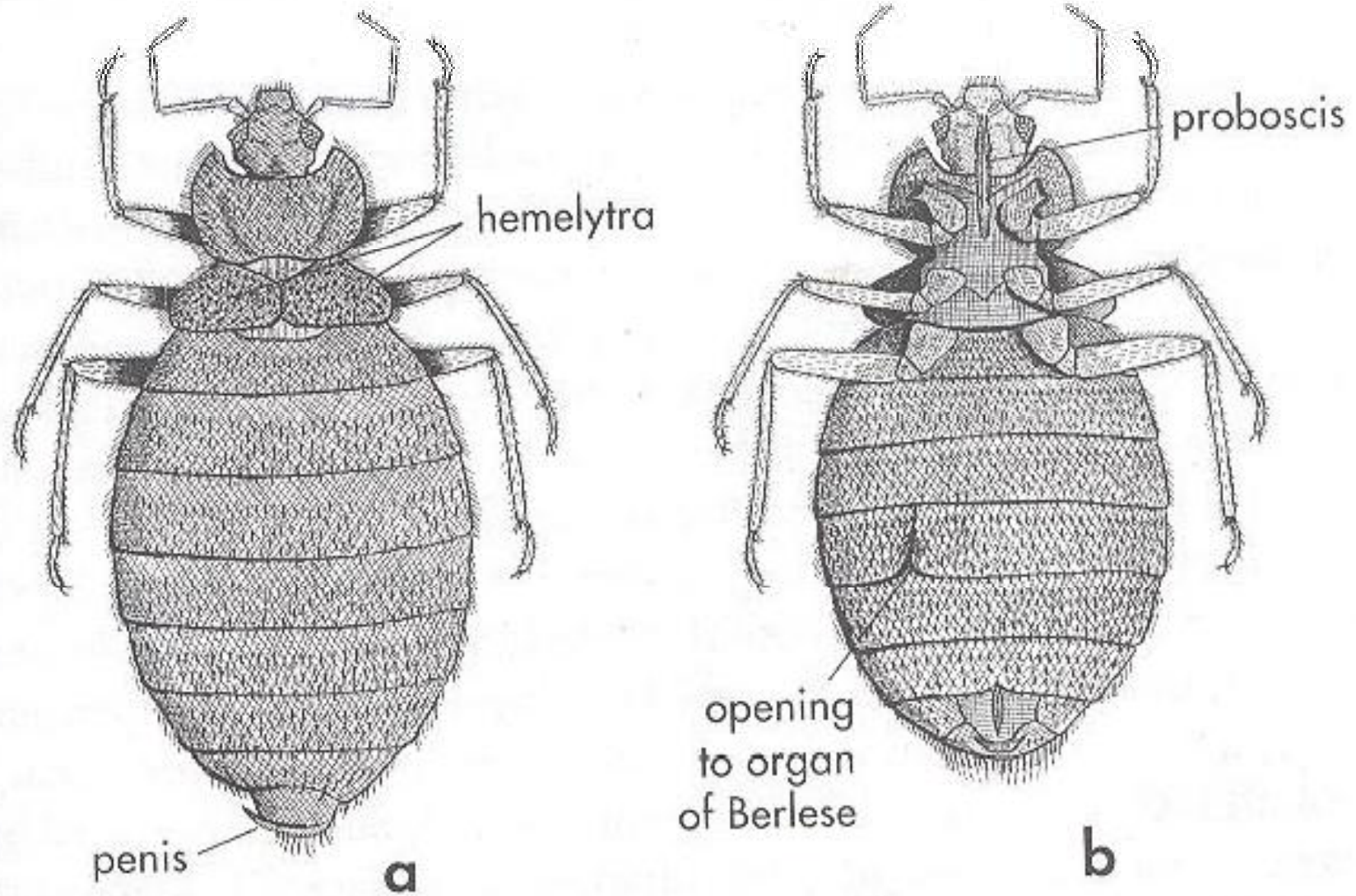


Figure 13.1 The bedbug, *Cimex hemipterus*. (a) Dorsal view of adult male; (b) ventral view of adult female.

The proboscis is slender, and is normally held closely appressed along the ventral surface of the head and prothorax, but when a bug takes a blood meal it is swung forward and downwards.

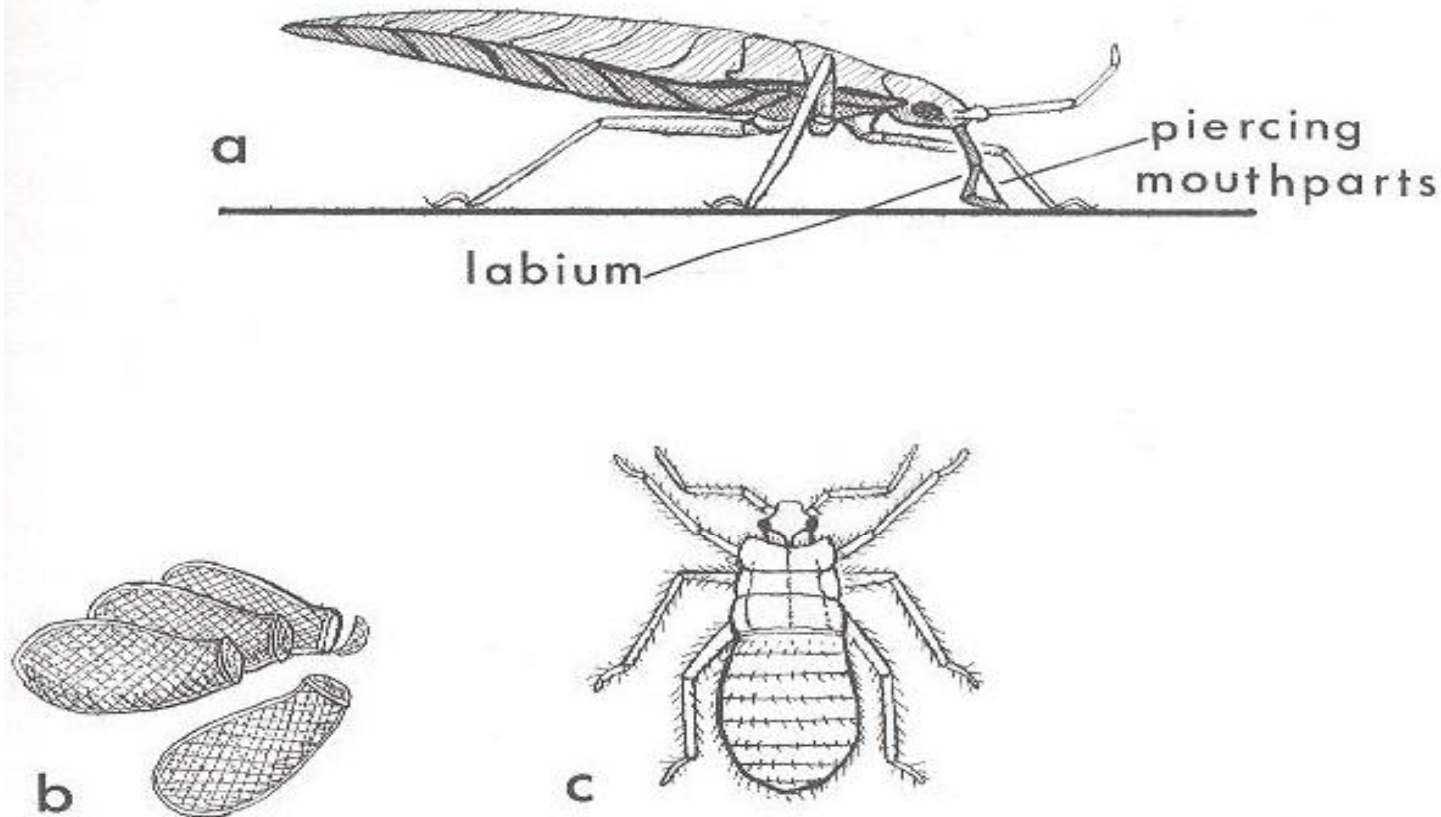


Figure 13.2 Bedbugs. (a) Diagram of adult with proboscis swung forward for feeding; (b) one hatched and three unhatched eggs; (c) first-instar nymph.

- The three pairs of leg are slender but very developed.
- Abdomen is divided into 8 visible segment
- In males the tip of abdomen is more pointed than females with a well developed and curved.
- Both female and male bites people.

Life cycle

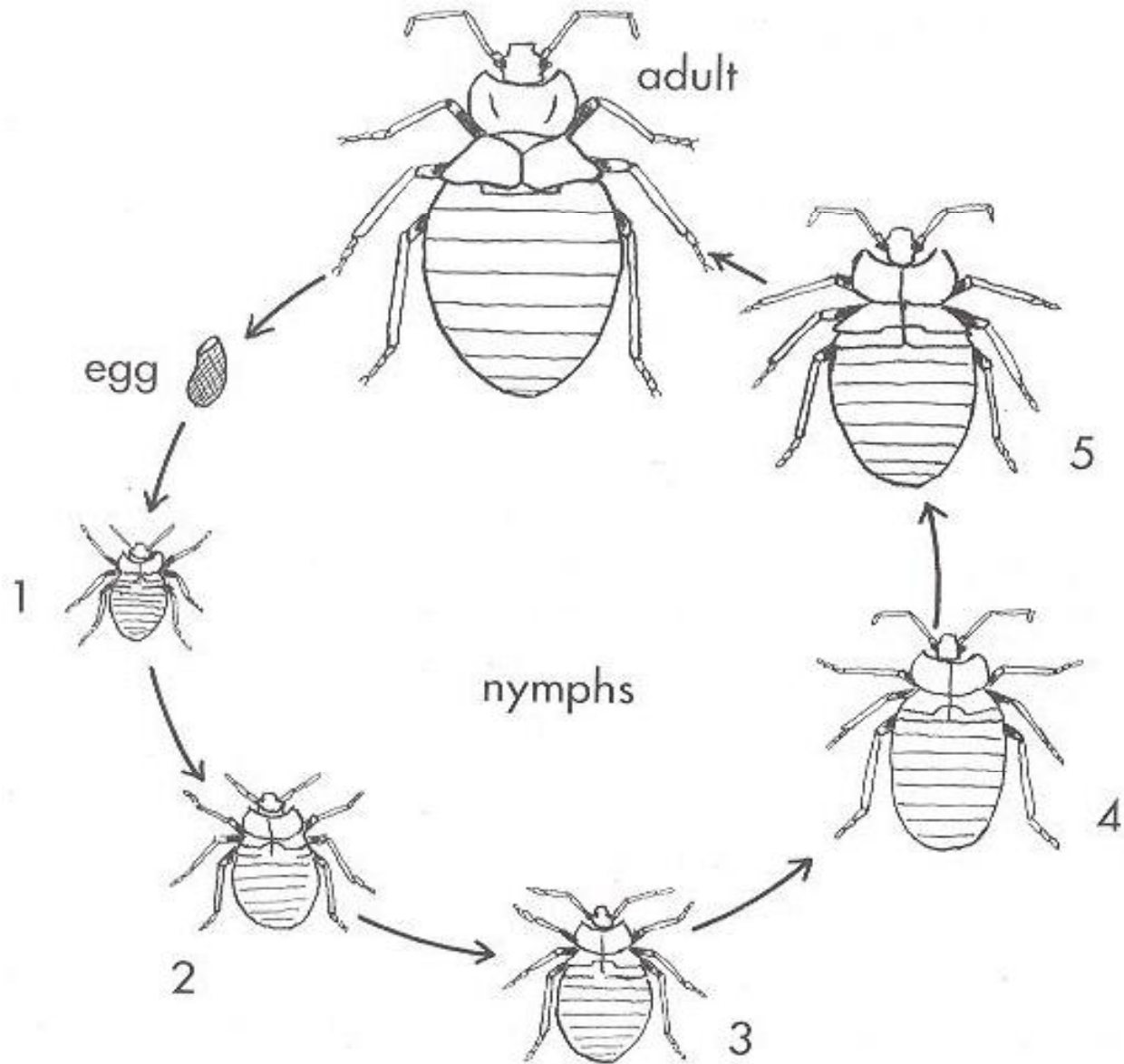


Figure 13.3 Life cycle of bedbugs.

- Both sexes of bedbugs take blood meals and equally important as pests.
- Feeding usually occur during the night on sleeping person.
- If the bedbugs are starving they will feed during the day in dark rooms or in light one.

- Bedbugs do not stay long on human just visit for taking blood meals
- In absence of people bugs will feed on variety of mammals, including rabbits, rats and bats and also on birds.
- During the day both nymph and adults are inactive and hide away in variety of dark and dry places, such as cracks and crevices in furniture and beds.
- Bedbugs are gregarious and are frequently found in large numbers.

- Female lay about 6-10 eggs a week which are placed in the same places where the bugs hide, such as in cracks and crevices of building and furniture.
- Eggs often hatch after 8-11 days (**hatchability is temperature dependant**)
- Hatched bedbugs (Nymph) are very pale yellow and resemble the adult, but are much smaller.

- The life cycle is **hemimetabolous** and there are five nymphal instars, each of which takes one or more blood meals.
- Nymphal period last 5-8 weeks (**It's temperature dependant**).
- The life cycle from egg to adult can be 3 to 6 weeks
- Adults can live up to four years and can starve for up to 550 days. It's very much dependent of temperature and humidity.

How can bedbugs be detected in House

- Bed bugs can be detected live, by the presence of cast-off skin of the nymphs, and hatched and unhatched eggs in cracks and crevices.
- Black spots might be found on bed sheets or walls; these are excreta.
- Houses with high infestation of bed bugs may have characteristics of sweet and rather sticky smell.
- Bedbugs can move very fast when disturbed and they have limited dispersal because they don't have wings.

Medical Importance

- Bedbugs are considered to be important disease vectors, but in addition to constituting biting nuisance they may aid the transmission of hepatitis B virus.
- Causes distress(extreme painful)
- Anaemia in infants in highly infested areas
- Annoyance

Control

- Use of bednets and repellents
- Use of insecticides for house spray (permethrin, Deltamethrin, Lambdacyalothrin)
- Bedding and mattresses can be slightly sprayed (not with Diazinon)

Challenges

1. Resistance to pyrethroids (Temu et al.,1999; Myamba et al.2002).
2. House structures improvement

Cockroaches

Order : Blattaria

- There are almost 4000 spp of cockroaches
- About 50 species have become domestic pests, and the most important medically are *Blattella germanica* (the german cockroach), *Blatta orientalis* and *Periplaneta americana* (the American cockroach).
- They belong to suborder Blattaria of order dictyoptera.
- They aid in transmission and harbourage of various pathogenic viruses, protozoan and helminthes.

External morphology

- Cockroaches are chestnut brown or black, 1-5cm long flatten dorsoventrally and have a smooth, shiny and tough integument.
- A pair of long and prominent filiform antennae arises from the front of the head between eyes.
- The cockroach mouth parts are developed for the chewing gnawing and scraping; they are not compose of piercing styles and therefore cockroach cannot suck blood.
- In adults of both sexes there are two pairs of wings.

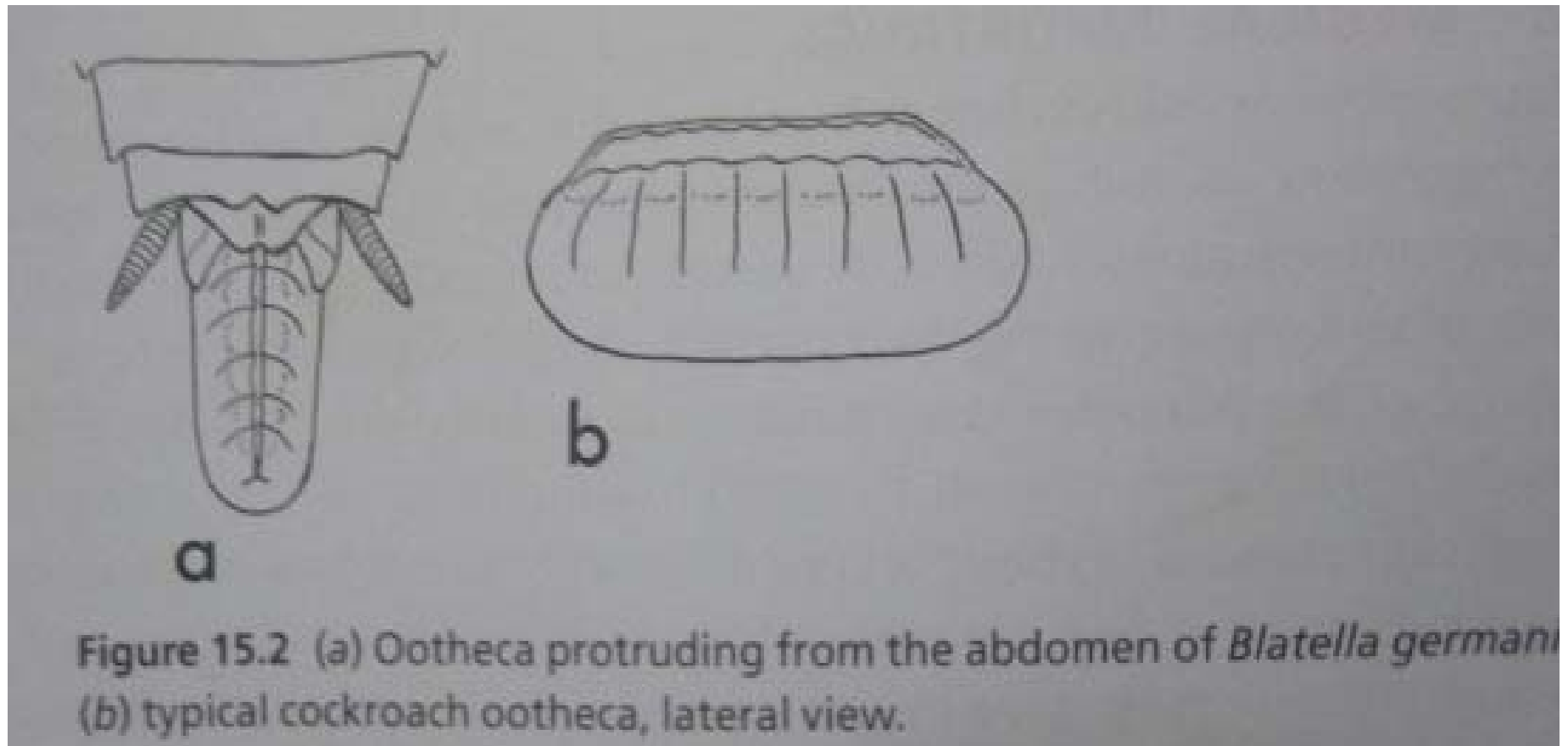
- In the females, wings may be shorter than those of the males, and in the females of *Blatta orientalis* they are very small and non-functional.
- The fore-wings are thickened and rather leathery in texture and are called tegmina; they are not used in flight but serve as protective covers for the hind wings which are membranous and can be used for flying.
- There are three pairs of legs which are well developed and covered with small spines bristle; the five segmented tarsi end in pair of claws.

- Segmented abdomen is more or less oval in shape and is partly or fully hidden from view depending on the species.
- Cockroaches are most readily distinguished from beetles (order Coleoptera) by having the fore-wings placed over the abdomen in a scissor like manner. In beetle the forewings (elytra) are not crossed over but they meet dorsally.

Life cycles

- Cockroaches like warmth and during the day they hide away behind radiators and hot water pipes. And in temperate countries they hide cesspits, drawers, cupboards, drawer septic tanks underneath chairs, table sinks and beds.
- They are usually common in kitchens especially if a lot of food is left out overnight.
- Also found throughout the world in hospitals.
- Cockroaches are nocturnal and rarely seen over the day unless disturbed.
- They are omnivorous and voracious feeder, any type of food is eaten.
- Cockroaches habitually disgorge their partially digested food and deposit their excreta on almost anything including food.
- They might leave for 5-10 weeks without water and for many months without food.

- - Young nymphs, however, may die within 7-10 days in absence of food.
 - Eggs are laid in brown case capsule called an Ootheca (figure 15.2a)
 - which can contain 12-50 eggs.



- Ootheca is deposited in cracks and crevices in dark places.
- Adult cockroaches live for several months to 2 yrs or more.
- During this time female will lay about 4 to 90 Ootheca, the number vary considerably with species.
- Nymph hatch from eggs after 1-3 months, the time depends on temperature and species.

- Young nymph are very pale and delicate version of the adult where as the older ones are progressively darker.
-
- There are usually six nymph instars, but in *Periplaneta americana* it might be 13 or more instars.
- Nymph may exist for 2-25 months depending on species and weather conditions.
- Cockroaches spread very fast from infested house

Medial importance

1. They are transporting agent of different disease pathogens,
 - *Entamoeba histolitica*
 - *Giardia interstenalis*
 - *Salmonella typhi*
 - *Toxoplasma gondii*
2. People are sensitivity to presence of cockroaches physically or by ingesting their waste products

Control

- Cleanliness /Hygiene conditions
- Insecticides spray or insecticides dust application in selected infested sites.
- Application of repellents to kitchen furniture.

Family Culicidae

Mosquitoes

- There are more than 3200 species of mosquitoes belonging to 37 genera, all contained in family Culicidae.
-
- This family is divided into 3 subfamilies
 - Toxorhynchitinae
 - Anophelinae (Anophelines)
 - Culicinae (Culicines)
- Mosquitoes have worldwide distribution, they occur throughout tropics and temperate regions
- The only areas where they are absent are in Antarctica.
- The most important pest and vector species belong to the genera *Anopheles*, *Culex* and *Aedes*.
- *Anopheles* species transmit malaria and are also vector of filariasis (*Wuchereria bancrofti*, *Brugia malayi* and *Brugia timori*).

- Anopheles gambiae complex contains six mosquito species which cannot be separated with morphological feature:

Anopheles gambiae senso stricto (*An.gambiae s.s.*)

- - They occur in areas with high humidity and fresh water breeding habitats
- - They are vectors of malaria and filariasis and several arboviruses
- - They are anthropophilic, endophilic and endophagic

Anopheles arabiensis

- They occupy semi arid, arid and savannah areas.
- **They are malaria vectors in semi arid and arid areas**
- They are zoophilic, endophagic, exophagic and exophilic

- *iii) Anopheles merus*

- They are malaria vectors, breeding in salt water in **east African coast, In Tanzania too.**
- They are anthropophilic vectors.

- *iv) Anopheles melus*

- They are malaria vectors, breeding in salt water in **Western African coast**
- They are both vectors of malaria and filariasis
- They are anthropophilic

- v) *Anopheles bwambae*

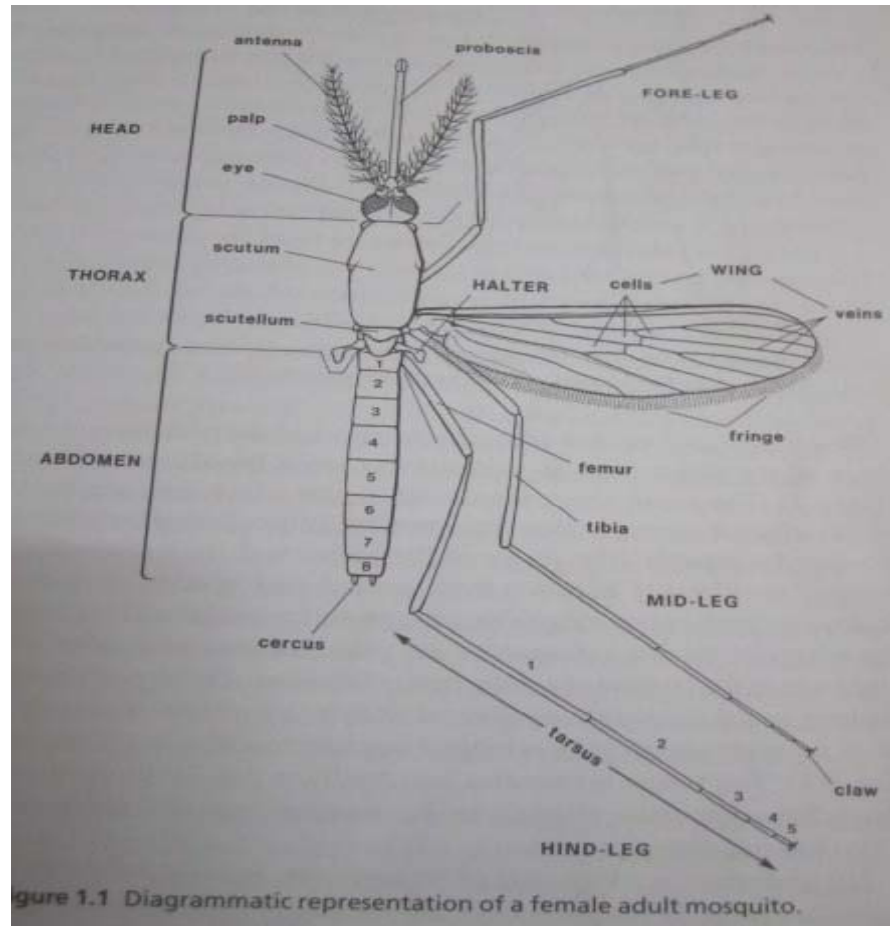
- They are found in hot water springs.
- They are vectors of malaria and filariasis
- They are zoophilic.

Anopheles quadriannulatus

- They are vectors of malaria found in savannah in areas with more wildlife and domestic bovids.
- They are zoophilic
- ***Culex species*** in subfamily Culicinae mostly *Culex quinquefasciatus* transmit *Wuchereria bancrofti* and few arbovirus
- The genus ***Aedes*** contain important vectors of yellow fever, dengue, encephalitis viruses

External morphology of mosquitoes

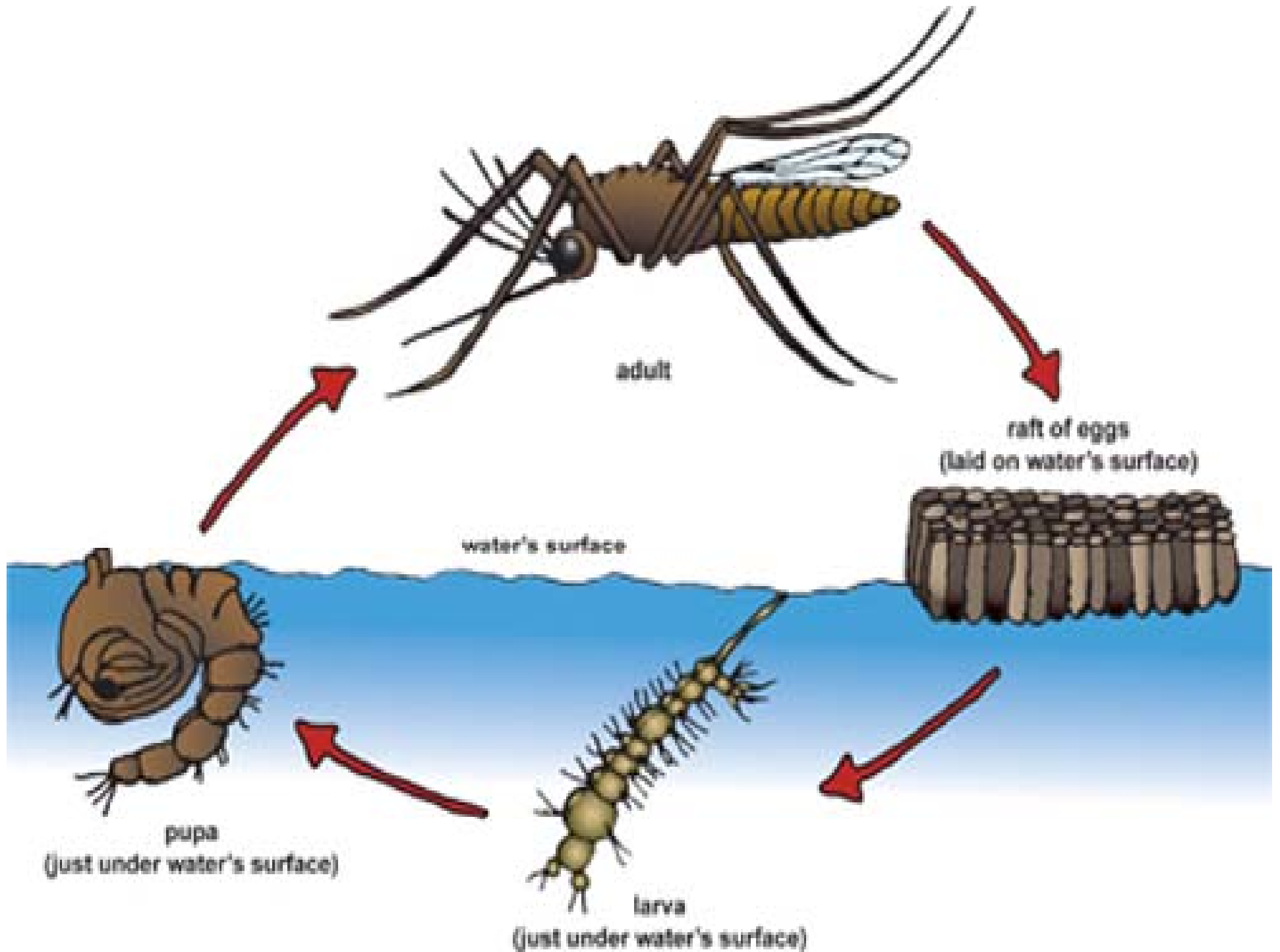
- Mosquito possess a pair of functional pair of wings; the fore wings
- The hind wings are represented by a pair of small knob-like halters (figure 1.1).



- Mosquitoes are distinguished from other flies by:
 - The possession of conspicuous forward projecting proboscis
 - The possession of numerous appressed scale on the thorax
 - A fringe scale along the posterior margin of the wings
- Mosquitoes are slender and relatively small insects, usually measuring about 3-6 mm in length.
- The body is divided into three, head, thorax and abdomen
- The head has a pair of kidney shaped compound eyes.
- They have a pair of segmented and filamentous antennae

- In female, the antennae have whorls of **short hairs** (that is pilose antennae), but in males, the antennae have many long hairs give them feather or **plumose appearance**.
- Those with **plumose antennae** are males and those without are females.
- Between the palps there is elongated proboscis, which containing the piercing mouthparts of the mosquito.

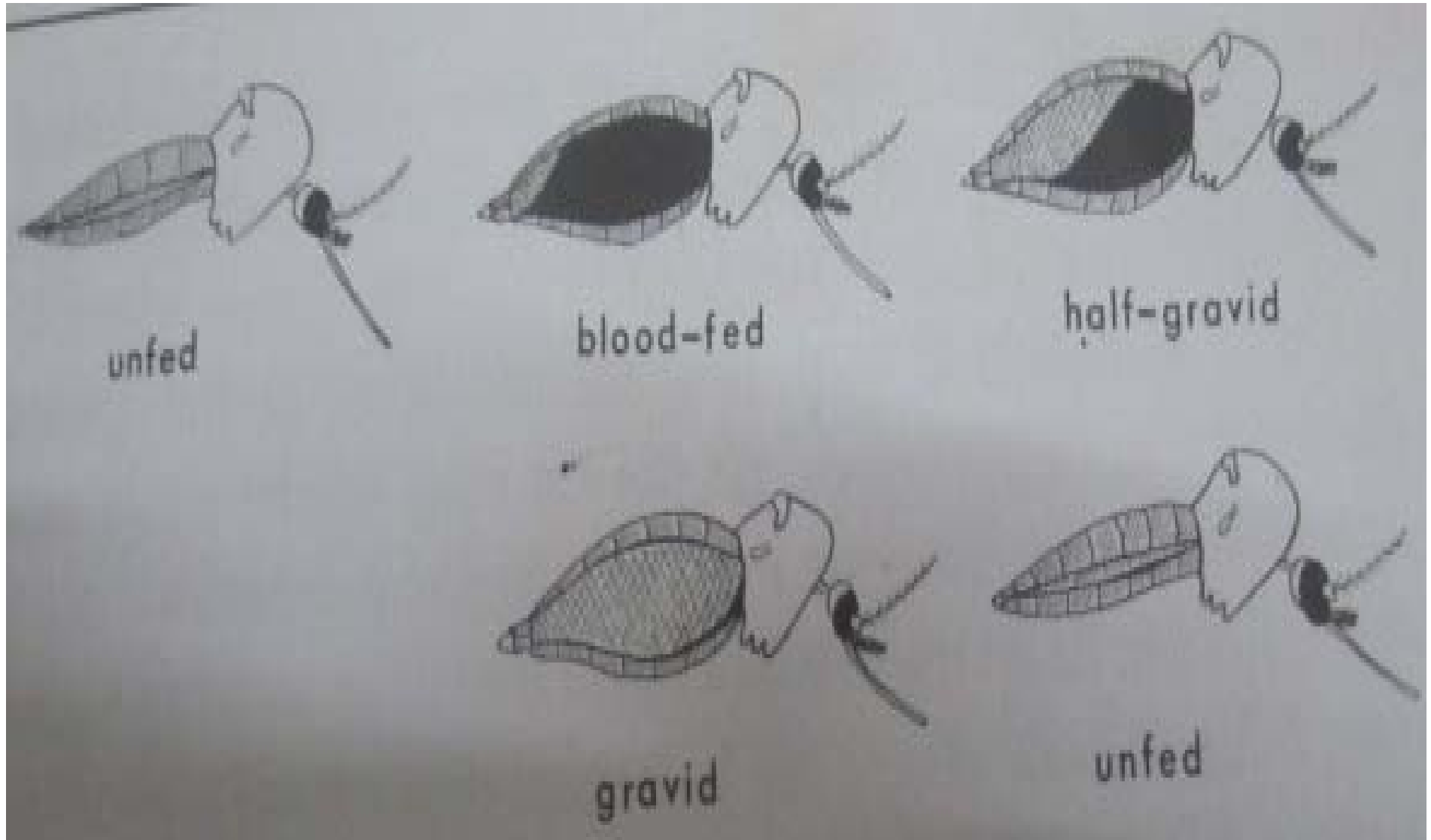
- The wings are long and relatively narrow and the number and arrangement of the wing veins is virtually the same for the all mosquito species **(Figure 1.1)**.
- Abdomen is composed of 10 segments but only the first seven or eight are visible.
- In unfed mosquitoes the abdomen is thin and slender, but after female have taken blood meals have taken blood meal from host resembles a red oval baloon.
- When abdomen is full of eggs its oval baloon but whitish and not red in appearance.



Life cycle

- Mosquitoes met shortly after emergence from the pupae.
- After mating spermatozoa passed to spermatheca and are enough to fertilize eggs in ovary in mosquitoes life time.
- Only one mating is required for a female mosquito
- The digestion of blood meal depends on the temperature, in tropical is 2-3 days; in cooler region its 7-14 days.

After blood meal is digested and abdomen becomes dilated and whitish due to the formation of full developed eggs (Figure 1.5).



- The gravid females starts to search for suitable oviposition site which are safe for larvae.
- After oviposition female mosquitoes takes another blood meal and after 2-3 days in tropics another batch of eggs is matured.
- The process of blood feeding and eggs maturation, followed by oviposition is repeated several times throughout the females life and is referred as gonotrophic cycle.
- Male mosquitoes mouth parts are insufficiently developed for piercing the skin and blood-feeding instead they feed on nectar of flowers. Also female feeds on nectars.

OVIPOSITION AND BIOLOGY OF THE EGGS

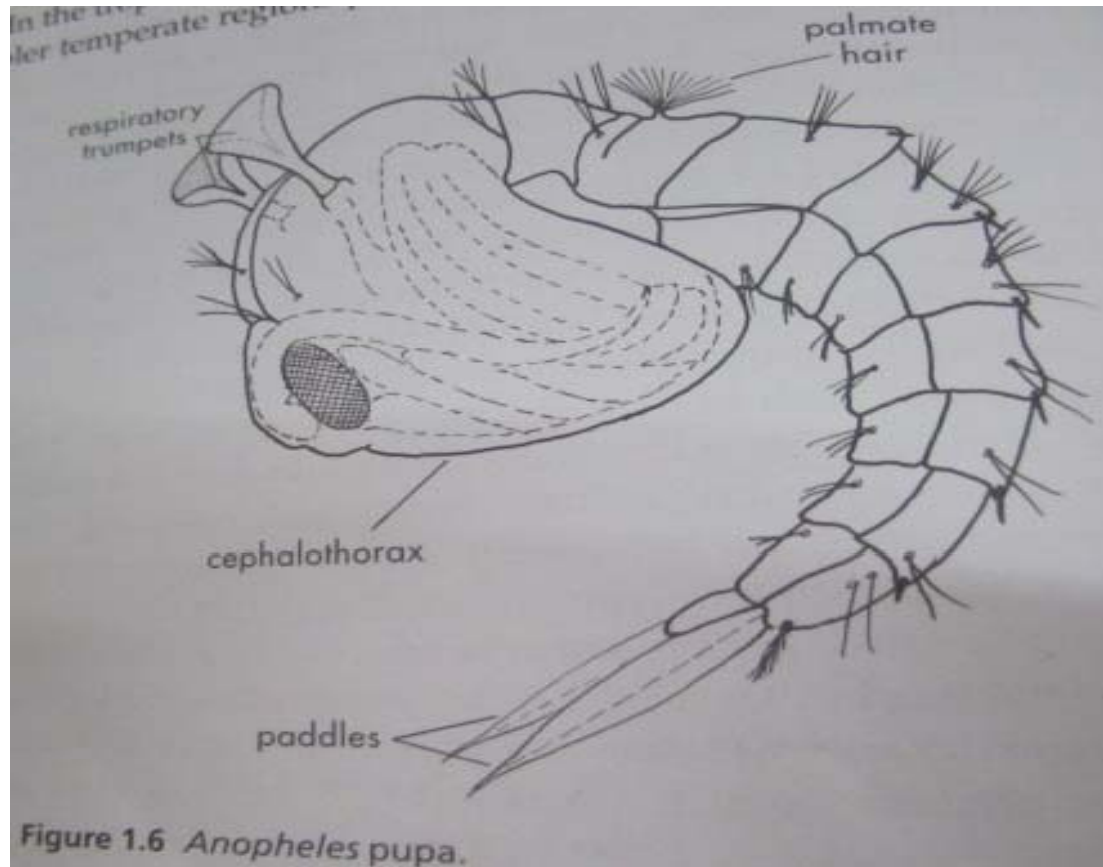
- Depending on the species females can lay about 30-300 eggs at one oviposition.
- Eggs are brownish or blackish are 1mm or less long
- Many mosquitoes lay their eggs directly on water surface.
- In anopheles the eggs are laid singly and float on the water, whereas those of Culex and laid vertically in several rows held together by surface tension to form an egg raft which floats on the water.
- None of the eggs of these mosquito eggs can survive desiccation hence they die in draught situation.
- Eggs of *Aedes species* withstand desiccation for months and even years and remain viable.

Larval Biology

- Mosquitoes larval habitats vary from large permanent collection of water such as fresh water swamps, marshes and rice fields, to small collections of temporary water such as pools, footprint, hoof prints, puddles, water field car trucks, ditches and drains and containers
- Larvae also occur in wells and manmade container habitats, clay pots, water storage tanks and vehicle tyres
- *Anopheles gambiae* complex prefer sunlit habitats
- *Anopheles* survive in fresh clear water except *An. merus* and *An. melus* while *Culex* species survives better in water contaminated with excreta and decomposing materials.
-

Pupal Biology

- All mosquitoes pupa are aquatic and comma-shaped
- Abdomen has 10 segment but only 8 are visible.
- Pupae do not feed the spent time on surface of water taking air through respiratory trumpets (**figure 1.6**).
- In tropics the pupal period in mosquitoes lasts only for 2-3 days but in cooler regions may be extended for 9-12 days.



Adult biology and behaviour

HOST PREFERENCE

- **Anthropophagic**- species that feeding preference is only on human e.g. *An. gambiae* s.s
- **Zoophagic**- feeding preference is mainly on animals but might feed on human in absence of animals. e.g. *An. arabiensis*
- **Ornithophagic**- feeding preference is mainly on birds e.g. *Culex*

Feeding behaviour

- **Exophagic**- feeds mostly outdoors e.g. *An. arabiensis*
- **Endophagic**- feeds mostly indoor e.g. *An.gambiae* ss

Resting behaviour

- **Endophilic** – resting indoor e.g. *An.gambiae* ss
- **Exophilic**- resting outdoor e.g. *An.arabiensis*

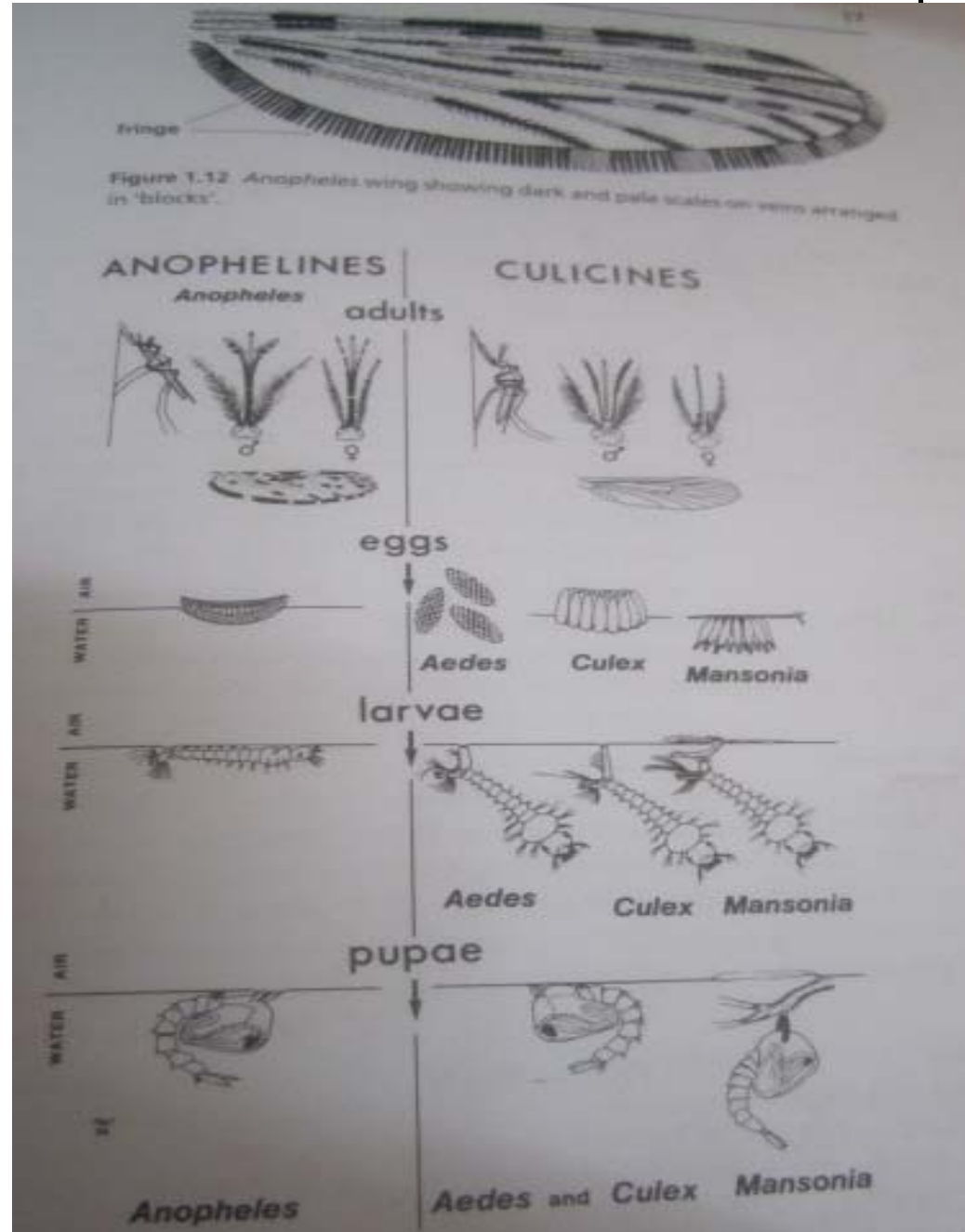
Medical importance

- Malaria- by transmitting *P.falciparum*, *P. vivax*, *P. ovale* and *P. malariae*
- Filariasis
- Chikungunya
- Harbiviruses

Mosquitoes control

- Use of insecticides treated Bed nets
- Use of repellents such as DEET(Diethyl toluamide) for personal protection
- Indoor residual spray with insecticides
- Larval habitats control using *Bacillus thuringiensis(Bti)*
- Environmental management, by altering all possible available mosquitoes habitats.
- House modifications- **by door and windows screening and eaves blocking.**
- Biological control= such as *Gambusia affinis*, toads, belestoma, Backswimmer
- Integrated control- combination of both insecticides and biological control.
- Genetic control- this is mostly the use of male sterile technique.

Differences between Culicinae and Anophelinae



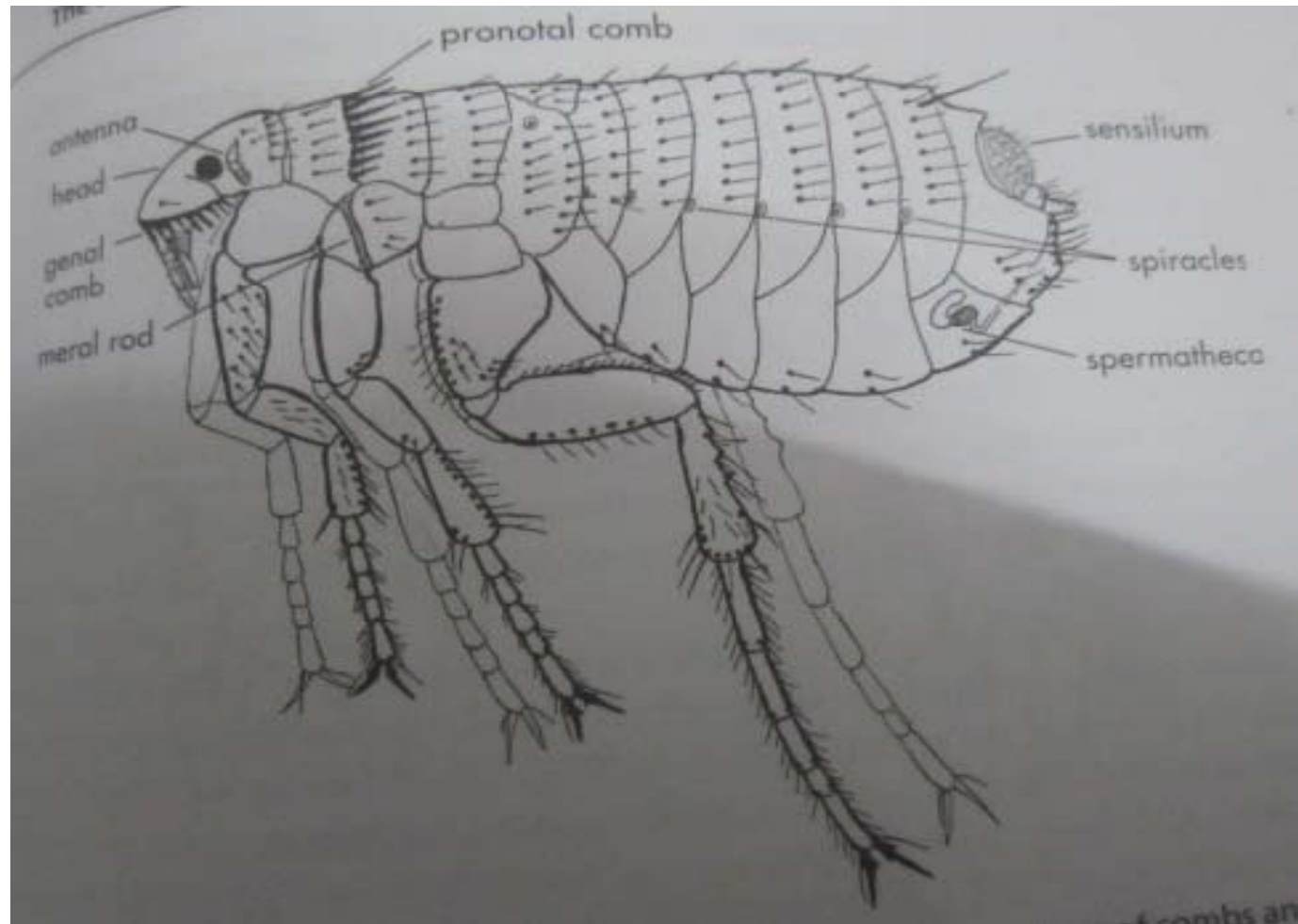
Fleas (Siphonaptera)

- There are some 2500 species and subspecies belonging to 239 genera.
- 94% of known species bite human and remainder are parasitic to birds.
- Fleas are found throughout the world but some species have restricted distribution, for example *Xenopsylla* which contains important vector of plague (*Yersinia pestis*) and flea-borne endemic typhus (*Rickettsia typhi*). Jigger flea (*Tunga penetrans*) burrows into the feet of people.

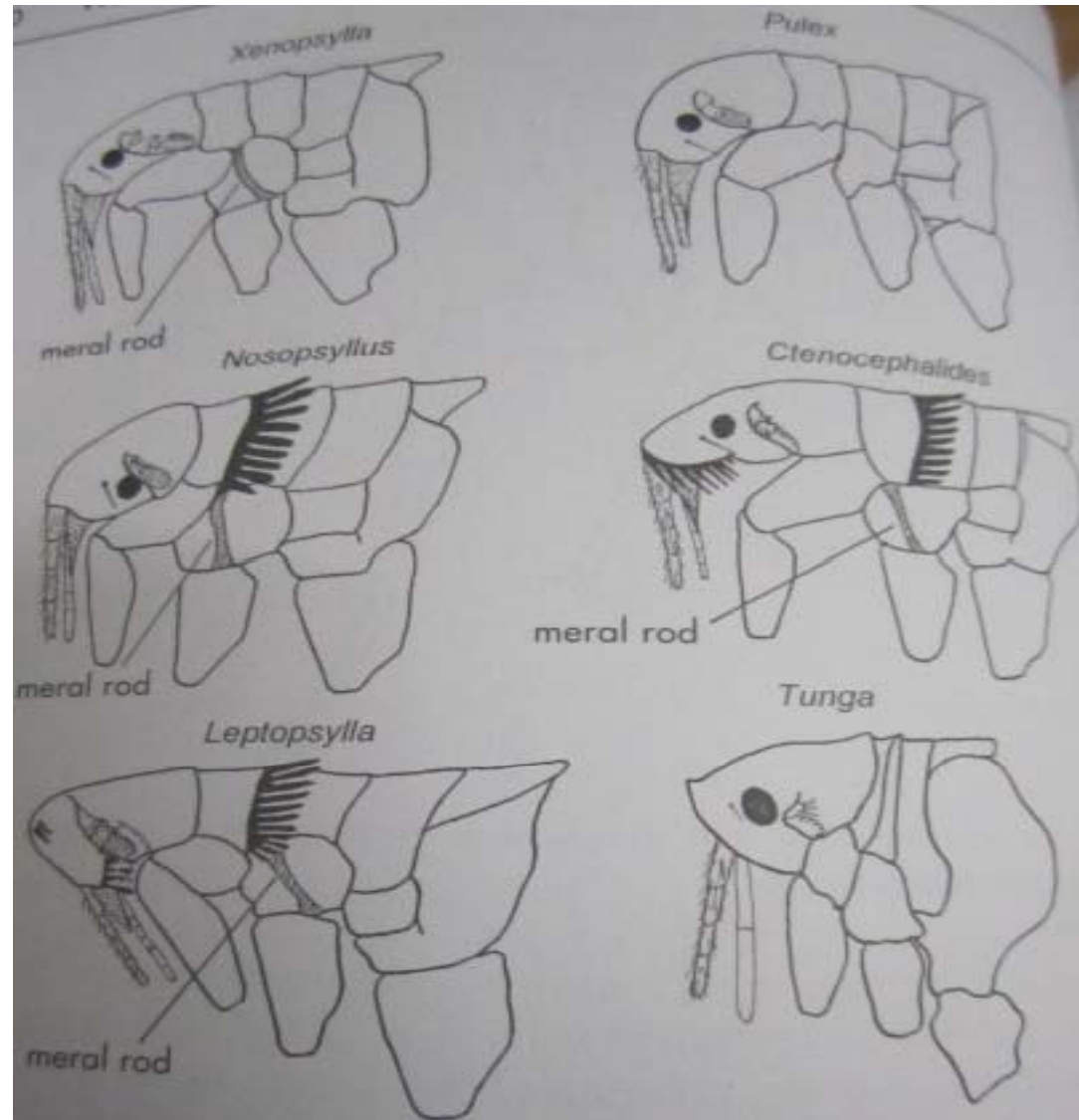
- **External morphology**
- Adult fleas are relatively small (1-4mm), more or less oval insect
- They are compressed laterally and varying in colour from light to dark brown.
- They are wingless
- They have three pairs of legs. The hind legs are specialized for jumping.

- The head is triangle in shape bearing a pair of conspicuous eyes (few species are eyeless).
- The legs and also much of the body are covered by bristle and small spines.
- The thorax has three distinct segments: the pro, meso and metathorax.

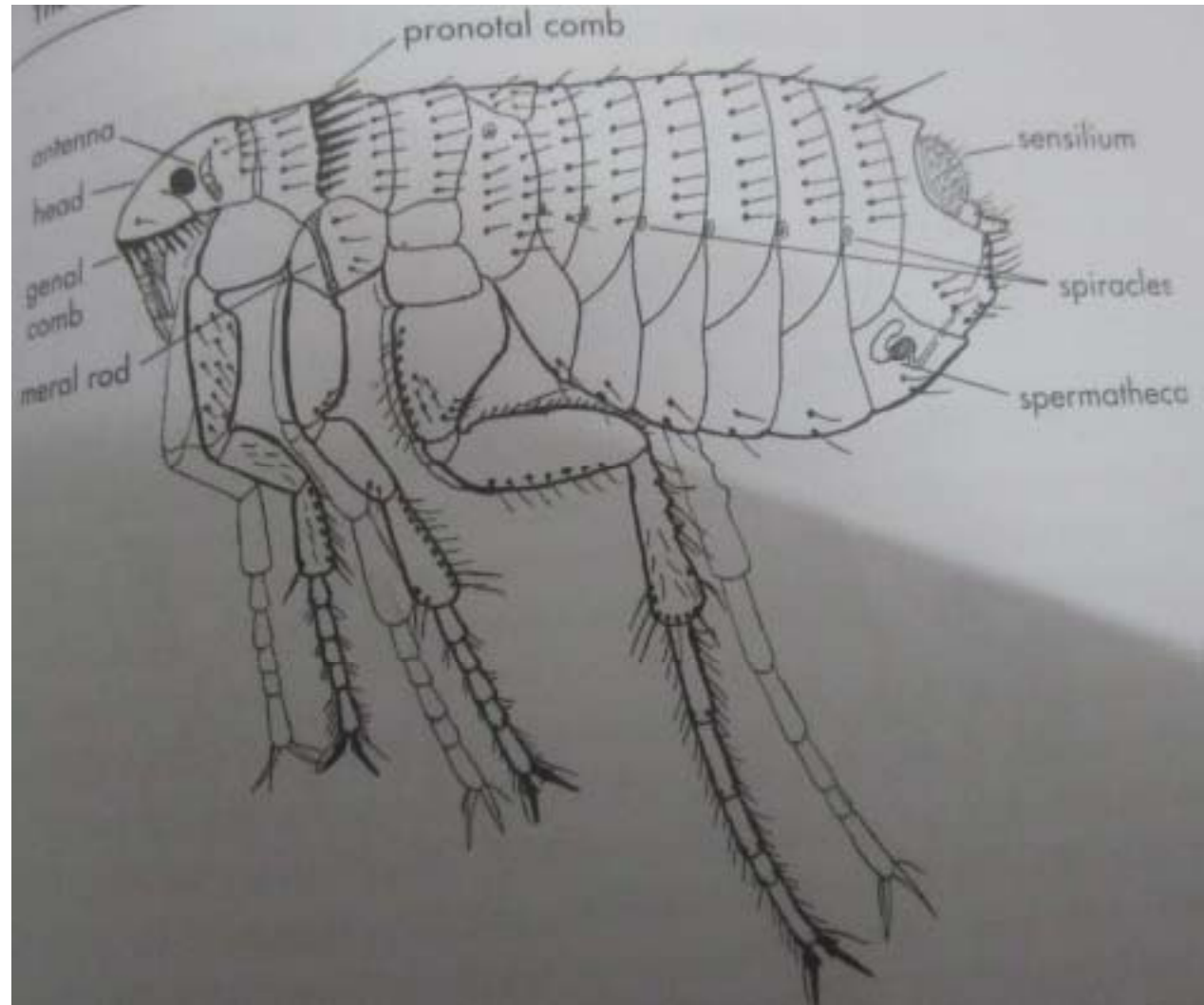
The posterior margin of the pronotum may bear a row of tooth-like coarse spine forming the *pronotal comb* or *pronotal ctenidium*.



Some flea genera lack both the pronotal and genal combs and are referred to as Combless flea (**figure 11.2**) where in their genera both combs are present (**Figure 11.2**).



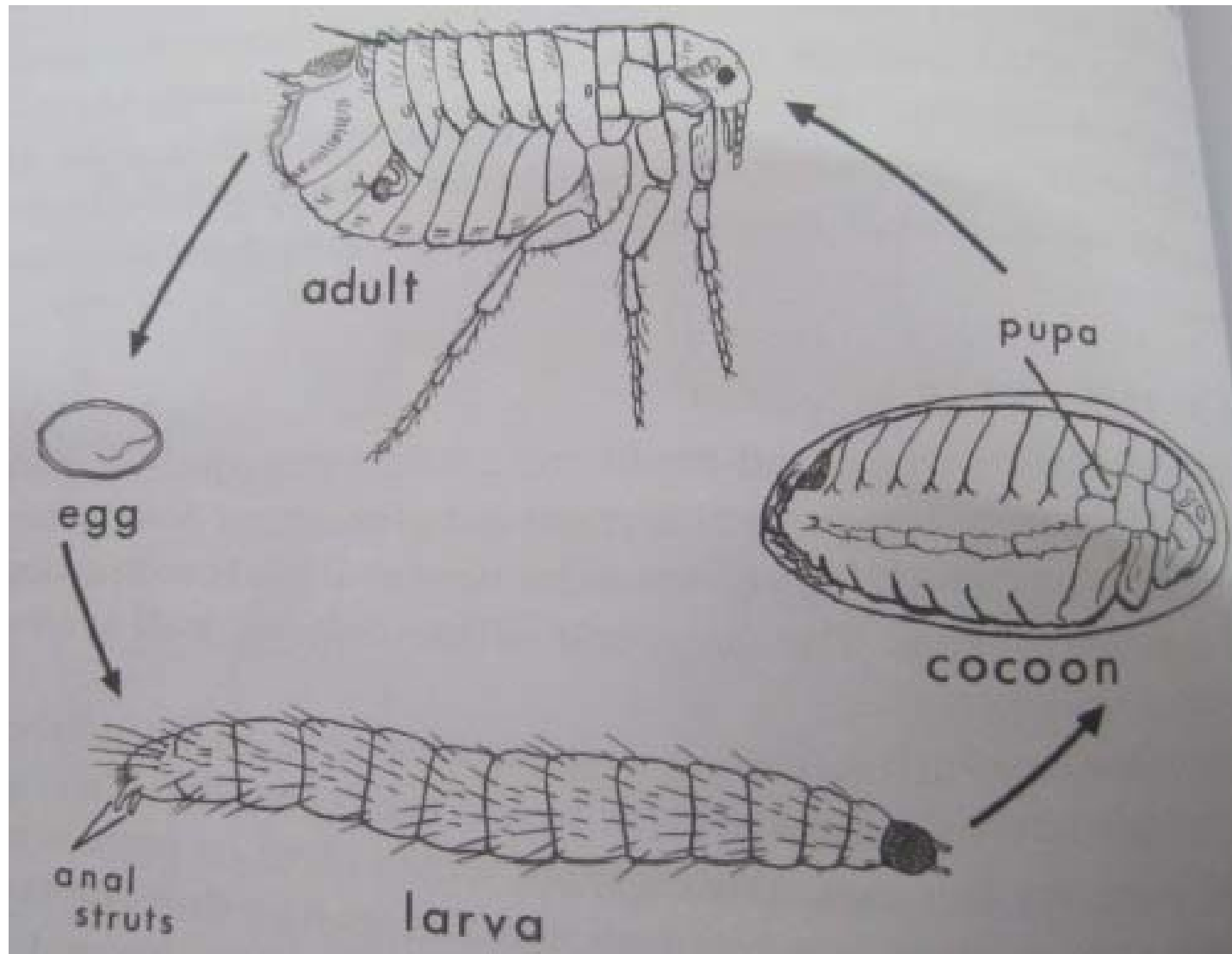
- Male fleas are identified by the upturned appearance of the abdomen.
- In the females the tip of the abdomen is rounded than in the male, and lying internally in about the position the sixth to eight abdominal segments are one or two distinct brownish spermatheca (**Figure 11.1**).



Life cycle

- Both sexes takes blood meals and are equally vectors of diseases
- The present account is a generalized description of the life cycle of fleas which may occur on humans or animals, such as dogs, cats and commensal rates.
- A female flea which is read to oviposit leaves the host to deposit her eggs in debris which accumulates in host's dwelling place, such as rodent burrows or nests.
- Females often lay their eggs in or near cracks and crevices on the floor or amongst dust dirt and debris.
- Adults leave for 10 days to 6 weeks, but sometimes for 6-12 months.
- During this time a female may lay 300-1000 eggs, mostly in small batches of 3-25 a day.
- Eggs hatch within 2-14 days, mostly after 5 days. Depends on species temperature and humidity.

A minute larvae emerged from the eggs (**Figure11.4**)



- Larvae are very active
- They avoid light and seek shelter in cracks and crevices and amongst debris on floors of houses, or at the bottom of nests and animal behaviour.
- Other times, larvae are found in animal fur
- Larvae feed on any organic matters including host's faeces
- Blood meals still important requirements for larval development.
- Usually there are three larval instars. But in few species there are only TWO instars (e.g. *Tunga penetrans*).
- The larval period may last as little as 10-21 days.
- Mature larvae are 4-10mm long.

- After having emerged from the pupae, the adults search for hosts by sensing the vibration of the hosts.
- Fleas avoid light and are therefore usually found sheltering among the hairs and feathers of animals.
- Fleas have one or more hosts for blood hosts.

Medical importance

- **Flea nuisance**
- Biting annoyance have been the main complaints. Fleas frequently bite people on ankles and legs.

- **Plague**
- Plague is caused by *Yersinia pestis* and is primarily a disease of wild animals, especially rodents. An important form of plague is urban plague.

- **Flea-borne endemic typhus**
- It is caused by *Rickettsia typhi* which is swallowed by flea with its blood meal.

- **Cestodes**
- *Dipylidium caninum* is the commonest tapeworm of dogs and cats and occasionally occur in children. It can be transferred to both human and rodents by flea.

Control of flea

- Repellents such as Dimps, DEET are useful for the personal protection.
- Use of insect growth regulators (IGR)

- **Cat and dog fleas**
- -These can be easily detected by observation on the belly of the host.
- -Control by powder insecticides

- **Rodents' fleas**
- They are controlled by the power insecticides
-
-

**The family Glossinidae
(TSETSE –FLIES)**

-There are 23 species of tsetse- flies belonging to genus Glossina

Distribution:

- Apart of two localities in the Arabian Peninsula, tsetse are restricted to sub Saharan Africa from between approximately latitude 10° north and longitude 30° along the Eastern coasted area.
- Some spp such as *Glossina morsitan* are found across West Africa to Central and East Africa, Other species are restricted in distribution such as *Glossina palpalis* occurs in the West Africa subregion.

Tse tse are vectors of both Human and Animal diseases

In Human (sleeping sickness)

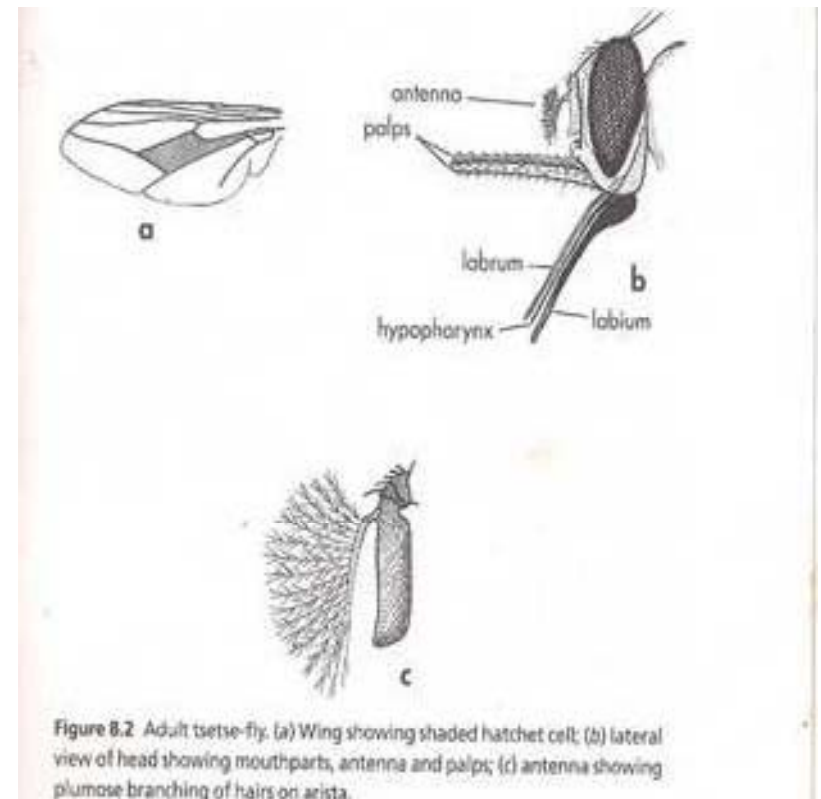
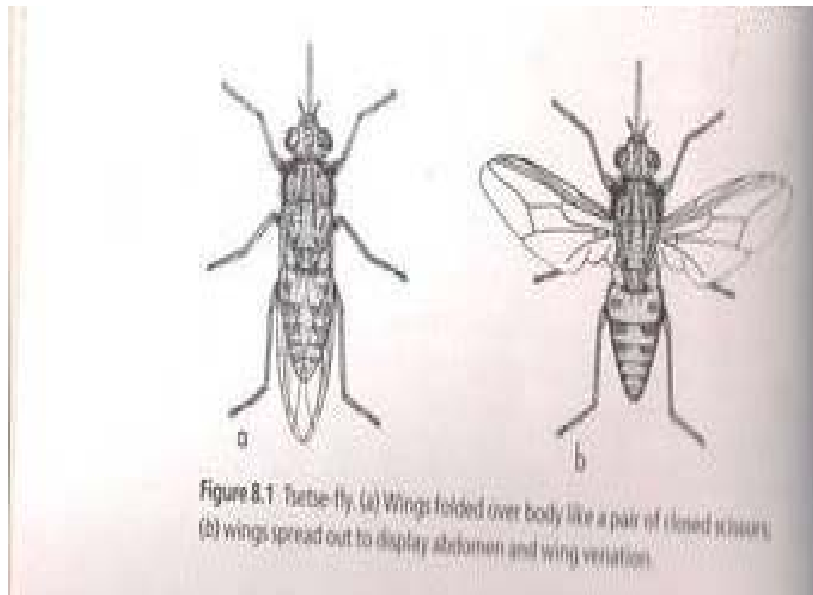
In Animal : African trypanosomiasis

The most important species are *G. palpalis*,
G. tachnoids, *G. fuscipes*, *G. pallidipes* and
G . morsitans.

EXTERNAL MORPHOLOGY

- Adult are yellowish or brown-black robust flies that are rather larger (6-14mm) than house flies.
- In some species abdomen is uniformly colored while in others they might be lighter – colored transverse stripes and median longitudinal ones.
- Tse tsetse flies are readily distinguished from other insects biting and non biting flies of similar size by combination of rigid and forwardly projected proboscis and a characteristic wing venation.

- Between vein 4 and 5 there is a close cell which with a little imagination, looks like an upside – down hatchet cell. This character served to identify them as a tse-tse



- Tse tse – flies also differ from most flies in that at rest the wings are placed over the abdomen like the closed blades of a pair of scissors
 - Along pair of palps arise dorsally, very close to the proboscis and lie alongside it. It's difficult to distinguish except when the tse tse is freely and proboscis is swung downwards while the palps remain projecting forward.
- The proboscis is relatively large and has bulbous base. When a tse tse feeds saliva containing anticoagulants is pumped down into the wound formed by the fly.

- The dorsal surface of the thorax of tsetse –fly has pattern of dark brown stripes or patches.
- There are 8 abdominal segments and these may be uniformly dark brown or blackish or have transverse stripes and a median one of a lighter brown or yellowish color.
- In male tsetse fly there is a prominent raised almost circular, button like structure called the hypopygium, which when unfolded reveals a pair of genital claspers. In the female fly there is no such button like protuberance

LIFE CYCLE

Feeding and reproduction

- Both male and female tsetse – flies bite people, a large variety of domestic and wild mammals. Both male and female take blood meal.
- No species of tsetse feed on one host most species show definite host preference.

Example: - In Africa *G. swynnertoni* feeds mainly on wild pigs and *G. morsitans* on domesticated bovids as well as on wild pigs.

-In W. Africa *G. morsitans* feeds mainly on warthogs

-In E. Africa, *G. pallidipes* feeds principally on wild bovids, where as in W. Africa, *G. palpalis* feeds Predominantly on reptiles and humans and *G. tachinoides* feeds on humans and bovids but in southern Nigeria predominantly on domestic pig.

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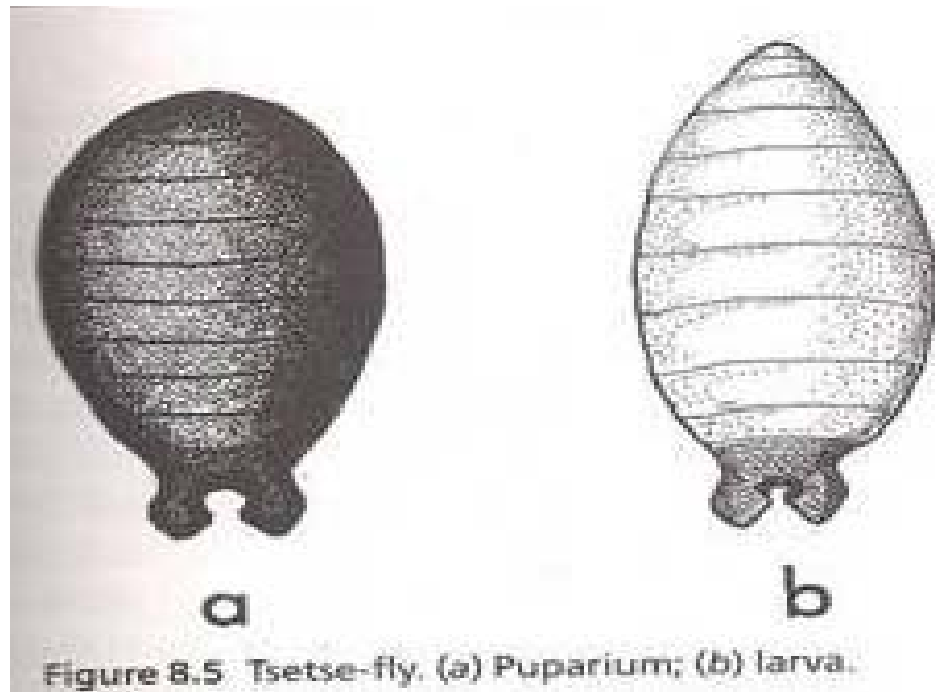
Tse tse flies take blood meal about every 2 -3 days, although this interval may be reduced in dry, hot weather or prolonged for about 10 days in cool humid conditions.

- Feeding is restricted to day light hours and vision plays an important part in host location, dark moving object being particularly attractive.
- During feeding blood is sucked up the proboscis, passes to the crop and later to the mid gut where digestion proceeds.

- After female tsetse fly has been inseminated by a male after it has taken a blood meal, a single egg in one of the two ovaries complete maturation. It then passes down the common oviduct into the uterus where it is fertilized by the release of spermatozoa from the sperm thecae.
- The eggs hatched within the uterus after about 3 – 4 days and empty egg shell passes out through the genital orifice (vagina).
- The uterus is supplied with conspicuous pair of branched secretory accessory gland which in tsetse flies are called the milk glands. Fatty, nutrients fluid from these gland flow through a small duct to enter the uterus as its anterior gland.

- The larva is oriented within the uterus so that its mouth is near the opening of the common duct of the milk gland. The secretion from this gland provide the larva with all the food its needs for growth and development
 - The larvae pass through the three instars in the female
 - Regular blood meals must be taken by the female for a continuous and adequate provision of nutrients fluid from the milk gland.
- If the fly is unable to feed, the larvae may fail to complete its development and as a consequence be aborted.

- Larvae development is completed after about nine days by which time the third and final instars larvae is five to seven mm long. It is creamy white in color and composed of twelve visible segments, the last of which bears a pair of prominent dark protuberances called the polypneustic lobes (figure -below) which are respiratory structure.



- A female containing full developed larvae is easily recognized because the fly's abdomen is enlarged and stretched, (i.e. the fly is obviously pregnant). The black polypneustic lobes can be seen through abdominal integument
- The mature third instar larvae wriggles out, posterior and first from the genital orifice, thus birth can be termed as breed case, Female always select shaded sites for larvae position.

- The larvae deposited on loose friable soil, sand or luminous, frequently underneath bushes, trees, fallen logs, rocks, between buttress root of trees, in sandy river beds in animal burrows and even in root holes in trees which might be formed some distance above the ground (four to five meters)
- Immediately the larvae are deposited it commences to burry itself under 2-5 cm of soil. After about 15 minutes the third in star larval skin contracts and hardens to form a reddish brown or dark brown, barrel- shaped puparium which is about 5 -8 mm long and has distinct polypneustic lobes.
- Within this puparial case the larvae pupate.

- The duration of puparial period is comparatively long usually extending over 4 to 5 weeks, but at high temperatures (30 °C), May be completed within 3 weeks and conversely at low temperature (20°C) prolonged to 7 weeks. After puparial development has been completed the fly emerged from the puparium forces its way to the surface of the ground and flies away.
- During development of larva within the female the tsetse feeds several times, about once every 2 -3 days. The first larva is deposited about 16 -20 days after the female has emerged from the puparium, thereafter, if the food is plentiful a larva is deposited about every 9 – 12 days.
- In the laboratory female tsetse flies have produced up to 20 offspring but the average is near 5-8
- Breeding continues throughout the year but in very humid condition production may be diminished. Maximum population size is attained at the end of rain season.
- The population diminishes in the dry season when suitable areas of refuge for adult flies and suitable larvae position site may become restricted and localized

ADULT BEHAVIUR

- Knowledge of certain aspects of behavior of tsetse flies is essential for an understanding of approaches to their control, and also the part vector species play in the transmission of sleeping sickness
- Blood engorged tsetse flies, and unfed hungry flies waiting to feed on suitable hosts, spend the nights and much of the day time hours resting in dark and usually humid sites.
- During the day the forwarded resting site of host species are twigs branches and trunks of trees and bushes. Flies are not found resting in areas with temperature above 36°C.

- At night tsetse prefer to rest on the upper surface of the leaves
- Most species in fact rest below 4m; in Nigeria 59% of *G. palpalis* and *G.morsitans* commonly rest between ground level and 30cm.
- Based on their morphology, ecology, karyotype and behavior tsetse can be separated into three groups:
- **Fusca group (forest flies)**
- **Morsitans group (savannah flies)**
- **Palpalis group (riverine and forest flies)**
-

- **FUSCA GROUP (Forest flies)**

- Fusca group contains 15 species and subspecies of Glossina, all of which are large (10.5-15.5mm). They are forest flies (Except *G.longipennis*, which occurs in arid areas of East Africa) and most are restricted to the equatorial forest of West and West Central Africa. For example, *G.fusca* occur mostly in relict forest of West and Central Africa, where *G. brevipalpis* is found in secondary forest of E.Africa.
- The fusca group rarely feeds on people and none of the species is a vector of sleeping sickness.

- **MORSITANS GROUP (Savannah flies)**

- Seven species and sub species are included within the Morsitans group. They are medium size insect 7.5-11mm long and typically inhabit the Savannah regions of Africa, which may extend from the coast or the edges of the forest to dry semi desert regions.
- *Glossina morsitans* occupies the savannah regions of West, Central and East Africa whereas *Glossina pallidipes* is found in Savannah of East Africa and parts of southern Africa; and *G. swynnertoni* is restricted to Savannah of a very limited area of E. Africa.
- *Glossina morsitans* and *Glossina pallidipes* occurs in areas ranging from wooded Savannah at the edge of forests to the dry thickest vegetation of arid zones whereas *G. swynnertoni* is restricted mainly to relatively dry thicket country.
- All three species are vectors of sleeping sickness, but most important is *G. morsitans*.

- **PALPALIS GROUP (Riverine and Forest flies)**

- Nine tsetse species and subspecies are included in the palpalis group, the smallest being about 6.5 mm in length and the largest 11mm.
- They are essential inhabiting meter type of vegetation, such as forests, luxuriant scrub and vegetation growing along rivers and shores of lakes.
- *Glossina palpalis* inhabit riverside vegetation bordering rivers and lakes, mangrove swamps and forested areas; occur throughout most of W. Africa down to Angola.
- *Glossina fuscipes* which is closely related to *G. palpalis*, occurs mainly in central Africa but extends its range to the western areas of E. Africa.
- *Glossina tachinoides* is riverside species found near streams and rivers in wet humid coastal areas, through wooded savannah region to the riverside vegetation of very dry savannah areas. It's mainly in west and central Africa but also in Sudan and Ethiopia.
- All these species are vector of sleeping sickness.

Medical importance

Disease vectors

- All species of glossina are potential vectors of African trypanosomiasis to human. It is the behavior of adult tsetse and the degree of fly human contact, and in the case of Rhodesian sleeping sickness also the degree of vector contact with the reservoir host of trypanosomes, that establishes whether a tsetse fly is a vector.
- Sleeping sickness is caused by two subspecies of trypanosomes in human namely; *Trypanosome brucei gambiensi* and *T. brucei rhodesiense*.
- These parasites are morphologically indistinguishable but produce different clinical symptoms and have different epidemiologies.
- The most important vector of sleeping sickness are; *G. palpalis*, *G.fuscipes*, *G.tachinoides*, *G.morsitans* and *G. pallidipes*.

Gambian sleeping sickness

- Gambian sleeping sickness is a form of the disease that occurs from West Africa through central Africa to parts of Sudan, Angola and Zaire.
- *G. palpalis* and *G. tachinoides* are most important in W. Africa.
- *G. fuscipes* is the vector in central and central Africa of *T. brucei gambiense*, the causative agent of Gambian sleeping sickness.

- This disease is relatively chronic with death often not occurring until after many years.
- The reservoirs of the disease parasites are humans, domestic pigs and some wild animals may harbour *T. brucei gambiense*.
- Vectors are commonly available at watering places along lakes, shores and fords across rivers.
- As a consequence there may be limited and localized foci for transmission.

- **Rhodesian sleeping sick sickness**

- The causative agent is *T. brucei rhodesiense*, causes a more virulent disease than *T. brucei gambiense* but it is not so wide spread, be more or less restricted to Tanzania, Malawi, Zambia, Zimbabwe, Mozambique and to the Northern area of lake Victoria in Kenya and Uganda.
- The most important Vectors are *G. morsitans*, *G. pallidipes*, species which feed on a variety of game animals and domestic livestock especially bovids in preference to people. These flies often occur in savannah areas highly populated by humans. Wild animals especially a number of bovid species, are important reservoir of *T. brucei rhodesiense*.
- Around Lake Victoria, *G. fuscipes* is the main vector and cattle are an important reservoir of diseases. The disease is Zoonotic

Control

- Because the immature stage are so well protected, the larva been retained by female for almost all its life, and the puparium being buried in the soil, control of tsetse – flies is aimed at the adult.

Insecticides

- Can be applied as persistent chemicals that will remain effective in killing flies for at least 2 -3 months, or as non-residual aerosol that kill when the droplets land or resting as flying tsetse flies.
- DDT, dieldrin, endosulfan, permethrin, deltamethrin and cypermethrin can be sprayed with normal pump in vegetation harboring adults.
- Success of this method depends on behavior and knowledge on resting of flies.
- Ultra- low volume –aerial spray- aircraft or helicopter

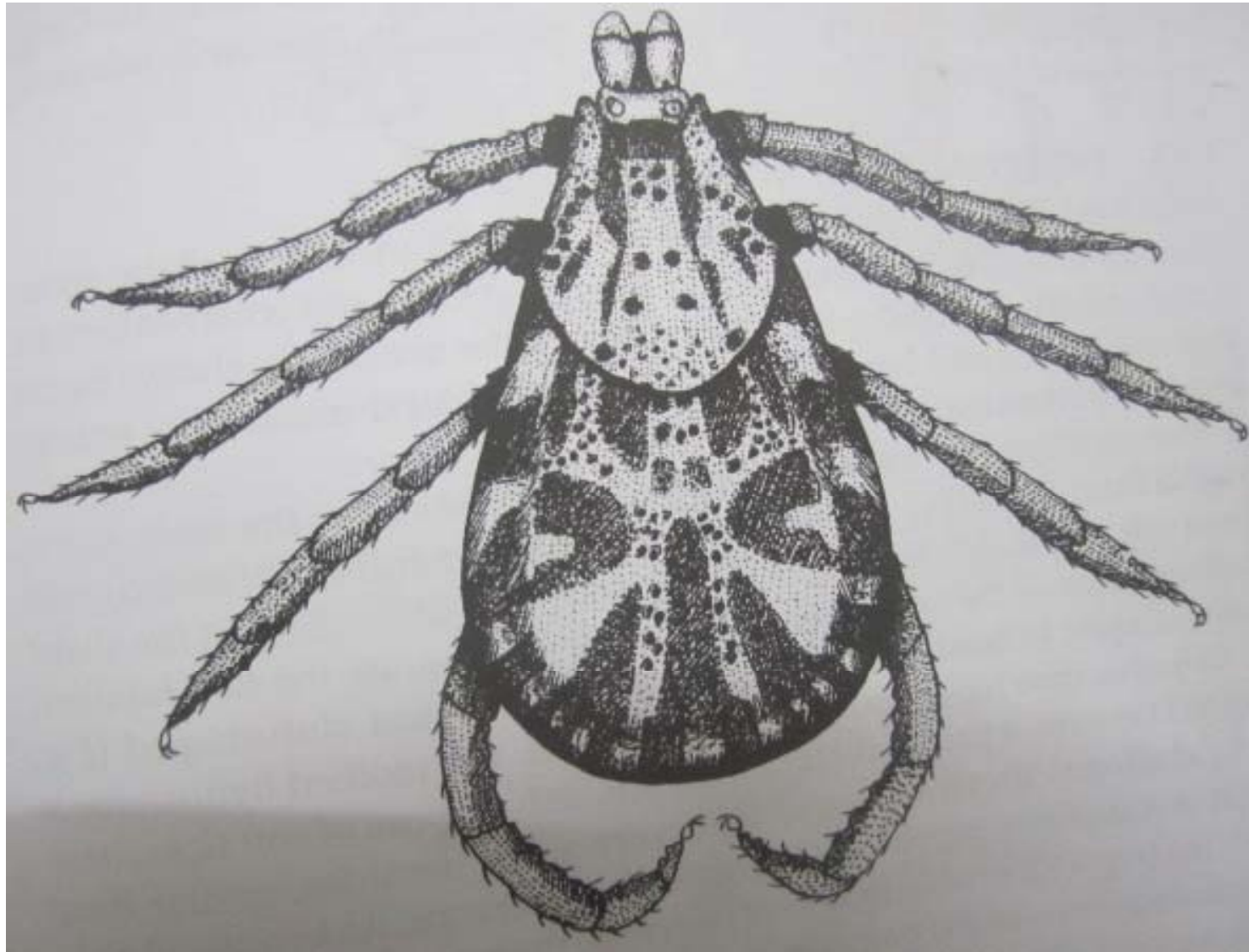
Targets and traps

- Targets are sometimes called screen, are coloured blue or black are about 1m and are mounted on poles or hung from trees. They are attractive to tsetse flies and once impregnated with insecticides they kill adults. Re-impregnation is needed every 3 -4 months.
- Piramidal traps
- These are made from dark blue or black material can be remarkably effective in attracting and trapping flies. Those that fail to enter the trap by landing on the trap surface die by contact with insecticides. Traps should be retreated about every 6 – 10 months.
- Traps and screens are critical for efficient control generally open and sunny sites are the best as they offer good visibility for the flies.

Genetic control

- This is done mainly using sterile male release method. The method has been successful in control and elimination of tsetse in Zanzibar.
- This approach is not feasible for sustained control of human sleeping sickness.

HARD TICKS (IXODIDAE)

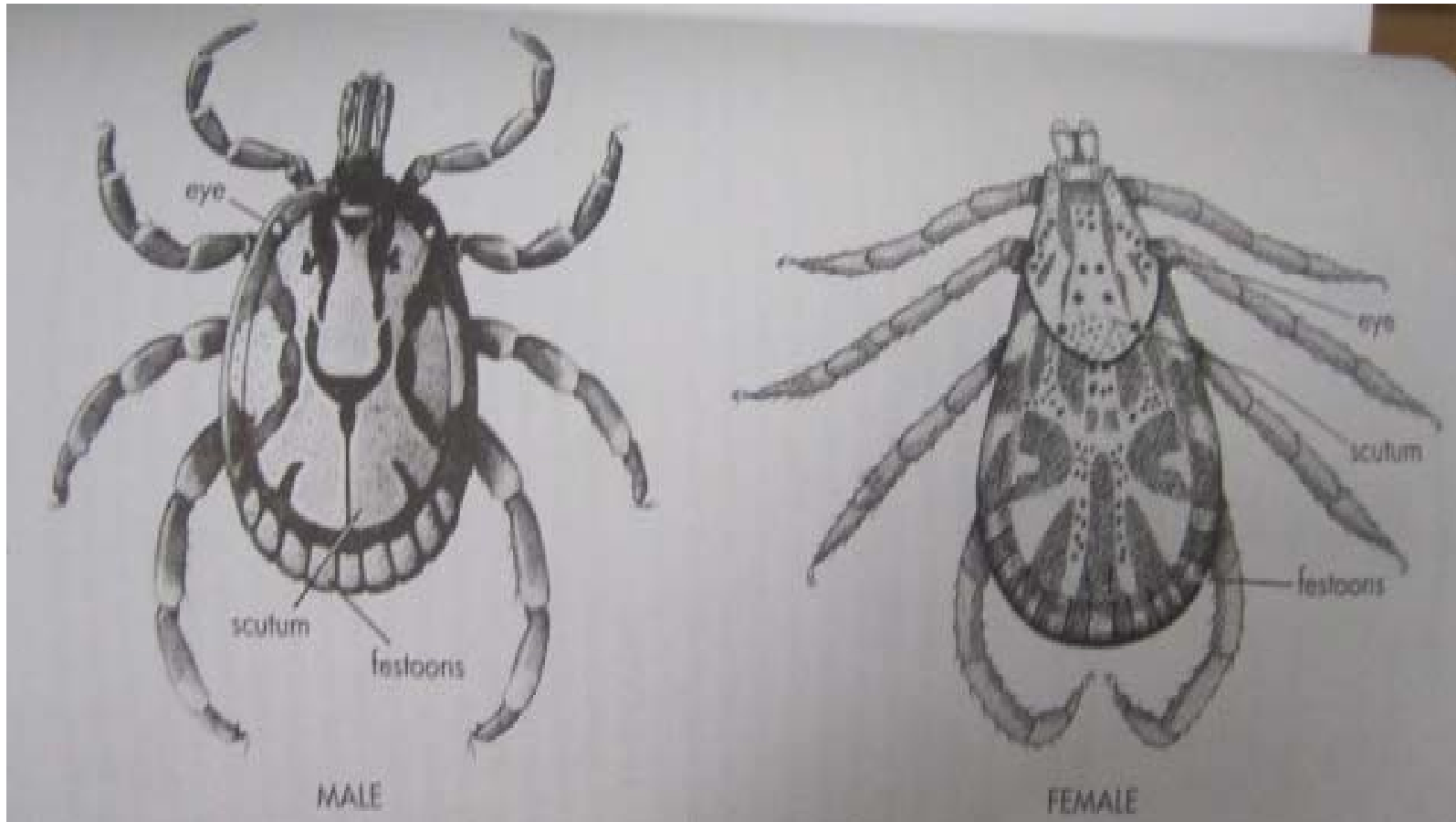


- Hard ticks occur mostly in temperate region.
- There are about 690 species of hard ticks belonging to 19 genera
- Important medical genera are: *Ixodes*, *Amblyomma*, *Haemaphysalis*, *Rhicephalus* and *Hyalomma*.
-

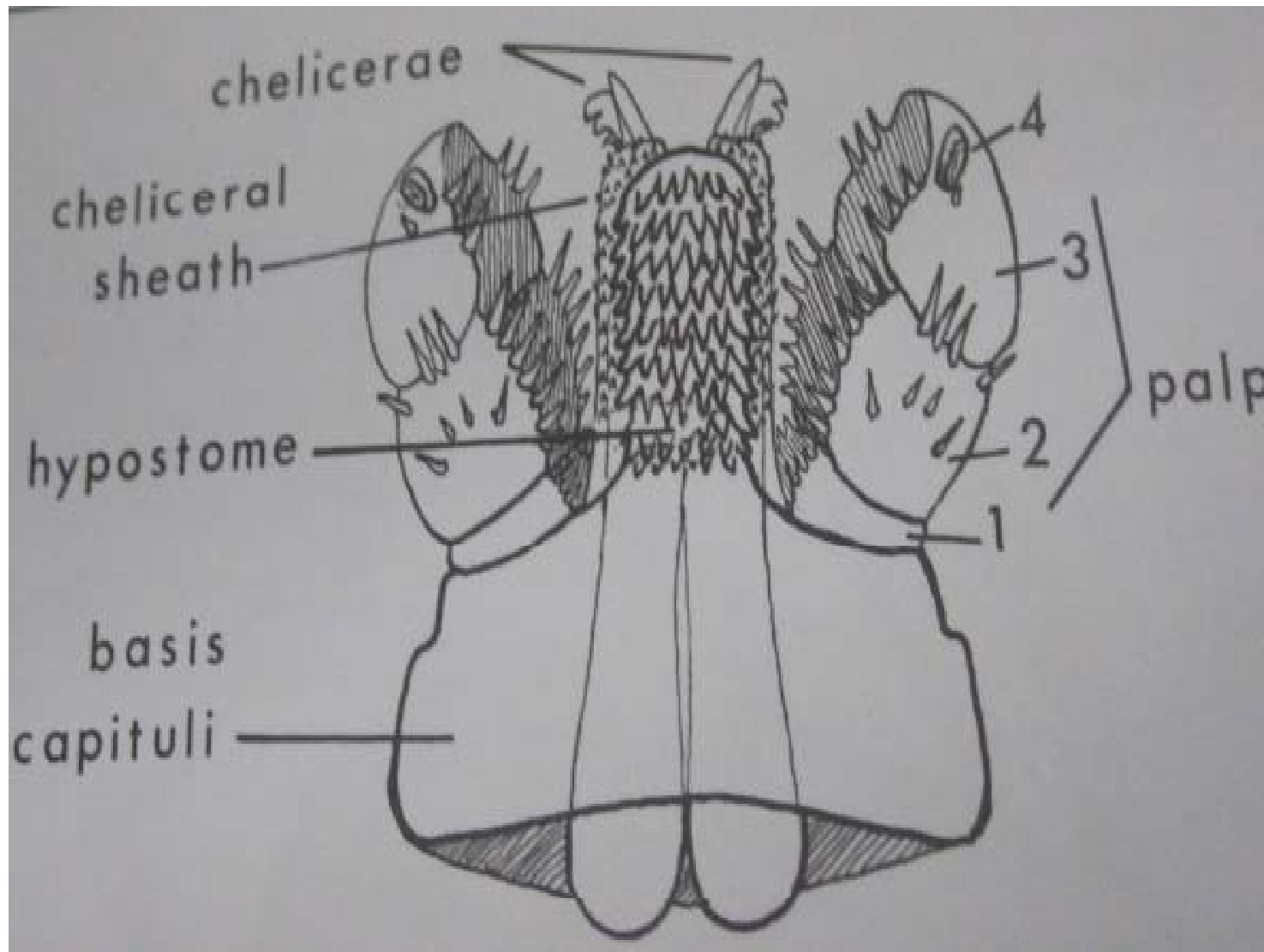
External morphology

- Adult hard ticks are flattened dorsoventrally and are oval in shape, measuring about 1-23mm long.
- Females are often bigger than males.

- Capitulum or false head projects forward from the body and is visible from above (Figure 17.1); which distinguishes the hard ticks from soft ticks.



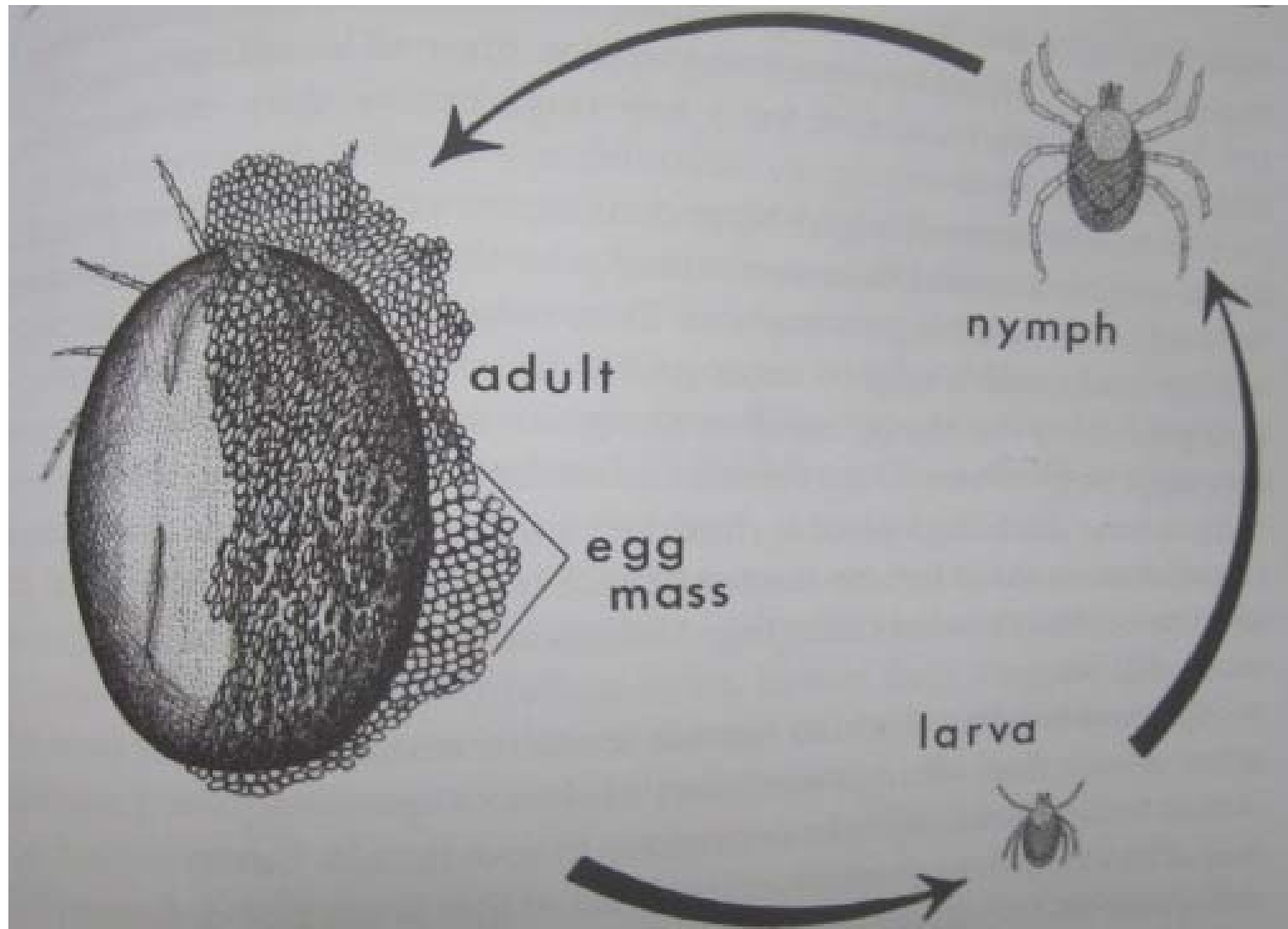
In hard ticks the palps are swollen and club-shaped (Figure.17.2), rather than leg shaped as in soft ticks.



- All hard ticks have a dorsal plate called a shield or scutum which is absent in soft ticks.
- In the larval and nymphal stages the scutum is small in both sexes.
- The body has four pair of legs terminating in a pair of claws.

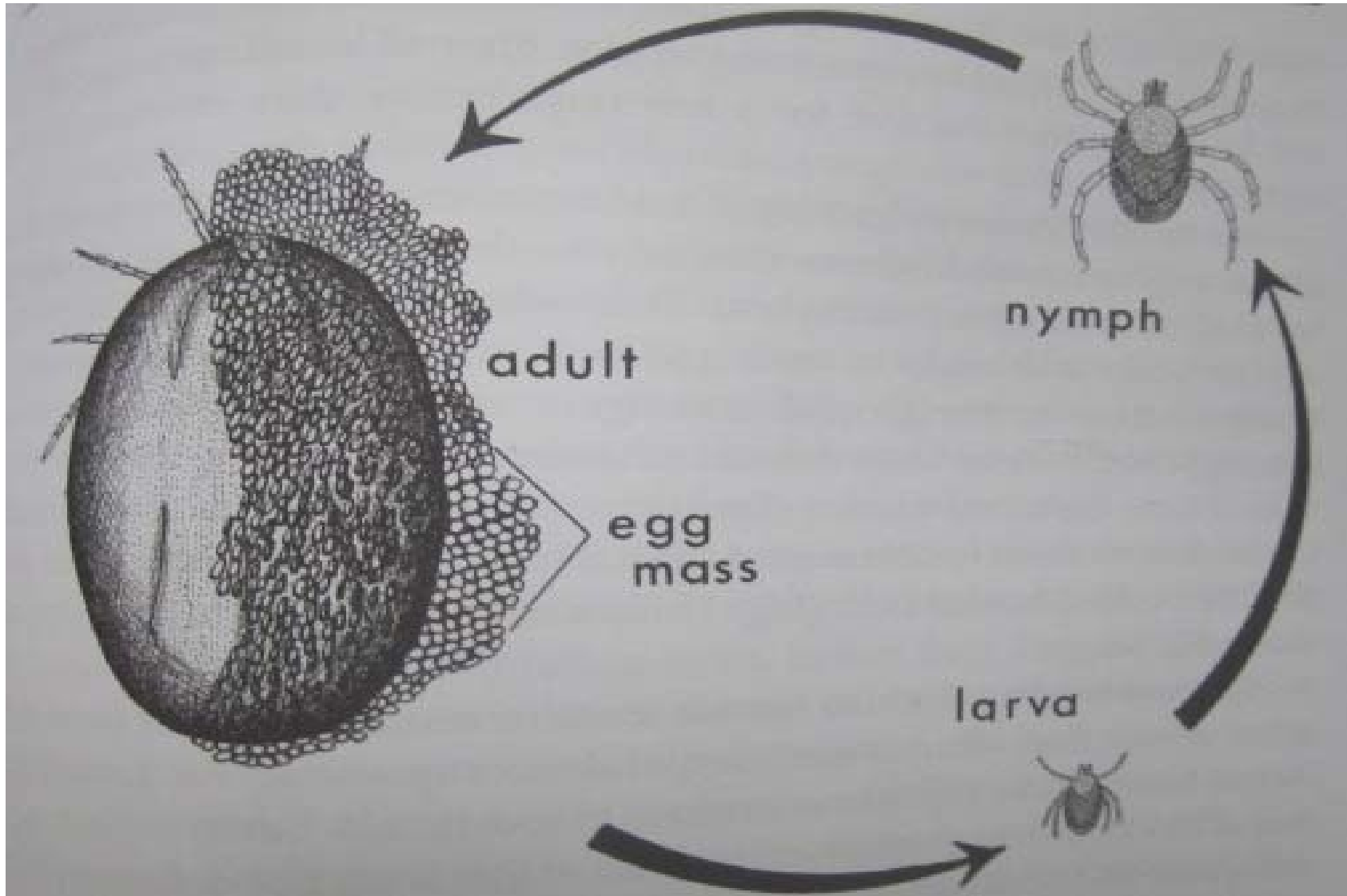
Life cycle

Have hemimetabolous life cycle (Figure 17.3)



- Adult ticks attached for long on its host as feeding lasts for 1 to 4 weeks.
- After been engorged, the ticks drops from host to ground and seek shelter under leaves, stones, detritus, among surface roots of grasses and shrubs.
- The time taken by female for blood meal digest and lay eggs varies with species and environmental conditions especially temperature.
- Oviposition often begins 3-6 days after the female has dropped from the female.

Thousands of eggs are laid in a gelatinous mass which is formed in front and on top of the scutum to the tick (Figure 17.3).



- Oviposition may last for 10 days, or extend over about 5 weeks
- The Ixodid female lays only one batch of eggs, after which dies.
- After 10-20 days to several months six legged larvae hatch from the time referred to as seed ticks.
- After hatching the larvae remain inactive for a few days after which they swarm over the ground climb up vegetation and cluster at the tips of grasses and leaves.

- When host passes in tick-infested habitats the larvae respond to stimuli such as carbon dioxide, host odours, warmth, shadows, vibration and movements by moving their front legs in the air.
- Larvae climb onto their hosts and crawl to their favoured sites for attachment, commonly in the ears or on the eyelids. But selected site depends on species.
- The hypostome are inserted deeply into skin of the host and the larvae commence blood-feeding.
- The larvae remain attached to their hosts for about 3-7 days.

- Larvae take 3-6 days for blood meal but in a cooler region it extends. After blood meal digestion, larvae take few days before moult to become nymph.
- Newly formed eight-legged nymphs crawl over the ground and climb vegetation and behave similarly to larvae.
- They attach themselves to host in areas of interest and stay feed fully engorged nymphs drop to the ground and digest blood meal.
- After 3-4 weeks the nymph breaks to adult ticks.

Medical Importance

1. Tick paralysis

- Female of some hard ticks, especially certain species of *Ixodes* and *Amblyomma* causes a condition known as tick paralysis.
- *Ripicephelus* and *Haemaphysalis* can also causes tick paralysis in pets and domesticated animals.
- **NOTE:** Tick paralysis is caused by saliva reaction and not any parasite

2. Tick borne encephalitis (TBE)

- Its principal vector is *Ixodes ricinus* in Europe. Rodents serve as reservoirs.
- TBE accumulate in mammary glands of goat, sheep and cow
-

3. Colorado tick fever (CTF)

- Is a viral disease occurring in USA and Canada. Principal vector is *Dermacentor andersoni*.
- CTF is a zoonotic disease. Rodents serve as reservoirs

Control

- Dipping of sheep and cattle is acaricidal baths or spray animals with acaricides (insecticides).
- Physical removal of ticks from animal
- Ground application of Diazinon, propoxur and Carbaryl.

Family Tabanidae
(Horseflies)

- Tabanids are large biting flies generally called horseflies
- They belong to the family Tabanidae which comprise of 4000 species in 30 genera.
- The most important species medically belong to genera Tabanus, Chrysops and haematop
-
- Tabanids have been associated with transmission of **tularaemia** in North America and the former USSR, and anthrax and it as been suggest to be vectors for Lyme disease (which is transmitted by hard licks).
-

- The main medical importance of the Tabanidae is that species of Chrysops, mainly, *Chrysops silaceus* and *C. dimidiatus* are vectors in west and central Africa of the filarial worm *Loa loa*
- Tabanids possibly play a very minor role in the mechanical transmission of human and animal trypanosomiasis
- In central and south America Tabanids are involved in the transmission of a form of *Trypanosome vivax* to cattle and sheep
- Tabanids have worldwide distribution.
- Species of *Tabanus* and *Chrysops* are found in temperate and tropical area but *Haematopota* is absent South America, and Australia and is common in North America.

- **EXTERNAL MORPHOLOGY**

- Generalized description is presented of the Tabanidae, with special reference to the genera *Chrysops*, *Tabanus* and *Haematopota*.

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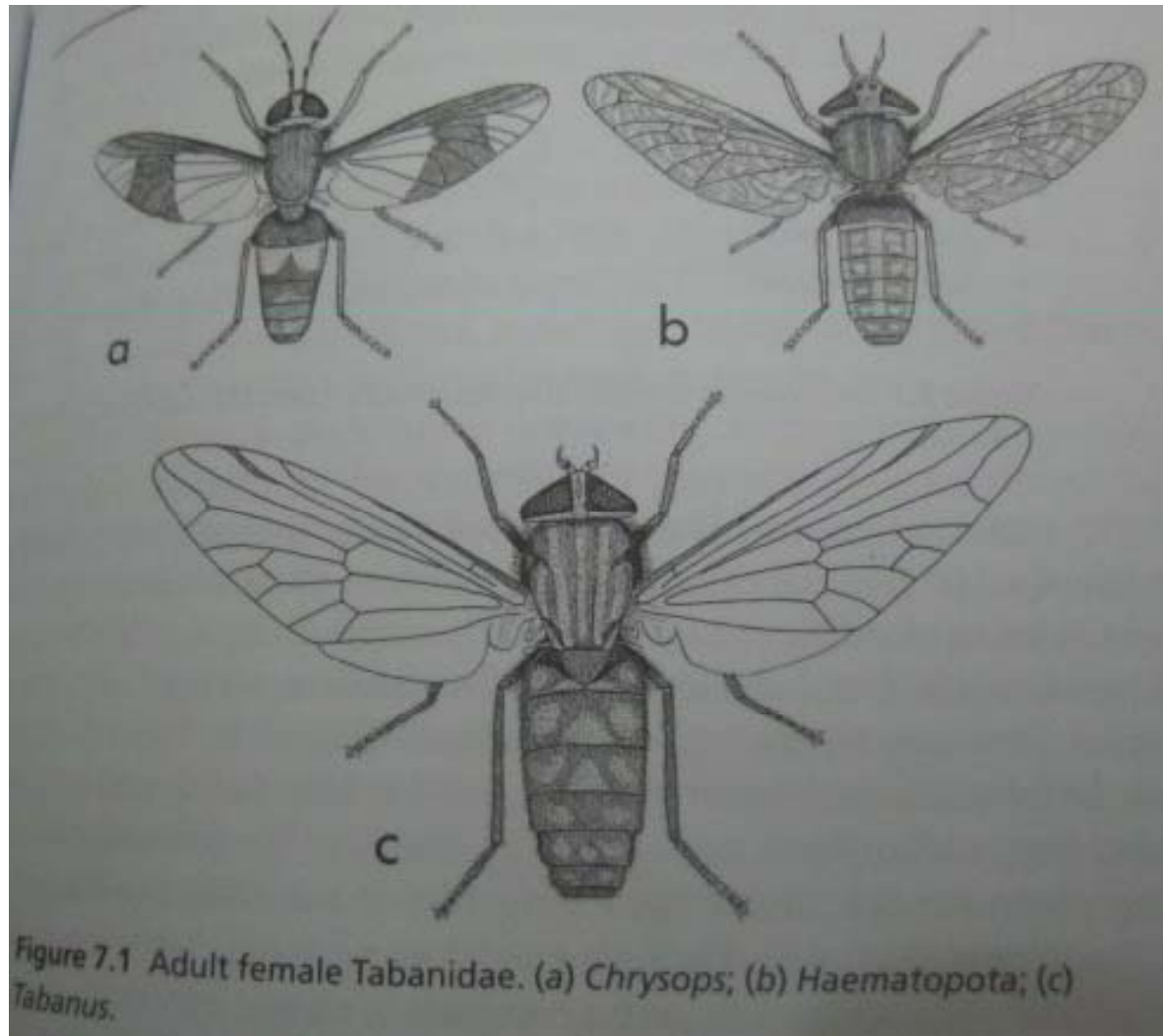
- Tabanids vary from 6-30mm long.

- In genus *Tabanus*, they are heavily built and this genus contains the largest biting flies, some attaining a wing span of 6.5cm long

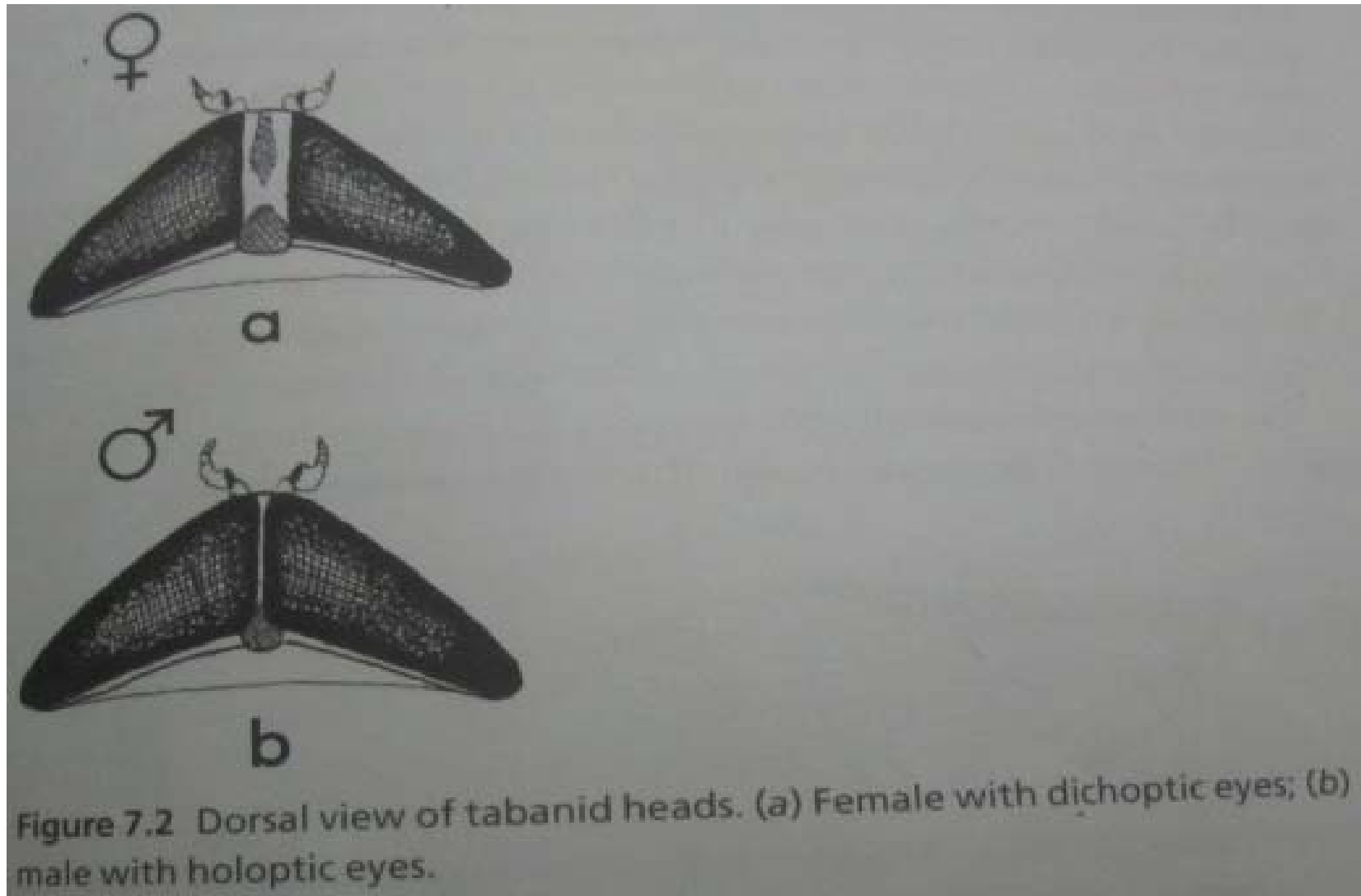
- Coloration range from dark brown, black to lighter reddish-brown, yellow or greenish.

-

Frequently the abdomen and thorax have stripes or patches of contrasting colours (Figure 7.1)



the female there is a distinct space on top of the head between the eyes. This is known as a **dichoptic condition** (Figure 7.2).



- In males, the eyes are so large that they occupy almost all of the head and either touch each other on top of the head or are very narrowly separated, this being known as a **holoptic condition** (Figure 7.2)
-
- Unlike Muscidae and Glossinidae, there are no antennae aristaes.
- The size and shape of the antenna serve to distinguish the genera *Chrysops*, *Haematopota*, *Tabanus*
- The mouth part of female are stout and adapted for biting and unlikely those of tsetse –flies, mosquito and *Stomoxys*, they do not project forward but hang downwards from the head.

- Only female Tabanids take blood meals.
-
- When adults are at rest the wings are placed either like a pair of open scissors over the abdomen or at a roof-like angle completely obscuring the abdomen.
- The abdomen is usually broad and stout and in unfed flies characteristically flattened dorsoventrally dark brown, blackish, light brown, reddish- brown

Life cycle

- Male feed only on naturally occurring sugar secretions.
-
- Female also feed on sugar substances found in addition bite on variety of mammals such as domestic animals especially horse and cattle, monkeys, reptiles and amphibia. They also feed on people.
-
- 100-1000 eggs are deposited by female Tabanids depending on species.
-
- Eggs are deposited underside of objects such as leaves, grassy vegetation plant stems, small branches, stone and rocks.

- These oviposition sites overhang or are adjacent to the larval habitats, which are mainly muddy aquatic or semi-aquatic sites. The eggs shells are water proof.
-
- Egg hatched after 4-14 days, the time depending on both temperature and space.
- After hatching, the young larvae drop down on to the underlying mud and or water

Larvae are cylindrical and rather pointed at both ends (7.5c)

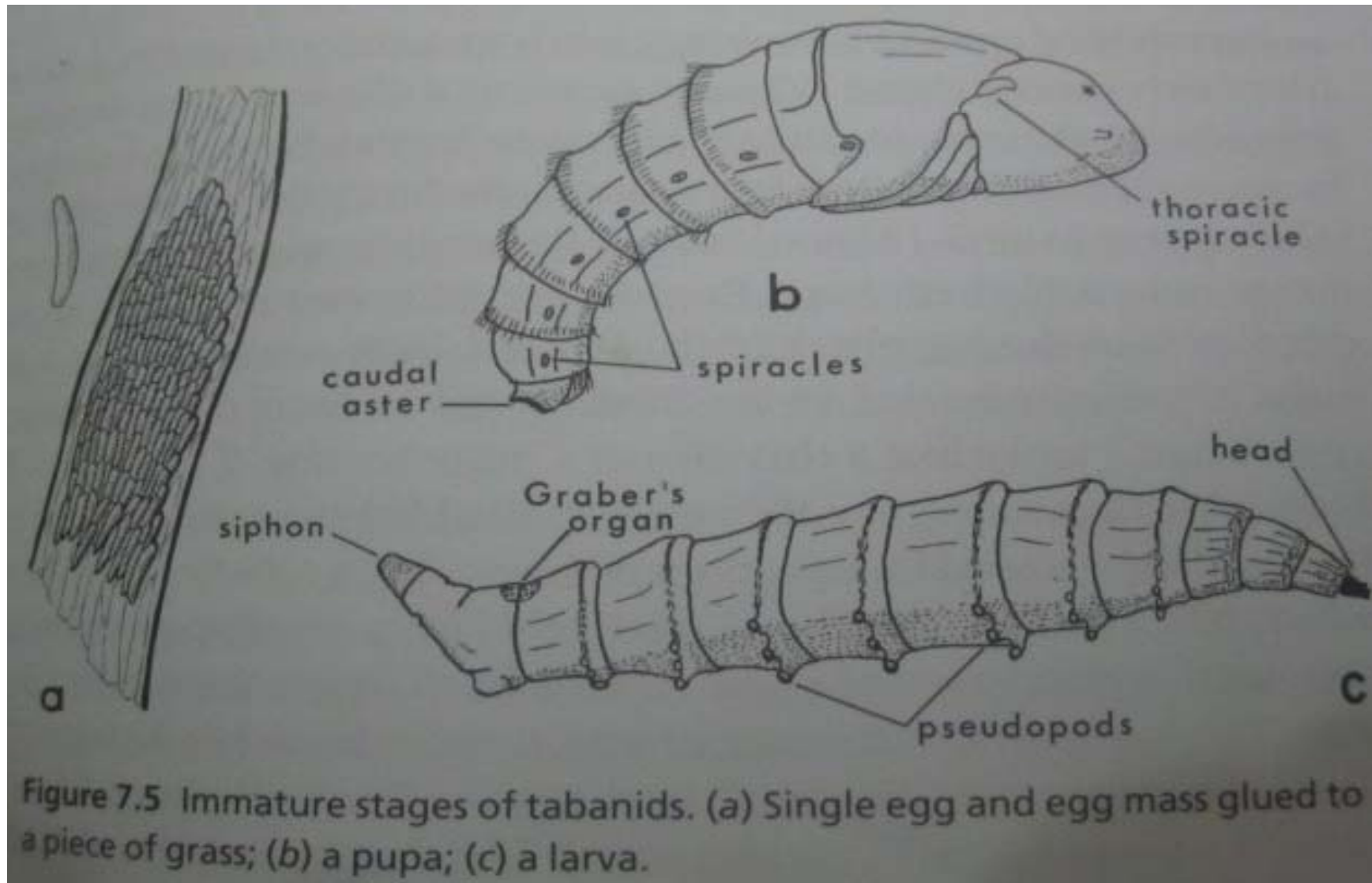


Figure 7.5 Immature stages of tabanids. (a) Single egg and egg mass glued to a piece of grass; (b) a pupa; (c) a larva.

- The head is very small black in colour which can be retracted into the thorax.
- The body has 11 segments
- Larvae live in mud, rotting vegetable; humus dump soil, in shallow and often muddy water.
- In aquatic environment larvae adhere to floating muddy water, at the edge of small pools, swamps, ditches or slowly moving streams.
- Larval development in temperate zones it takes 1-2 years and several species might remain as a larva for 3 years.
- Prior to pupation mature larvae migrate to drier areas at the periphery of the larval habitats where they pupate.
- Pupa is partially buried in the mud or soil in an upright position.
- The pupal period lasts for 5-20 days

Adult behaviour

- **Female of most species feed during the daylight hours and are especially active in bright sunshine, very few species feed during the night.**
- They locate their hosts mainly by sight (colour movement), although olfactory stimuli such as Carbon dioxide and other host odours also play a role in the host location.
- Tabanids are powerful fliers and may disperse several Kilometers
- Most Tabanids inhabit in woods and forests.
- Many Chrysops species are common in swampy woods.
- Adults do not enter houses to feed but *C. silaceus* is an exception

- *C. silaceus* is attracted to smoke from wood burning from forest fires.
-
- Due to their harder mouth parts, bites from *Tabanids* are deep and painful. The wound inflicted by *Tabanids* continue to bleed after departure.
-
- Due to painful bite during feeding *Tabanids* are highly disturbed by host.
-
- Several blood meals might be taken from different hosts to complete a full blood meal.
- This interrupted feeding behaviour increase their likelihood of being mechanical vectors of disease.
-
- Population of adult decrease in dry seasons and maximum number of biting flies usually appear towards the beginning of rainy season.

Medical Importance.

1. Minor Infections

- Due to disturbances during feeding Tabanids feed from multiple hosts hence can be mechanical vectors. It can spread Anthrax (*Bacillus anthracis*). In USA and USSR they spread *tularaemia* (*Francisella tularensis*) from horses, rabbits and other rodents to man.
- Also they are suggested to be vector of Lyme disease (*Borellia burgdorferi*) which is normally transmitted by ixodid ticks.
- Tabanids are also mechanical transmitters of *Trypanosoma evansi*, which causes a disease called surra in camels, horses and dogs.
- In south Tabanids are also mechanical vector of *Trypanosoma vivax* to livestock. This vivax does not infect people.
- People develop allergic reaction due to saliva pumped in to prevent blood clotting.

Loiasis

- Tabanids transmit loiasis to man. The parasite nematodes *Loa loa* are causative agent. They undergo development cycle in the fly.
-
- It's distributed in equatorial rain forests of Sierra Leone westwards to Ghana, Nigeria and Central Africa, the Southern Sudan and into Western parts of Uganda.
-
- Diurnal periodic microfilariae are found in the peripheral bloods of human and ingested by Tabanids with their blood-meal.
- Not all microfilariae survive the process of blood digestion. Then, they penetrate the gut wall and migrate to the abdominal and thoracic fat bodies. Here they grow and moult twice and develop into shorter and fatter larval forms (2mm long). After 10-12 day they migrate down to proboscis.
-

- When Chrysops feed on human the infection worms migrate from other parts of the body to the proboscis and enter the skin.
-
- They develop to adult worms which feed on subcutaneous tissue of people.
- Microfilariae of *loa loa* are more or less absent from the blood circulation of people at night but appear in it during the day especially in the morning and thereafter ready picked up by *C. Silaceus* and *C. dimidiatus* species which bite during the day.
- *Loa loa* from human can be transmitted to monkeys and some believe that loasis may be a zoonosis (Zoonotic disease).
- *Loa loa papionis* is a monkey's parasite which is not transmitted to human but only to monkey.
-

- **CONTROL**

- Drying swamps and potential Larval habitats
 - Use of Insecticides
 - Attractant trap for adults
 - Removal trap (coloured trap painted with adhesive materials)
 - Personal protection by use of repellents.
-
- **Challenges**
 - Hard to understand potential habitats
 - High dosage of insecticide is required.

Family Muscidae

House flies and stable flies

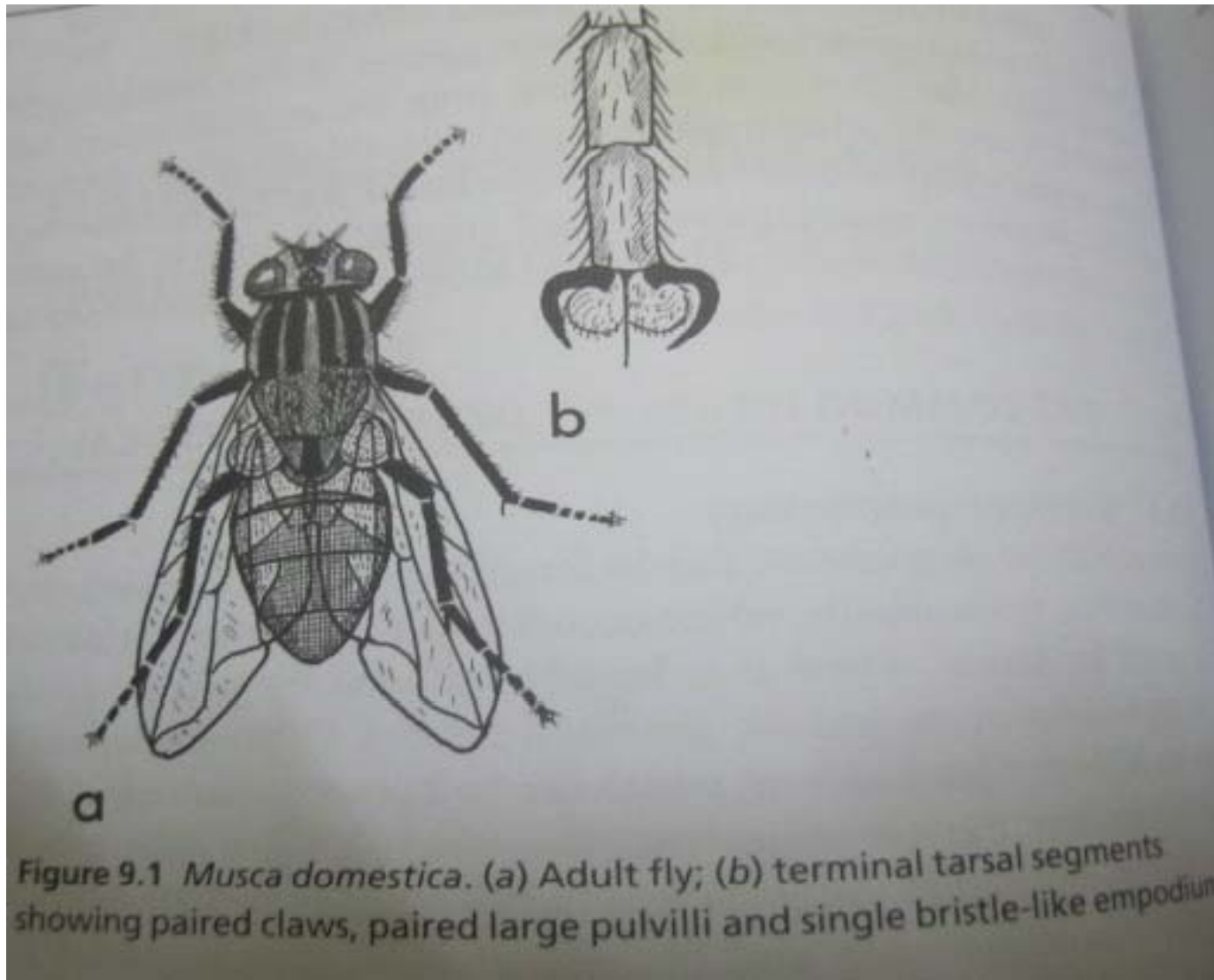
- There are about 3900 species belonging to family Muscidae
- The most important in medical aspect are the common house fly, of which have more or less world-wide distributions.
- The house flies can be vectors of helminths, faecal bacteria, protozoan and viruses resulting in spread of such enteric diseases as the dysenteries and typhoid, where the stable fly can cause the biting nuisance.

Common house fly (*Musca domestica*)

External morphology

- There are 66 species of flies in the genus *Musca*.
- The most common is *M. domestica*, which occurs globally but mostly in Africa.
- Other important related species include *Musca sorbens* which are found in Africa, Australia and elsewhere.
- Houseflies are 6-9mm in length, non-metallic flies.

They have four longitudinal lines on dorsal surface on the thorax (figure 9.1a).



- Antennae consist of three segments, the distal and cylindrical which has a prominent hair , called aristae
- The mouth parts (proboscis) of the housefly are specially adapted for sucking fluids or semi fluids.

- When they are not in use they are partially withdrawn in the head capsule (9.2a), it's extended downwards when the flies feeding (9.2b).

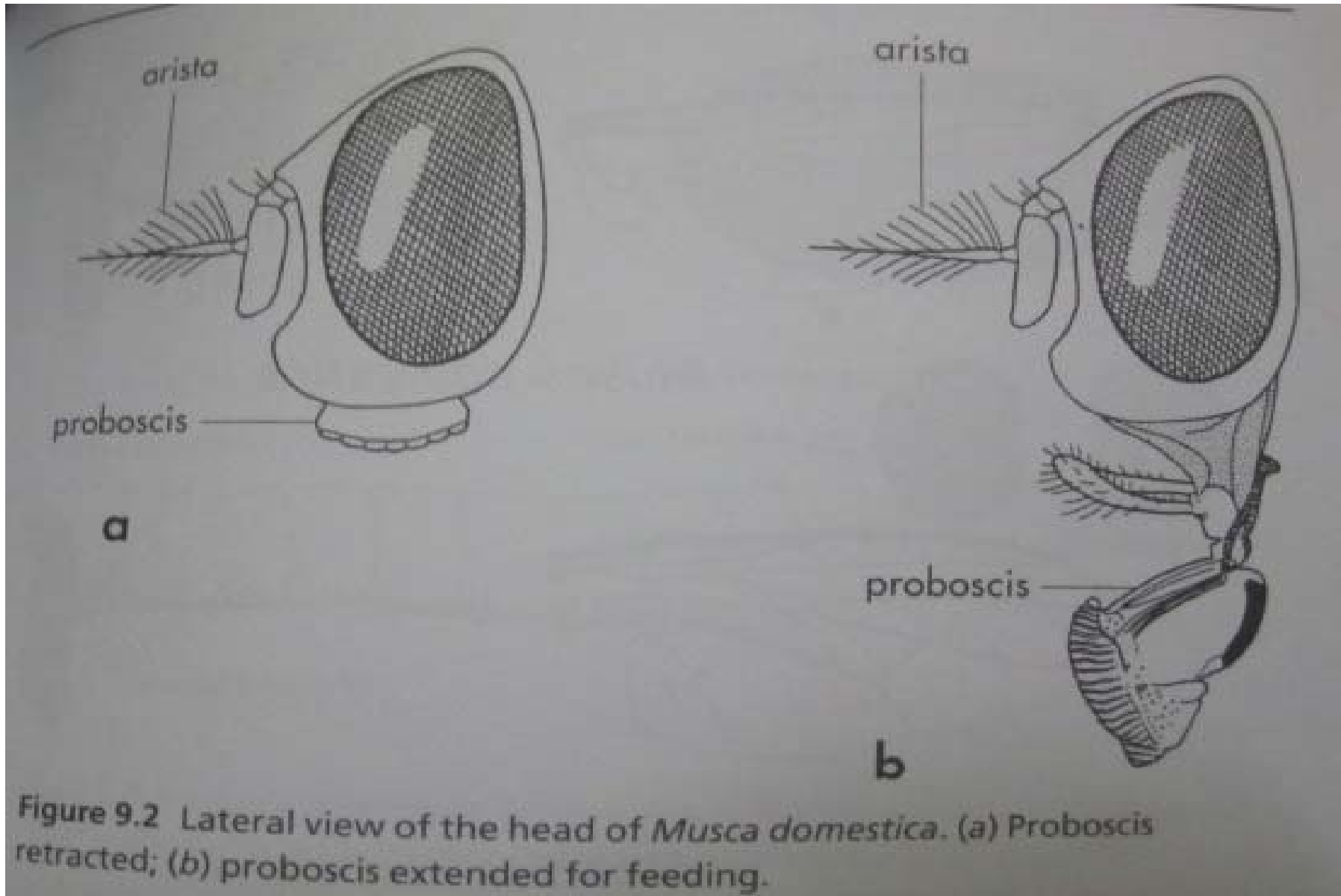
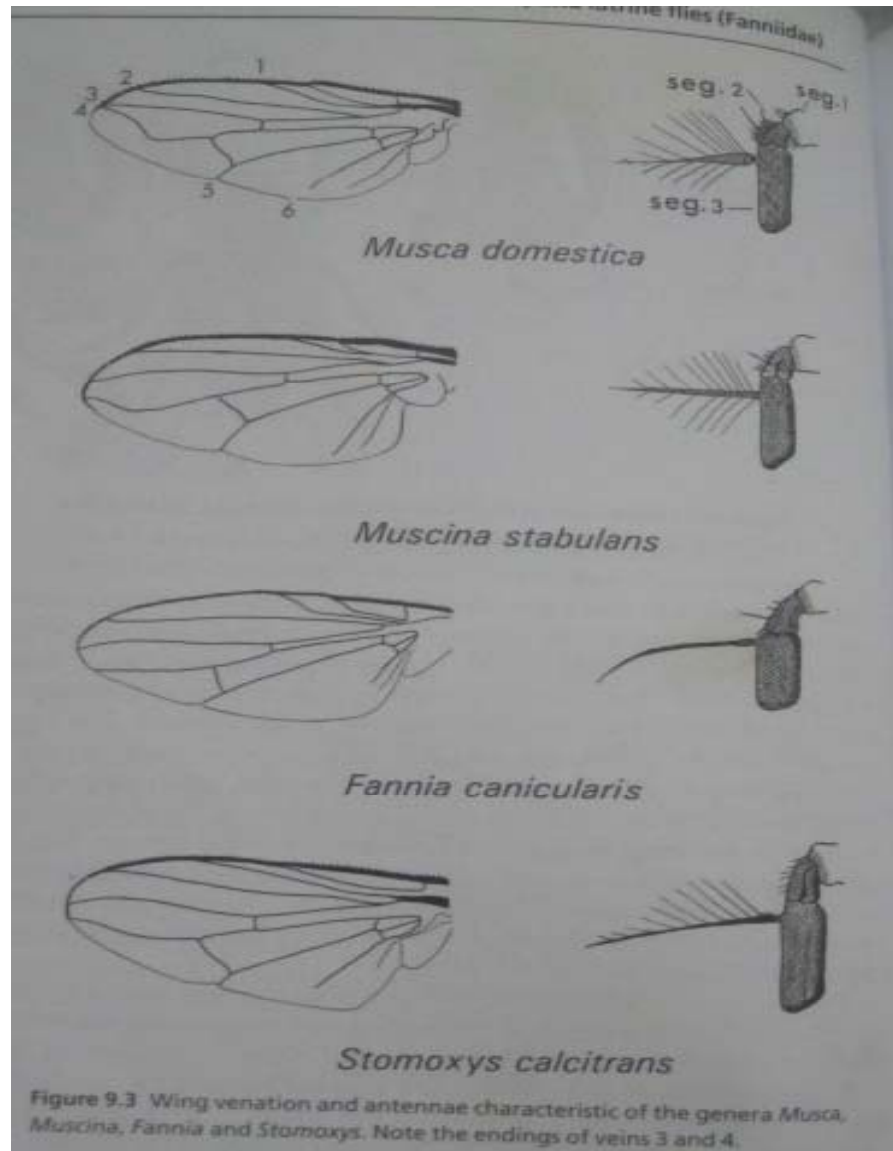


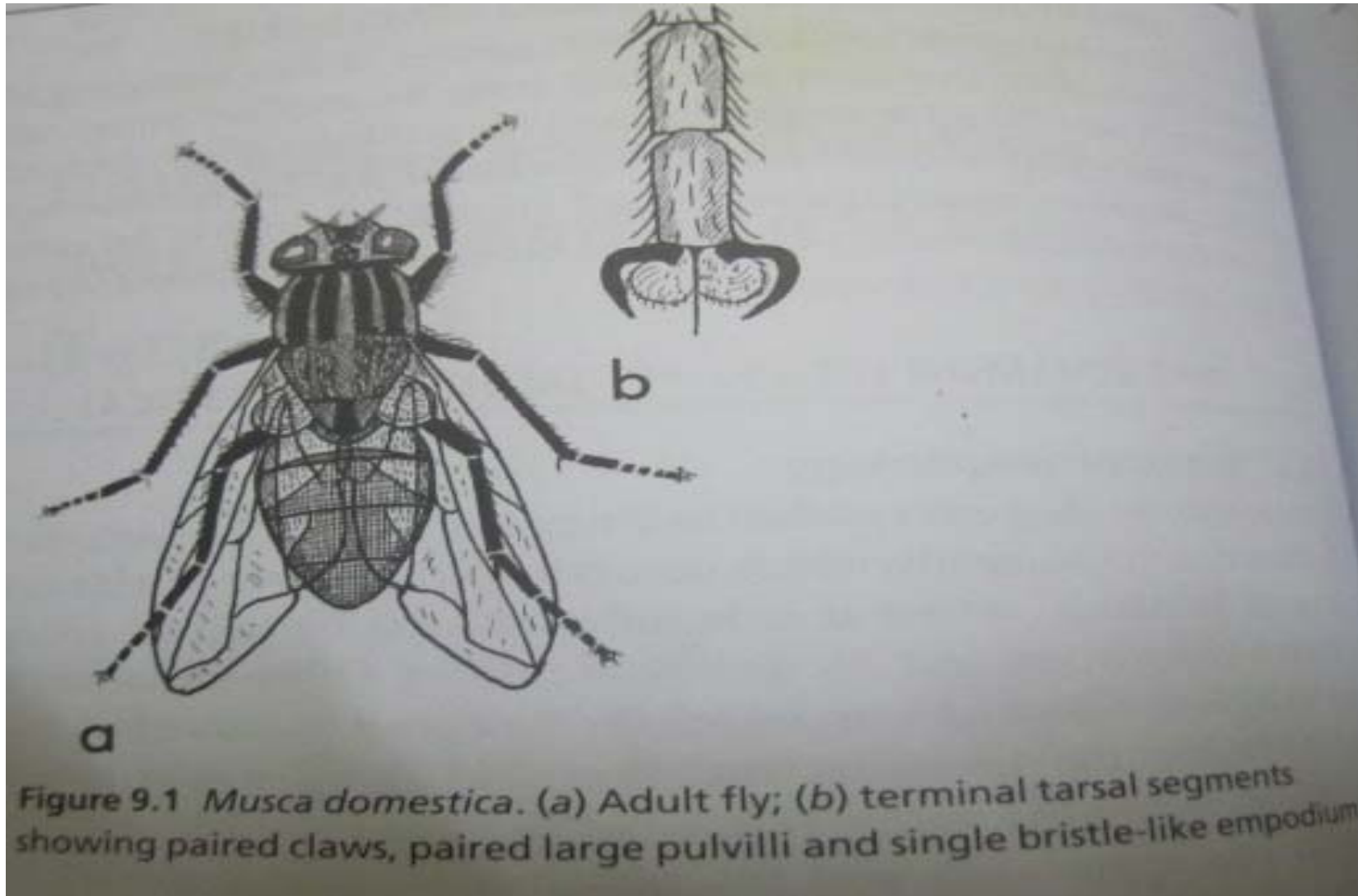
Figure 9.2 Lateral view of the head of *Musca domestica*. (a) Proboscis retracted; (b) proboscis extended for feeding.

- House flies feeds on a great variety of substances such as sugar, milk, all most all food of human, rotting vegetables.
- The mouth parts orientation during feeding differs with the type of the food.

- The wings of the house-fly have veins bending up sharply to joint costa close to vein 3 (**figure 9.3**). This is an important taxonomical character which can be used to distinguish *Musca* from other similar flies.



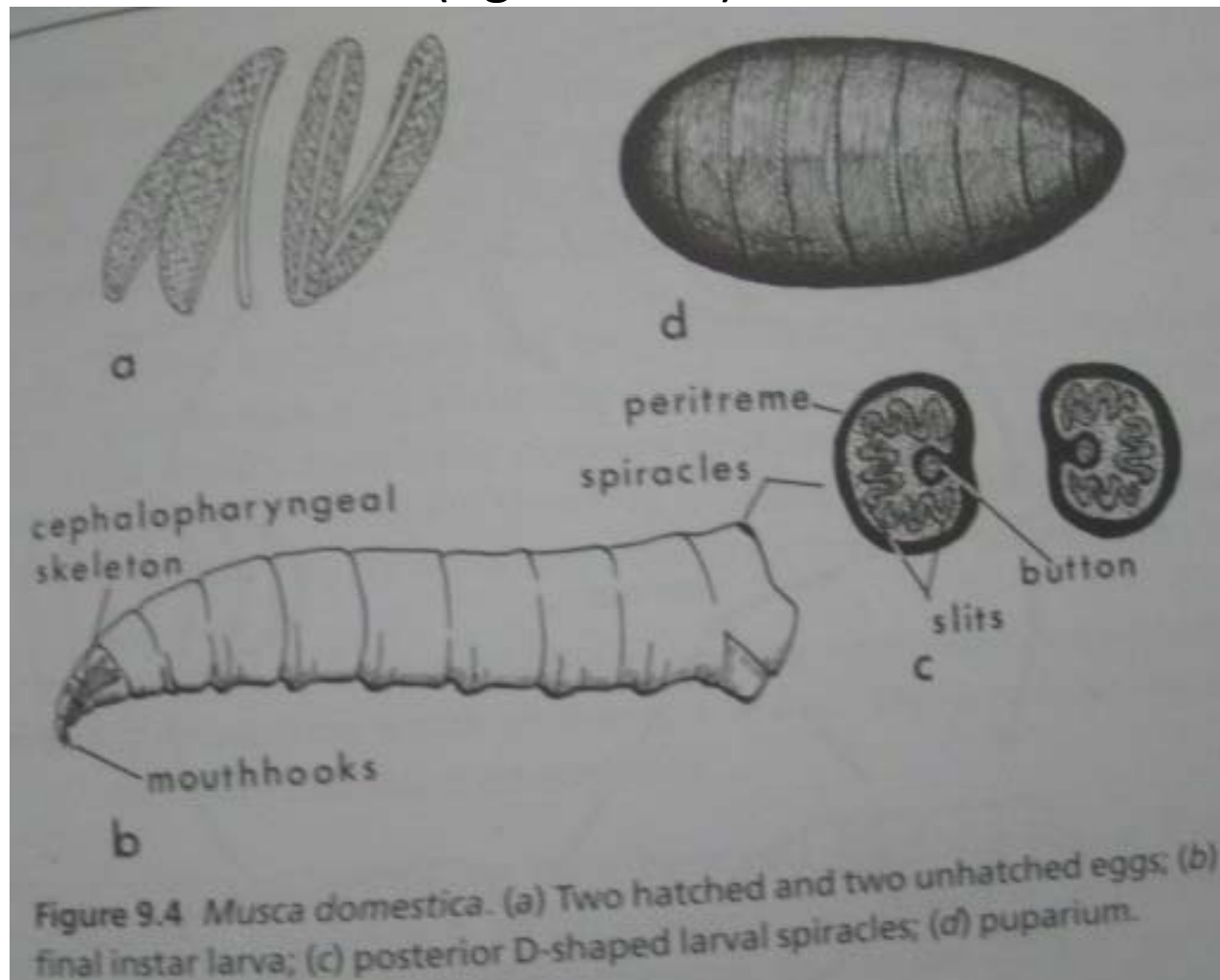
-Each of the three pair of legs ends up with a pair of claws and a freshly pair of pad-like structure called the pulvilli which are supplies with glandular hairs (figure 9.1b)



Life cycle

- Female *Musca domestica* are attracted to a variety of decomposing material for egg laying, such as horse manure, poultry dung, urine-contaminated bedding, foodstuff, carcasses, decomposing organic materials found in rubbish dumps.
- During egg laying 75-120 eggs can be deposited together, or in separate batches either in cracks or crevices or scattered over the surface.
- The eggs are creamy-white, 1-1.2 mm long, with a banana shape.
- Eggs can hatch in 6-12 hours but depends on weather.

- Eggs cannot withstand desiccation; they die if they dry out. At a temperature below 15 or above 40 degree celcius eggs die.
- The white creamy larvae hatched from the eggs have a small head followed by an 11-segmented cylindrical and maggot-shaped body (figure 9.4b).



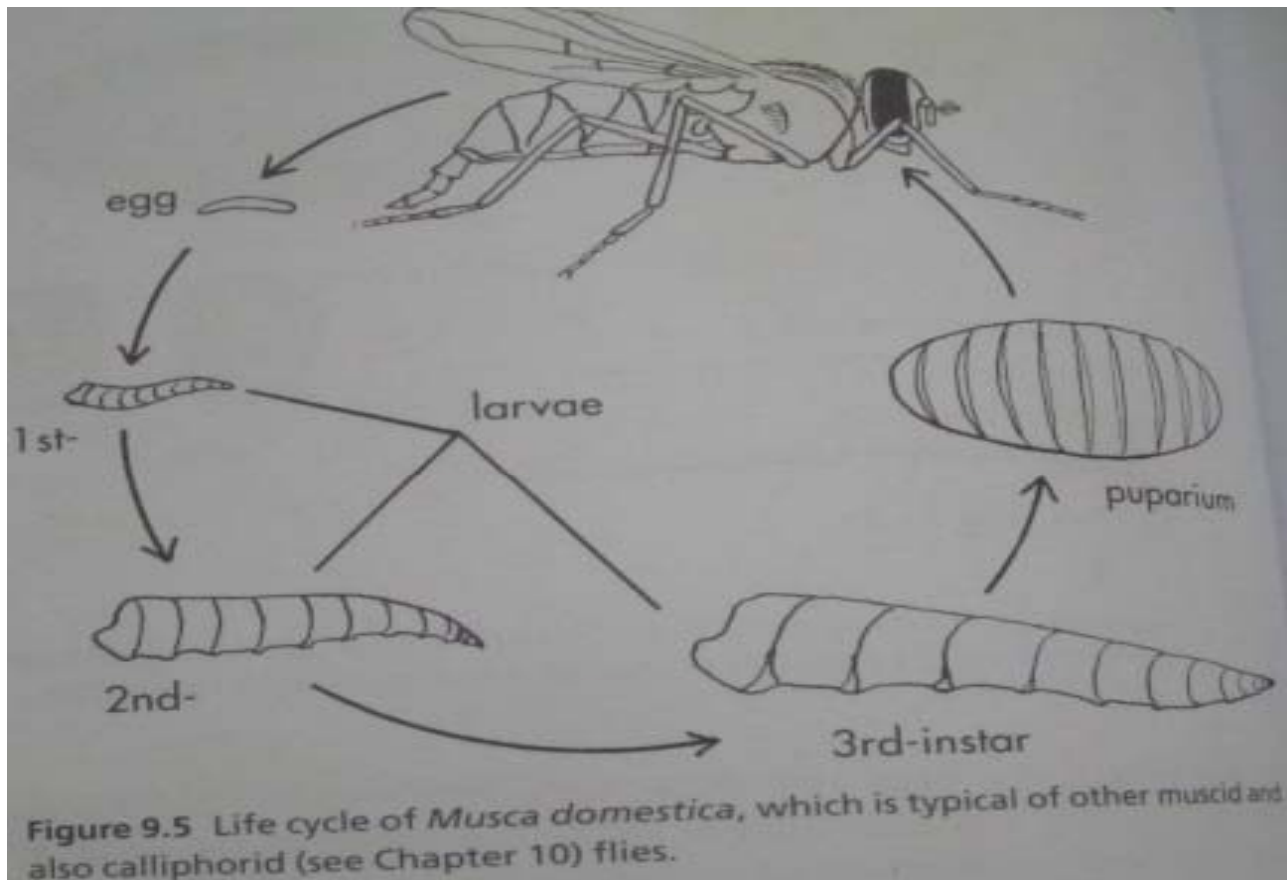
- Larvae feed on liquid food resulting from decomposing and decaying organic material.
- There are three larvae instars.
- Mature larvae measure about 8-14mm; the final size and growth rate depends on the environmental conditions, especially the amount of food and temperature.
- Prior to pupation, the third instar larvae migrate from their larvae habitats to the drier ground.
- Pupation starts with the contraction of the larvae skin, hardening and turning dark brown.

-The puparial stage lasts about 3-5 days in warm weather but may be prolonged to 7-14 days cooler periods.

-

Developmental time eggs to adult is about 49 days at 16 degree celcius, 25 days in 20 degree celcius, 16 days in 25 degree celcius, 10-12 days at 30 degree celcius and 8-10 days at 35 degree celcius

(figure9.5)



- The adult fly escape from its puparial case by pushing off its anterior end and crawling out
- After the hardening of the cuticle and inflation of wing, the adult flies away.
- Adult *Musca domestica* avoids direct sunlight and hide in the houses inhabited by human beings or other animals.
- *Musca domestica* and other flies are called domestic flies because they are associated closely to human being and their environments.
- House flies defecate randomly and regurgitate their food resulting in unsightly.
- Adults tend to stay 500M of their breeding sites, but can fly 1-5 km, and sometimes greater distances.

- *Musca sorbens* is widely distributed in Africa and Asia where it is a great pest than *M. domestica*, because the adults more commonly settle on suppurating wounds around eyes, sweaty skin and other body secretions than does common housefly (*M. domestica*).

Medical importance

- They transmit different disease pathogens through the three major
- By flies contaminated feet, body hair and mouth parts, a disease such as **Trachoma**.
- By flies vomiting on food, a disease such as **cholera**.
- By defecation on food.= **responsible for mostly enteric disease pathogens**

Control

- Physical and mechanical barrier
- Environmental sanitation
- Insecticides control by;
 - Larvicides such as *Bacillus thuringiensis*,
 - insect growth regulator for larvae
 - spray against adults
 - toxic baits
- insecticidal cords

Stable flies (*Stomoxys calcitrans*)

- Stable flies have worldwide distribution.
- The most common species is *Stomoxys calcitrans*
- Adults have four black longitudinal stripes on a dark grey thorax and are about a size of 5-6mm of houseflies, which they superficially resemble.

- In Africa, the adults might be confused with tsetse fly which also has the forward projecting proboscis, but *Stomoxys calcitrans* is a smaller fly.
- Also when at rest their wings do not cross each other as in tsetse fly but are kept apart as in house fly.
- Furthermore there is no enclosed **hatchet cell** in wings as found in tsetse.

Life cycle

- Both female and males takes blood meals from wild and domesticated animals and also feed on man.
- Their bites might be very painful.
- During hot weather the insects digest blood meal within 12-24 hrs and feed about as it's on food every 1-3 days. But in cooler climate the blood digestion prolonged to 2-4 days and feeding occur every 5 to 10 days.
- Most biting occurs outdoor but in some times they will enter house for feeding.

- They are mostly found where horses are kept and mostly restricted in rural areas than in townships.
- Eggs are creamy white resembling the house flies.
- Resultant larvae are creamy coloured maggots which resemble those of house fly.
- Larvae prefer high degree of moisture hence they are found in manures or vegetable at advance level of decomposition.

- Under optimum condition the larvae period last for 6-10 days. When its cooler or with shortage of food the larvae development 4-5 weeks.
- Larvae migrate to the drier areas and bury themselves in the soil prior to pupation.
- The puparium is dark brown resembling that of house fly.

Medical importance

- They do not transmit any disease to human but they transmit *Trypanosoma evansi*, the causative agent of surra, a disease which infect camels, horse and animals in tropical countries.
- Annoyance with painful biting.

Control

- Not allowing pile of manure
- Don't allow Grass cutting or decomposing vegetable accumulation
- Using organophosphate for larviciding.
- Spraying animal shelters can reduce the adult population

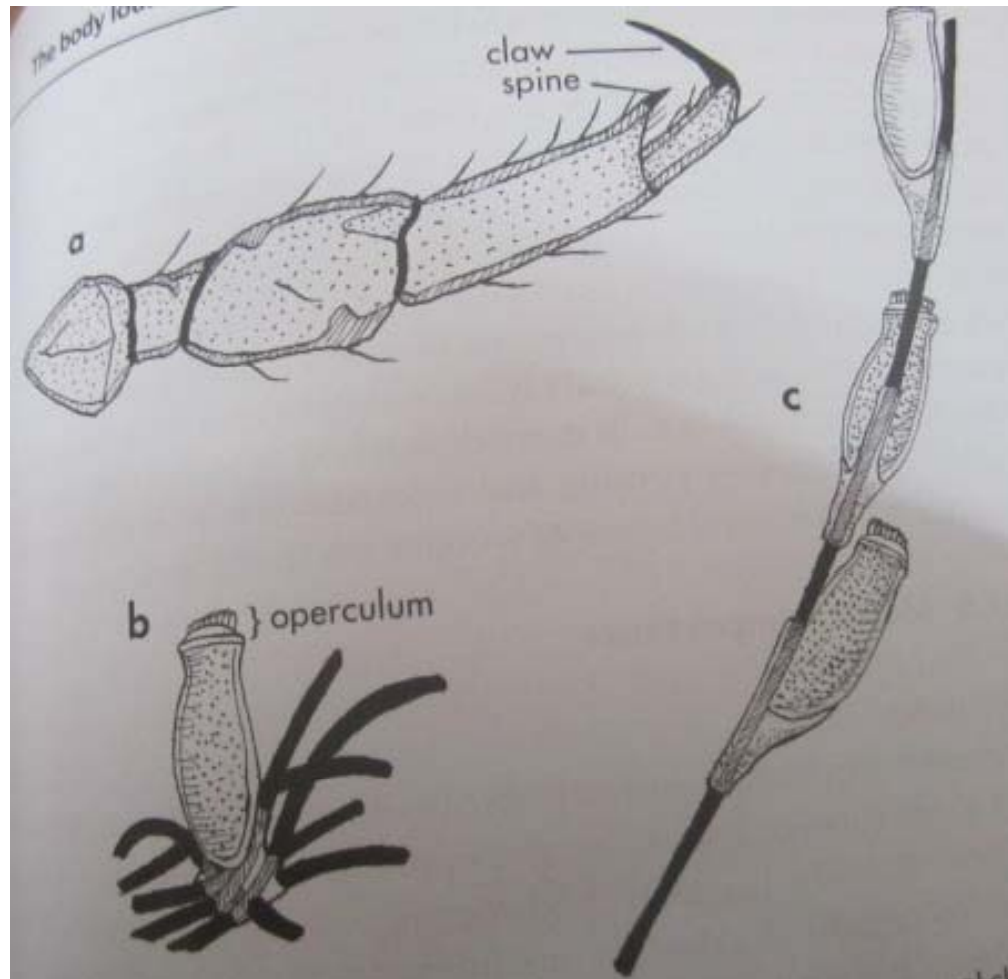
Lice (Anoplura)

- Human Blood sucking lice comprise of three types:
 - - Pubic or crab louse (*pthirus pubis*)
 - - The body lice (*Pediculus humanus*)
 - - The head lice (*pediculus capitis*)
- Morphologically it's very difficult to separate head and body louse. They can also interbreed
- All species of lice have less world-distribution but mostly in temperate region.

The body lice (*Pediculus humanus*)

- - **External morphology**
- Adult are small
- Wingless insect with a soft but rather leathery integument.
- Flattened dorsal ventrally
- Male measure 2-3mm and female 3-4mm
- Head has a pair of short five segmented antennae with inconspicuous eyes.
- The three pairs of legs are stout and well developed.

- The short thick tibia has a small thumb-like spine on its inner side at the apex, and the short tarsus has curved claws (**Fig.12.2a**). In females the claw on the fore-legs is shorter than in males.



- Mouth parts do not have projected piercing proboscis like other blood sucking insects.
- They consist of a flexible, sucking, almost tube-like mouth called *haustellum*.
- It has minute teeth which grips the host skin during feeding.
- In the males there are dark transverse bands on the dorsal surface of the abdominal segment and the tip of the abdomen is rounded, whereas in female it is bifurcated.

Life cycle

- Both sexes take blood meals and feeding occurs anytime during the day or night.
- Both immature and adults live permanently on human clinging to the hairs of their body.
- Female glue about 6-9 eggs per days on the hairs of clothing.
- Eggs are commonly oval, white about 1 mm long and have a distinct operculum (cap) with several minute perforations.
- Female lice leave for 2-4 weeks and lay 200-300 eggs.

- Egg duration is normally about 7-10 days. Eggs cannot survive longer than 4 weeks
- Lice has hemimetabolous life cycle
- Lice have three nymphal instars; and about 7-12 days they become adults. Nymphal stage on not worn clothes takes longer.
- The body louse is a true ectoparasite of humans
- Unfed lice dies within 2-4 days

- Lice are very sensitive to change in temperature, they abandoned a dead person quickly as the effect of temperature cool down. Also, they can't feed on a person with a temperature above 40 degree celcius.
- Heavily infested person may have 400-500 lice on clothing and body. There is a record of 10000 lice and 10000 eggs from a single shirt.
- Body lice are spread by close contact and are especially prevalent under conditions of overcrowded.
- They are highly found in primitive jails, refugee camps and in trenches during war and insanitary conditions.
- People in highlands areas of tropica regions are mostly infested for wearing many clothes for long during cold seasons.

- **MEDICAL IMPORTANCE**

-

- **Pediculosis**

- The skin of the people who harbour large numbers of body lice may become pigmented and tough.

-

- **Louse-borne epidemics typhus**

- Body lice ingest *Rickettsia prowazeki* during blood meal by both male and female.
- Human therefore become infected with typhus either by the contamination of faeces of lice or by crushing it, NOT by its bite.

-

- **Trench fever**

- Trench fever is caused by *Bartonella quintana*, the bacteria being ingested by the louse during feeding.

-

- **Louse-borne epidemics relapsing fever**

- The causative agent is *Borellia recurrentis*, is ingested by lice from a person suffering from epidemic relapsing fever.
- Epidemics occur in only areas with high louse infestation.

-

-

CONTROL

- - Change and wash the infested clothes in water hotter than 60 degrees celcius.
-
- -Insecticides lotions
-
- - Impregnation of clothes with pyrethroid
-
- - frequent body washing and ironing of clothes

The head lice (*pediculus capitis*)

- **Life cycle**

- The life cycle is similar to that of body lice except eggs are not laid in clothes but are cemented on hair of the head.

-

- **Medical importance**

-

- Under experimental conditions head lice transmit both **Rickettsia** and **spirochaetes**

-

- **Control**

- Regular washes with soap and warm water

- Shaving head

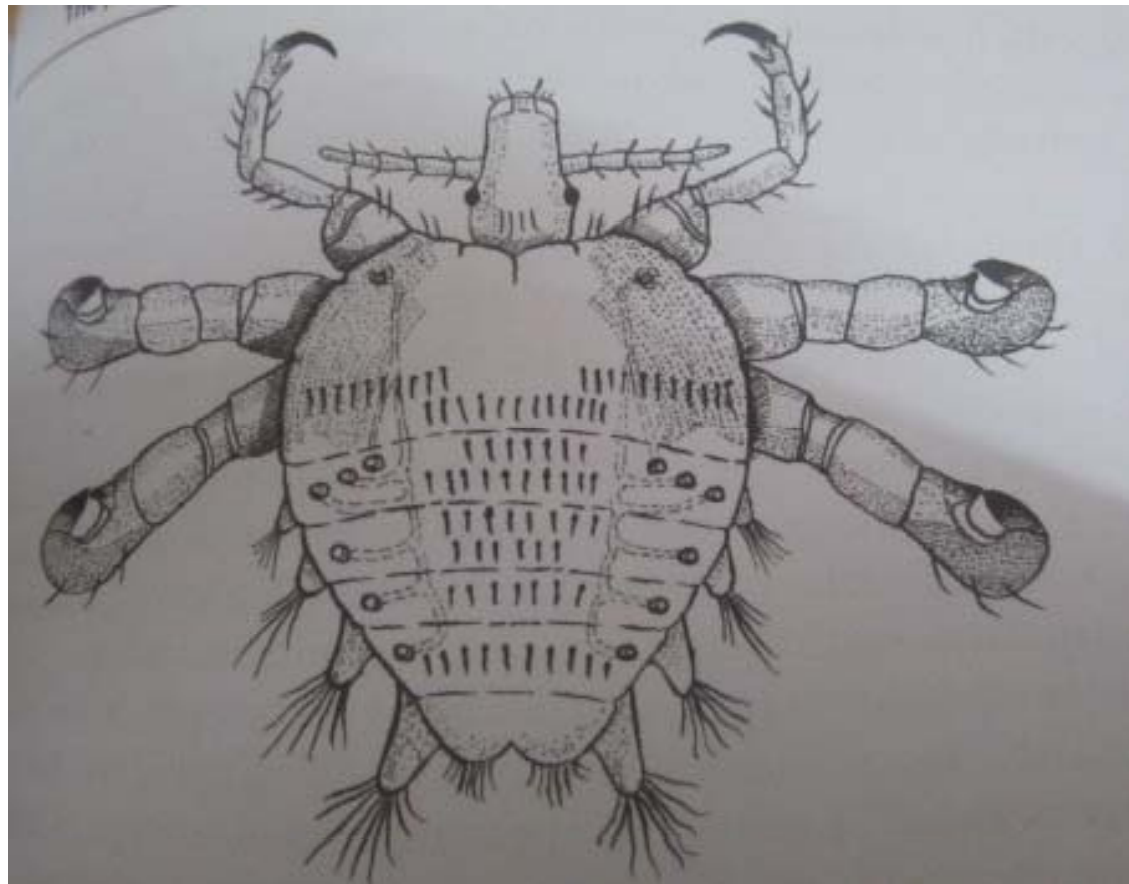
- Application of insecticidal lotions- leave for 12 hours

-

-

Pubic or crab louse (*pthirus pubis*)

The pubic louse is smaller (1.5-3mm) than pediculus
Middle and hind legs have massive claws (**Figure 12.3**)



Life cycle

- The life cycle of the *pthirus pubis* is very similar to pediculus

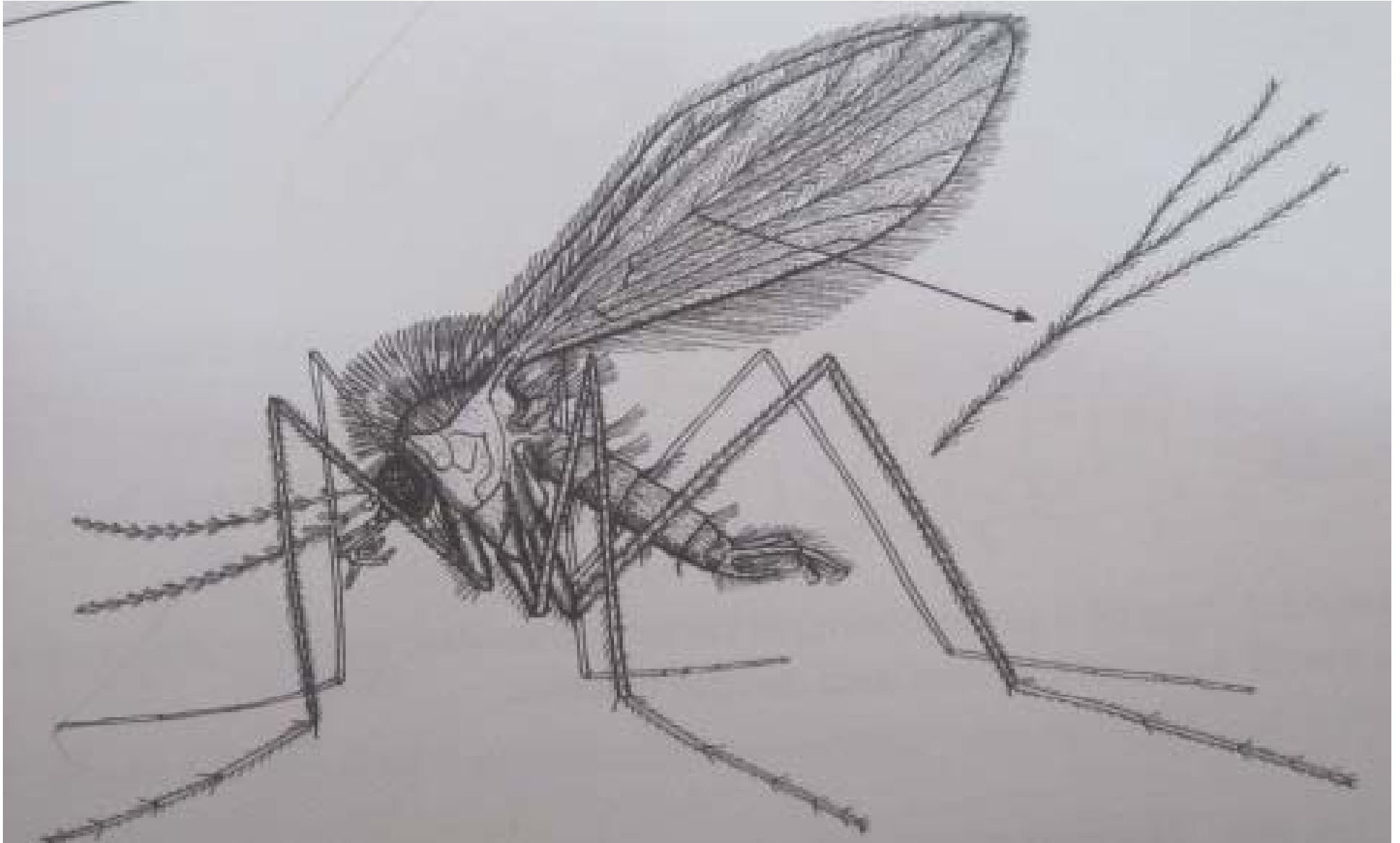
Medical Importance

- Under laboratory conditions they transmit louse-borne typhus; there is little evidence that under natural conditions they do.
- They cause severe allergic reaction (*Pruritus*) develop to their bites due to the saliva deposited around the wound.
- They cause Pediculosis pubis or **phthiriasis**.

- **CONTROL**

- Shaving pubic hair
- Application of insecticidal lotion and emulsions(sometimes insecticides may cause irritation and dermatitis due to sensitivity of the genital region)

Phlebotomine sand flies (Phlebotominae)



- There are some 700 spp phlebotomine sand flies in six genera within the subfamily Phlebotominae of the family psychodidae.
- Species in 3 general-Phlebotomus, Lutzomyia and sergentomyia. They suck blood from vertebrates.
- Phlebotomus and Lutzomyia are more important medically as they contain disease vectors.

- The genus *Phlebotomus* occurs only in the Old World especially in southern parts of the northern temperate areas such as the Mediterranean, few species occur in tropical Africa especially West Africa. Most *Phlebotomus* species inhabit semiarid and savannah areas in preference to forests.
- *Lutzomyia* species by contrast are found only in the New World tropics, occurring mostly in the forested areas of central and South America.

- *Sergentomyia* species are also confined to the old world being especially common in India subregion, but also occurring in other such in central Africa and Asia. A few species of *Sergentomyia* bite people, but they are no disease vectors.
- The most important species include *Phlebotomus papatasi*, *P. sergenti*, *P. argentipes*, *P. ariasi*, *P. perniciosus* and species in the *Lutzomyia longipalpis* and *Lutzomyia flaviscutellata* complex
- In both old and New world sand flies are vectors of Leishmaniasis, The virus responsible for sand fly fever and an organism causing a disease called *Bartonellosis* (carrion's disease)

External morphology

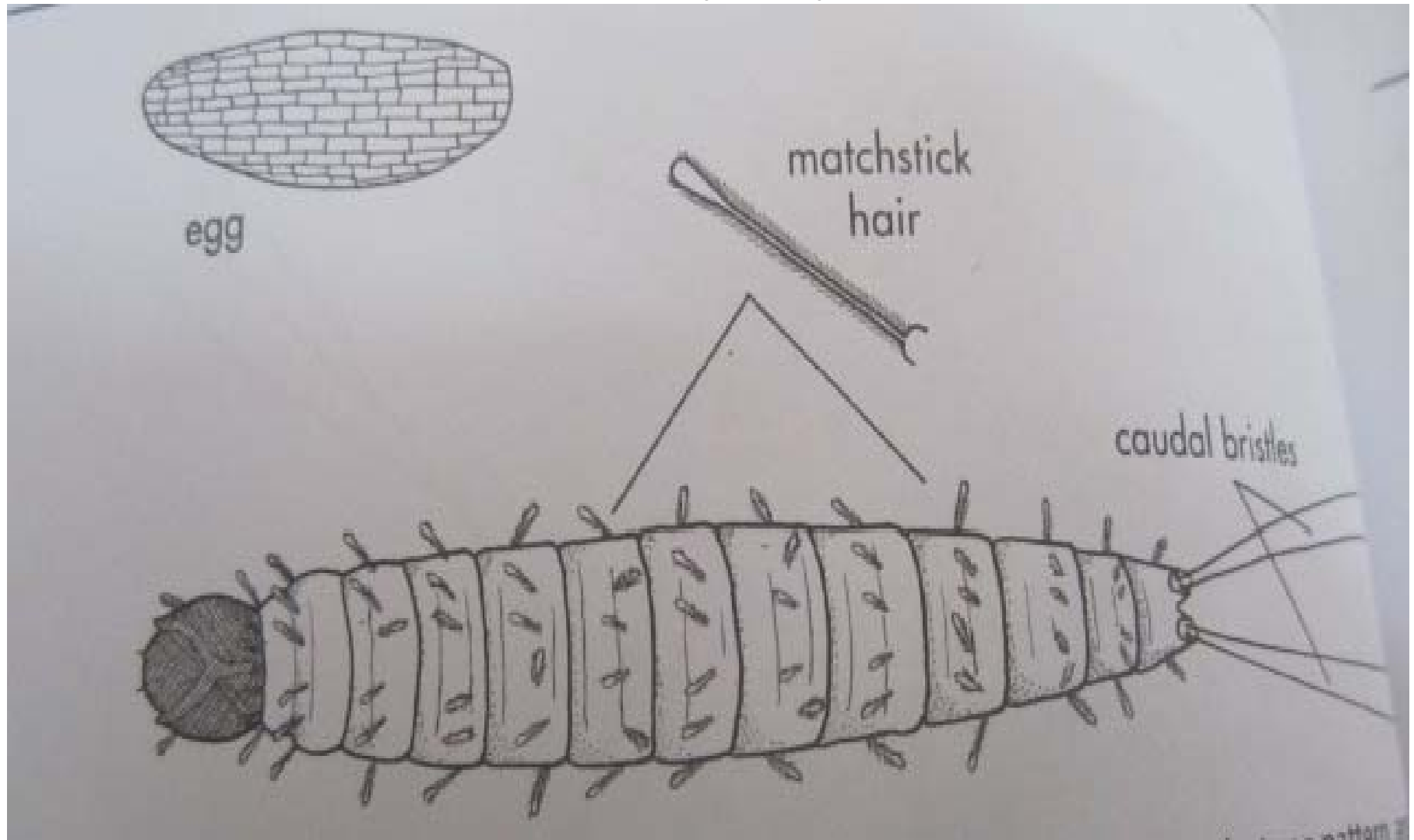
- No details are given for distinguished between the adults of *Phlebotomus*, *Lutzomyia* and *Sergentomyia* because this requires specialized knowledge and detailed examination, generally species biting people in the old world will be *Phlebotomus* and in the new world *Lutzomyia*.
- Adult phlebotomize shadflies can be readily recognize by their minute size (1.3-3.5 mm), hairy appearance, relatively large black eyes and their relatively long and stilt-like legs.
- Phlebotomine sand flies have the head, thorax, wings and abdomen densely covered with long hairs.

- The antennae are long and composed of small bead-like segments with short hairs; they are similar in both sexes. Mouth parts are small and conspicuous and adopted for blood sucking. At their base are pairs of fine-segmented maxillary pulps which are relatively conspicuous and droop downwards.
- Wings are lanceolate in outline and quite distinct from the wings of other biting flies.
- The Phlebotominae can be distinguished from other sub-families of the family psychodidae, which they may superficially resemble; by the wings.

- In sand flies the wings are held erect over the body when the fly is at rest, whereas in non-biting psychodidae flies they are folded, roof-like over the body
-
- Their abdomen is moderately long and in the female more or less rounded at the tip. In males it terminates in a prominent pair of genital claspers which give the end of the abdomen an upturned appearance.
-
- Identification of adult phlebotomized sandflies to spp is difficult and usually necessitates the examination of internal structures, such as the arrangement of the teeth on the *Cibarial armature*, the shape of the spermatheca in females, and in males the structure of the external genital (terminal).

Life cycle

The minute eggs (0.3-0.4mm) are more or less ovoid in shape and usually brown or black and careful examination under a microscope reach that they are patterned



- Some 30-70 eggs are laid singly at each oviposition. They are deposited in small cracks and holes in the ground, at the base of termite mounds, in cracks in masonry, or stable floor poultry houses, amongst leaf litter between buttress roots of fig trees. The oviposition site differs according to species.
- Eggs are not laid in water they require a moist microhabitat with high humidity, They are unable to withstand desiccation and hatch after about 6-17 days under optimal condition, However hatching might be prolonged in cooler weather.
- Larvae are mainly scavengers, feeding on organic matter such as fungi, decaying forest leaves, semi-decaying vegetation, animal feces and decomposing bodies of arthropods.

- Some species especially of *Phlebotomus* genus occur in semiarid areas, the actual larval habitats must have high degree of humidity. Larvae can usually survive if their breeding places are temporally flooded by migrating to drier areas in the edges of water body.
- There are four larval instars. The mature larva is 3-6 mm long and has a well-defined black head which is provides with a pair of small mandibles; the body is grayish or yellowish and 12-segmental.
- The first sever abdominal segments have small pseudopods but the most striking feature of the larva is the presence, on the head and all body segments, of conspicuous thick bristles with feathered stems, which in many species have slightly enlarged tips.
-

- The feathered stems are called **Matchstick** hairs and identify the larvae as those of phlebotomine sand flies. In most species the last abdominal segment bears two pairs of conspicuous long hairs called the **caudal setae**. The first instar larvae has two single bristles not two pairs
- Larvae development is completed after 19-60 days, the duration depending on species, temperature and food availability.
- Before pupation the larva assumes an almost erect position in the habitat, the skin splits open and the pupa wriggles out. The larval skin is not completely cast off but remains attached to the end of the pupa. The presence of this skin. With its characteristic two pairs of caudal bristles aids in the recognition of the phlebotomine pupae.

- Adult emerge from the pupae after about 5-10 days. The life cycle, from oviposition to adult emergence, may be 30-60 days, but extends to several months in some species with diapausing larvae.

Adult behaviour

- Both sexes feed on plant juices and sugary secretions but females in addition suck blood from a variety of vertebrate, including, livestock, dogs, urban and wild rodents, snake, lizards and amphibians, few spp feed on birds.
- In the old world many *Phlebotomus species* bite people whereas most species of *Sergentomyia* feed mainly on reptile and rarely bite humans.
- In tropical Americas *Lutzomyia spp* feed on variety of mammals including humans.
- Biting is usually restricted to crepuscular and nocturnal periods but people may be bitten during the in darkened rooms, or on forests overcast days.

- Most species feed outdoors (exophagic) but some species, also feed indoors (endophagic).
- A few species are **autogenous**.
- Adults are weak fliers and do not disperse more than a few hundred metres from their breeding places. Consequently biting may be localized to a few areas.
- Windy weather inhibits flight activities and biting. Because of their very short mouth parts sand flies are unable to bite through clothing.
- During the day adult sand flies rest in shelter, dark and humid sites but on dry surfaces.

- Species that commonly rest in houses (endophilic) before or after feeding on human are often referred to as domestic or peridomestic species e.g. *Phlebotomus papatasi* in Mediterranean and *Lutzomyia longipalpis* complex in South America.
- There is a great well marked seasonal changes in species abundance.

- **Medical Importance**

- 1. Annoyance

- Biting nuisance

- 2. *Leishmaniasis*

- Leishmaniasis is a term used to describe a number of closely related disease caused by several distinct *species*, *sub species* and strain of Leishmaniasis parasites. The disease occurs in three main clinical forms, cutaneous, mucocutaneous and visceral Leishmaniasis. A fourth less common is termed diffuse cutaneous Leishmaniasis.
- Phlebotomine sand flies are the only vectors.
- Parasites (amastigotes) are ingested by females sand flies with a blood-meal and multiply in the gut. They develop a flagellum and attach themselves to either the midgut or hind gut wall. After development migrates to the infective metacyclic promastigotes and from there to the esophagus.
- After 4-12 days after taking intensive blood meal metacyclic forms may be found in mouth parts, from which they are introduced to the new host during feeding.
- Infective flies often probe more than uninfected flies.
- Most types of Leishmaniasis are zoonoses.
- The epidemiology of the disease is largely determined by the species of sand flies their ecology and behaviour the availability of a wide range of hosts and also by the *species* and strains of Leishmania parasites.

Cutaneous Leishmaniasis (oriental sore)

- In Africa it's found in west, East and Southern Africa, in S. America in Mexico and Argentina.
- In Southern America its found mainly in forests. Several species of parasites are involved; *Leishmania major* and *Le. tropical* for Africa while *Le. braziliensis* and *le. mexicana* complexes in America.
- *Le. major* is usually zoonotic and in most of its range gerbils are reservoir host, *Le. tropica* occurs in desert populated areas and although dogs are also infected, humans are the main reservoir host.
- Important vectors of *cutaneous Leishmaniasis* include *P. Papatasi* (*Le. major*), *p. longipes* (*Le. aethiopica*) and *P. sergenti* (*le. tropical*)



Mucocutaneous Leishmaniasis (espundia)

- Is severely disfiguring disease found from Mexico to Argentina.
- It's mainly caused by *Leishmania braziliensis* and *Le. Panamensis*, parasites which normally infect a wide variety of forest rodents, marsupials, primates and also domestic dogs.
- Disease is spread by *Lutzomyia spp* including *L. wellcome*, *L. intermedia* and *L. amazonensis*.



Diffuse cutaneous Leishmaniasis

- Is a form that causes widespread cutaneous nodules or macules over the body and usually results from infection with *Leishmani aethipica* in Ethiopia and Kenya or with *Le. Amazonensis* in S. America.



Visceral Leishmaniasis (Kala-azar)

- Is caused by *Leishmania donovani* in most area of its distribution, such as a India, Sudan, East Africa and Ethiopia.
- Among vectors are *P. argentipes* and *P. orientalis*.
- Most transmission is from person to person.



Bartonellosis (Oroya fever of Carrions disease)

- Is encountered in arid mountainous area of the Andes in Peru, Ecuador and Colombia.
- The small rod-like micro organism named *Bartonella bacilliformis* and is transmitted by *Lutzomyia verrucarum* and possibly other *Lutzomyia* species.
- Transmission is by contamination of the mouth parts of vector.



Fig. 2 - Miliary (left arrow) and mulaire (right arrow) lesions.

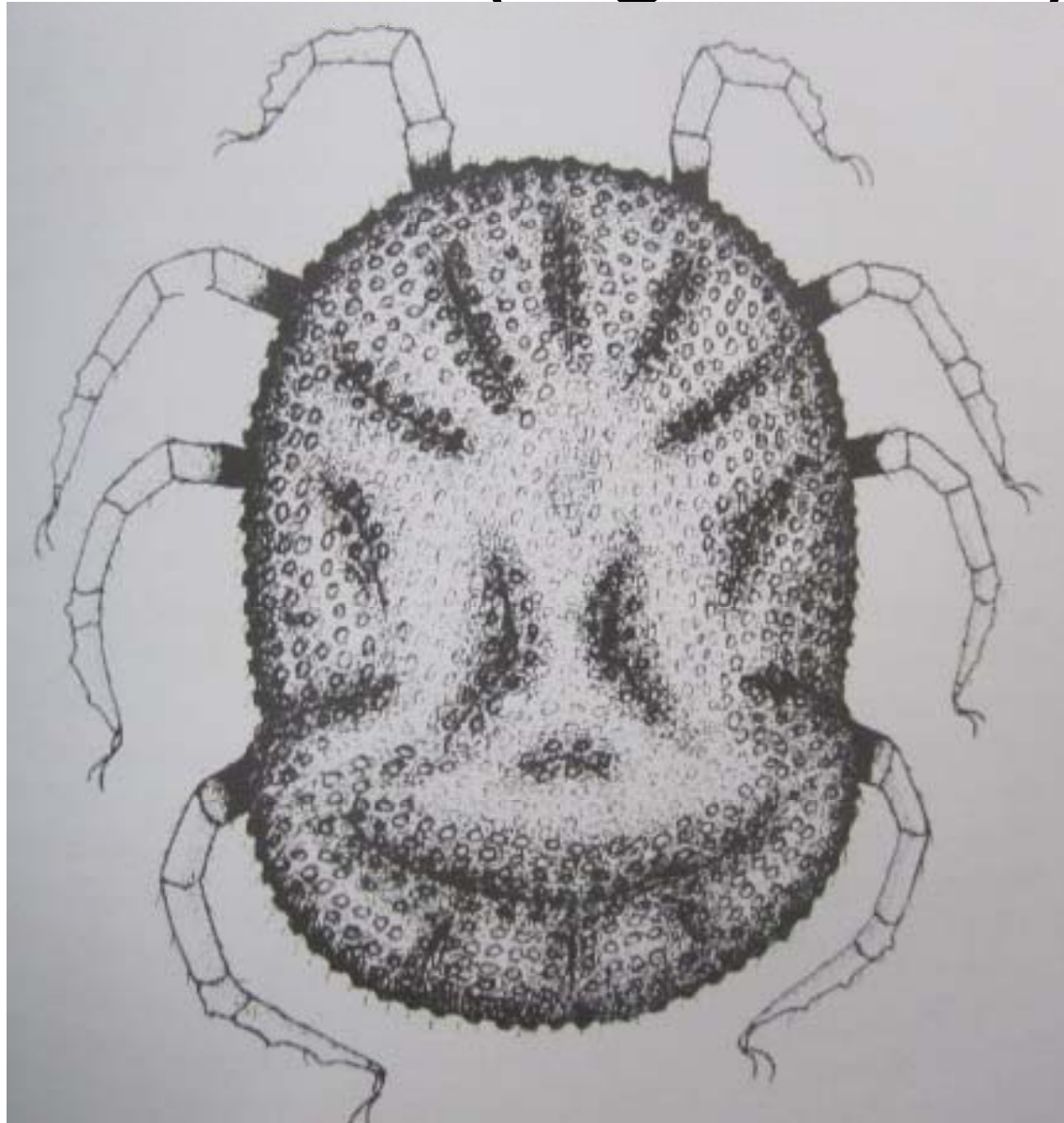
- **Sand fly fever (viral infection)**

- Occurs in Mediterranean and extend up to Nile in Egypt and the middle East the most important vector is *P. Papatasi*.

- **Control**

- Insecticides – DDT, malathion, Fenitrothion and propoxur
-
- **Challenges:** where sand fly are exophagic and exophilic
-
- Personal protection repellants: DEET (diethyltoluamide), Dimp (demethylphthalate)
-
- Window and door screening with wire mesh
-
- **Note:**
- 1: Control of larvae still impossible- species specific habitats are not known.
- 2. Eliminate reservoir -Not possible

Soft ticks (**Arganisiidae**)

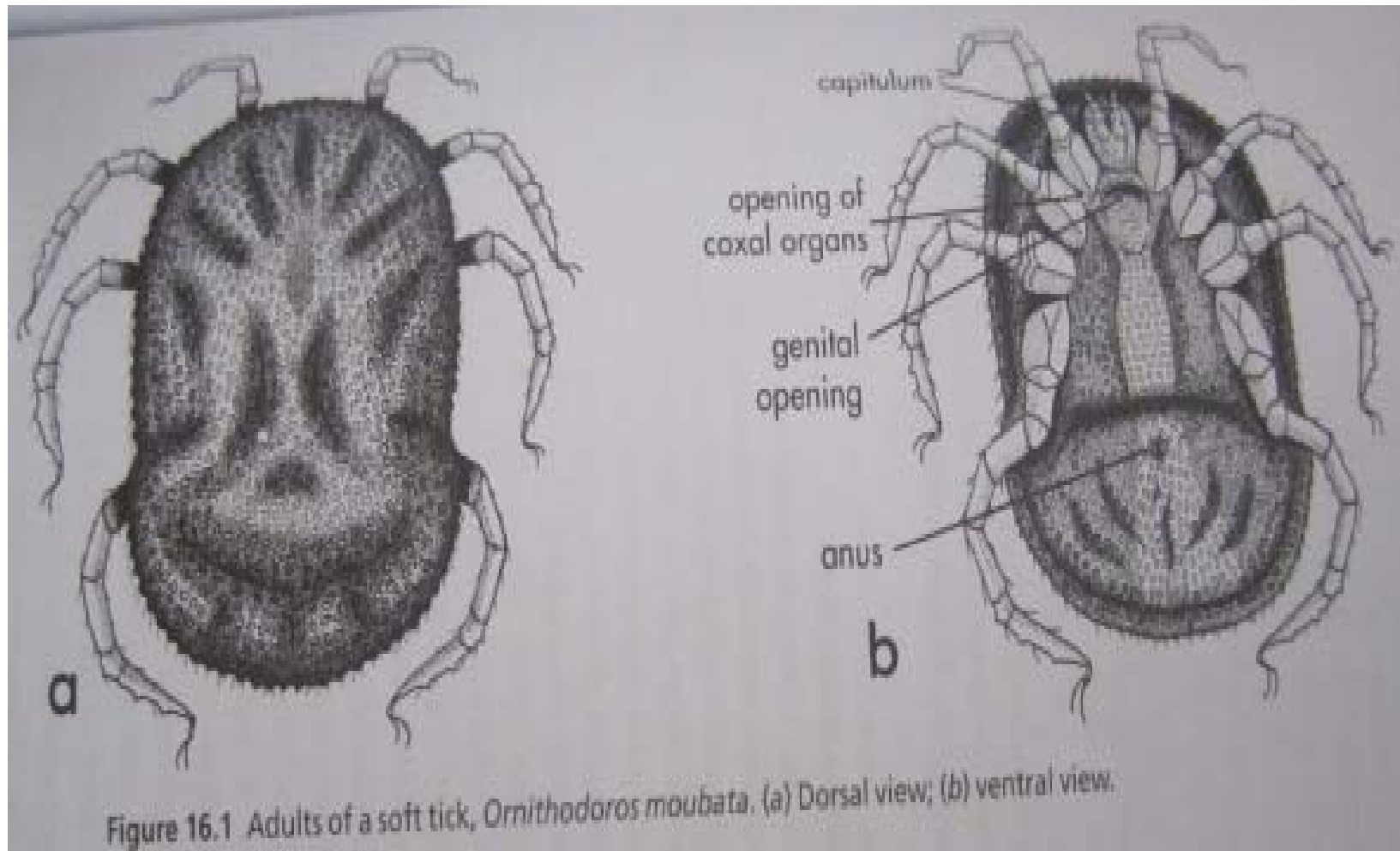


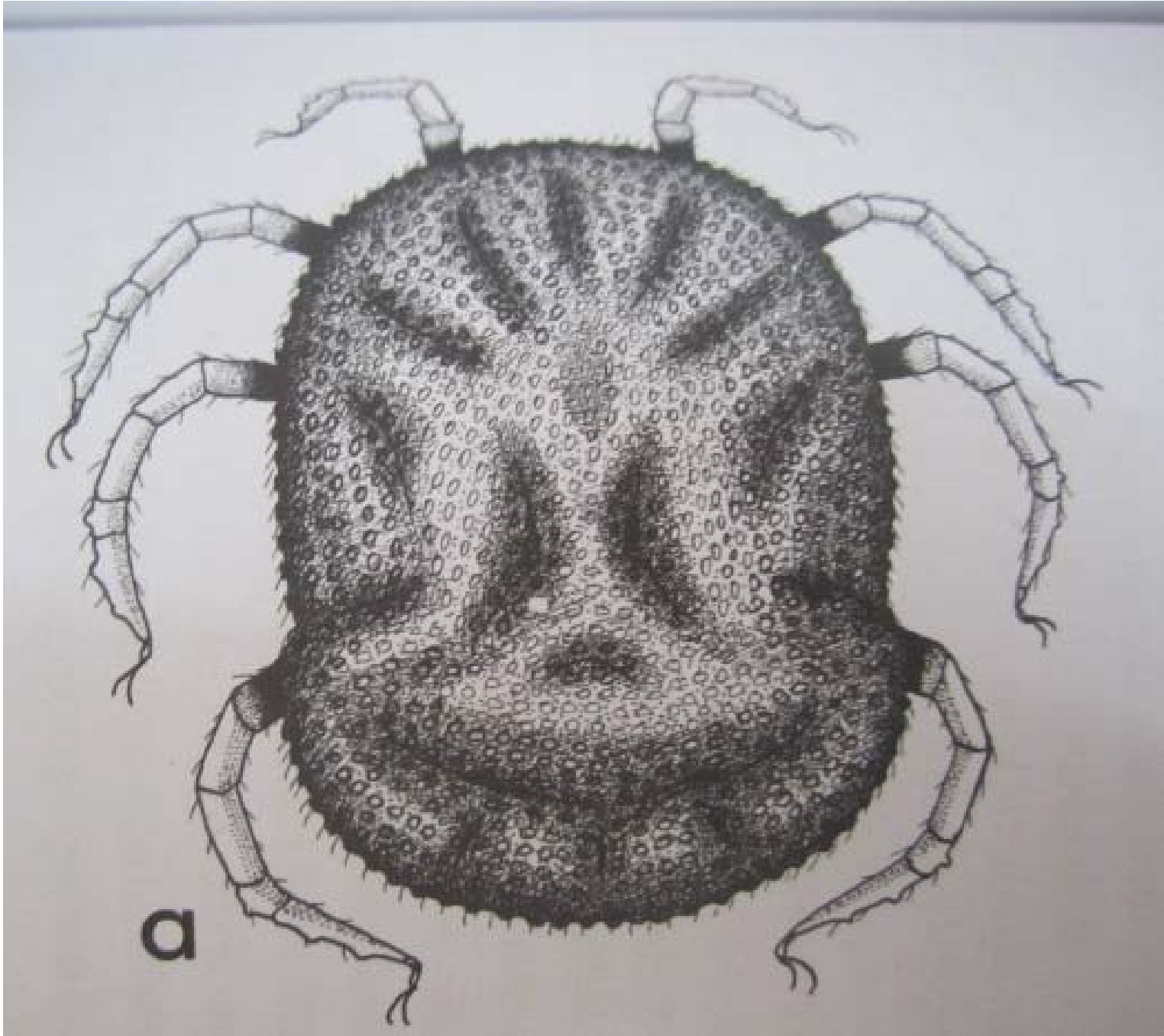
- Soft ticks have more or less worldwide distribution
- There are some 180 species belonging to 11 genera, but most important ticks of medical importance belong to the genus ***Ornithodoros***.
- Most important vector is *Ornithodoros moubata*, which is a species within the *O. moubata* complex
- *Ornithodoros moubata* is a vector of tick-borne relapsing fever, which is caused by *Borrelia duttoni*

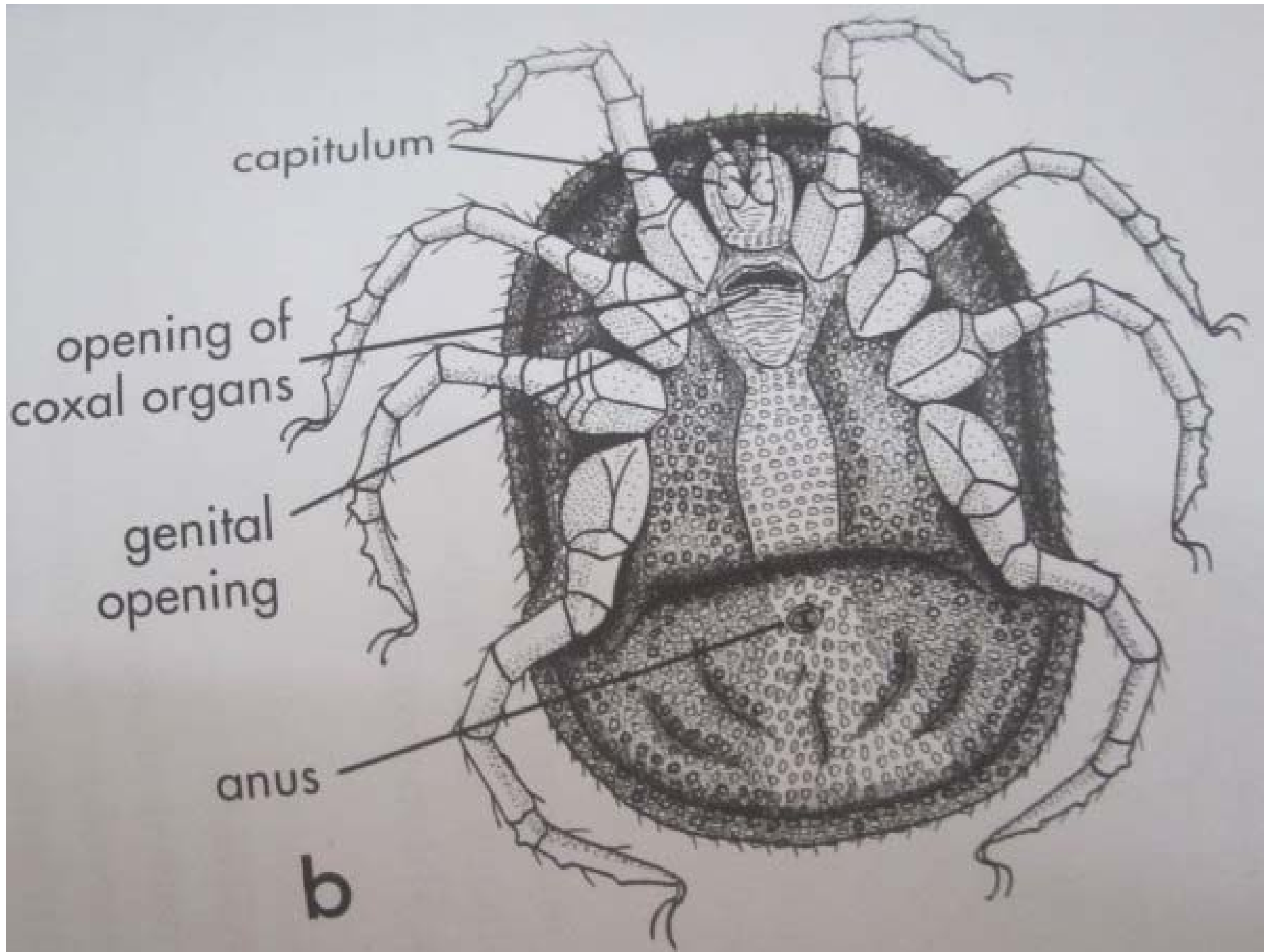
EXTERNAL MORPHOLOGY

- Adult ticks are flattened dorsal ventrally and oval in outline, but the shape varies according to species.
- The integument is tough and leathery, wrinkled and usually has fine tubercles.
- There is no scutum or dorsal shield as is found in Ixodid (hard) ticks

- The mouth parts termed the capitulum, gnathosoma or false head; are situated ventrally (**Figure 16.1b**).
- The four pair of legs are well developed and terminate in a pair of claws







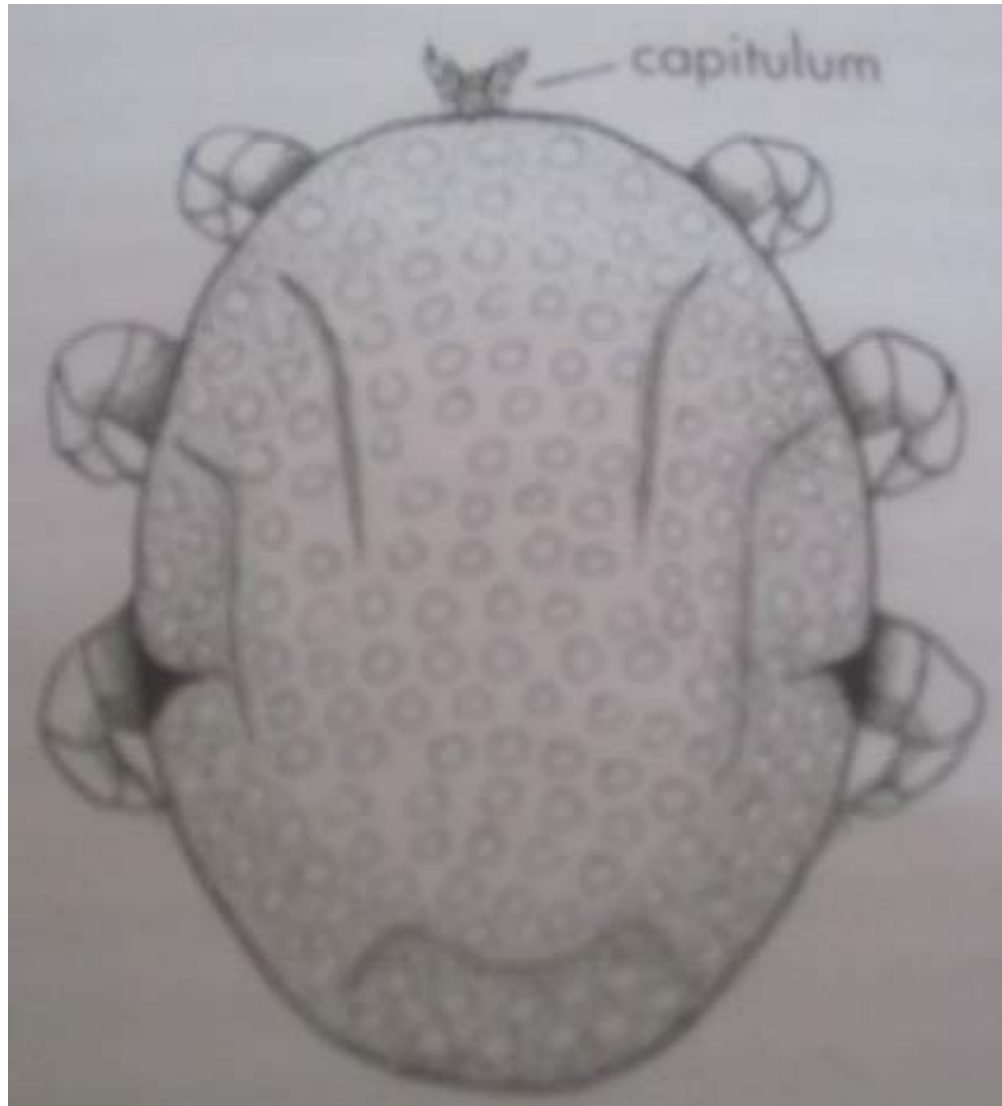
- The coxal organs (glands) open between the bases of the coxal of the first and second pairs of legs (**Figure 16.1b**), and are osmoregulatory in function.
- Spiracles (stigmata) are paired structures located on the margin of the body just behind the last pair of legs and are often surrounded by circular, oval or comma shaped plates.
- The genital opening is situated ventrally just behind the capitulum.
- Male and female are very similar in appearance and difficult to separate.
- Blood engorged females can be considerably larger than females because they ingest much blood than males
- Both male and females are equally import disease vectors.

LIFE CYCLE

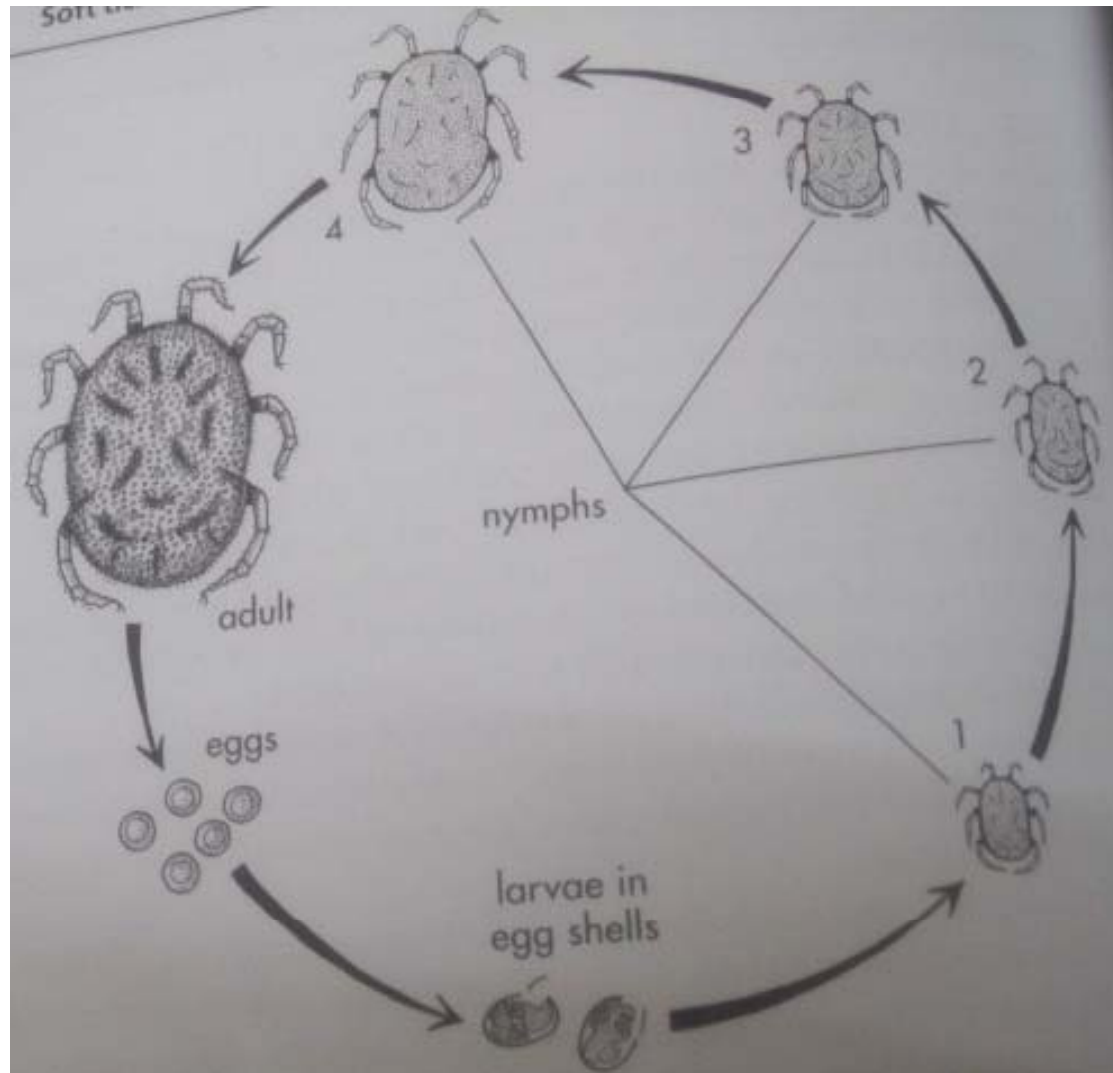
- A blood meal is essential for maturation of ovaries and egg laying.
- Most female ticks ingest large blood meals
- After each blood meal female argasid tick lay several small egg batches, each of about 15-100 spherical eggs.
- Adult ticks can live for many years, so a female may lay thousands of eggs during her life time.

- Eggs are deposited in or near host resting places of the adult ticks such as in cracks and crevices in the walls, floors and furnitures of houses.
- Eggs hatching within 1-3 weeks, but because they have been coated during oviposition with a protective waxy secretion from the female's organ they can remain viable for many months under adverse climatic conditions.
- They have hemimetabolous life cycle

The capitulum projects from the body and is visible from above
(Figure 16.3).



- Blood feeding on the host typically last for 20-30 minutes. Engorged larvae drop to the ground and after few days they moult to produce an eight-legged nymph.
- Argasid ticks have four to five nymphal instars (**Figure 16.4**).



- Each nymphal stage requires blood meal before proceeding to next stage.
- The time in life cycle between eggs to adult depends on species temperature and food availability about 6-12 month.
- In absence of host a tick can live 12 years without blood meal.
- The distribution of the larvae, nymphs and adults of argasid ticks is usually patchy and restricted to homes.

MEDICAL IMPORTANCE

1. Tick borne relapsing fever

- The infections occur throughout most of the tropics, subtropics and all temperate regions.
- *Borrelia*, spirochaetes ingested with blood meal multiply in the gut and concentrate along the wall of the midgut.
- When *O. moubata* is feeding on host, saliva is injected into the wound and spirochaetes can be transmitted.

Q-fever

- Q-fever is Rickettsia disease caused by *Coxiella burneti*. It can be transmitted by tick bite or during feeding.

Viruses

- *Ornithodoros species* however are the main vector vectors of African swine fever virus among pigs.

CONTROL

- Suitable repellent application including DIMP, DEET.
- Clothing can be impregnated with insecticides such as permethrin.
- Indoor residual spray with insecticides

**The family Simuliidae
(Black-flies)**

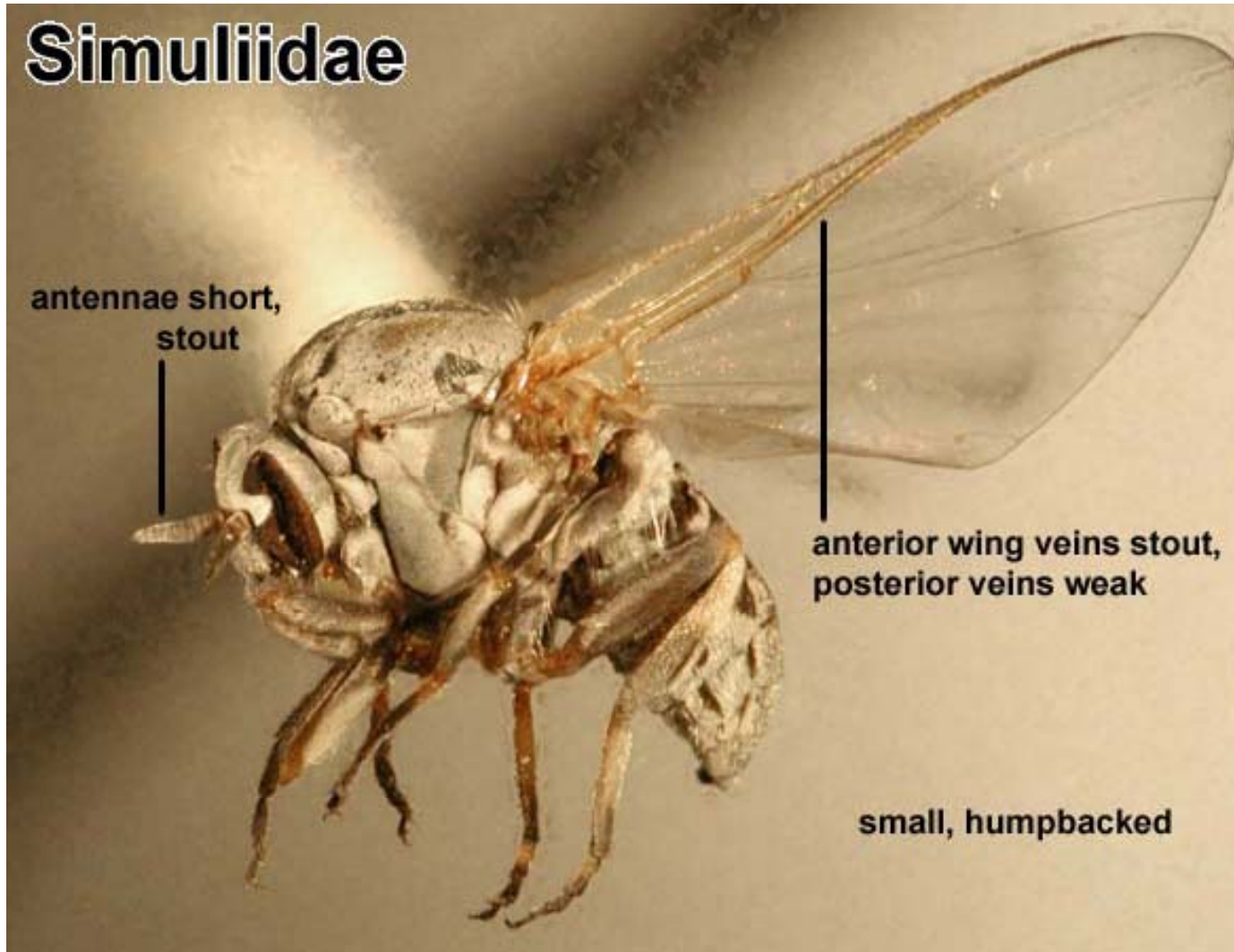
The family Simuliidae

- **Black-flies belong to the order of the *Diptera* and family of *Simuliidae***
- **The family contains twelve genera, of which three are regular man-biting species**
- ***Simuliids* are commonly known as “black-flies” although many are orange, yellow, dark, gray or tan**
- **The flies have worldwide distribution with about 1600 species in 19 genera**
- **Black-flies of the genus *Simulium* are of special medical importance**
- **In Africa, *Simulium damnosum* complex and *Simulium neavei* group (in East Africa) are important vectors of human onchocerciasis (river blindness).**

Morphology: *Simulium* species

- **Adults small, stout flies measuring 1.5-6mm long in length**
- **The head possess eyes distinctly separated in the midline in the female (dichoptic) and in males the eyes are large and meet at the vertex (holoptic)**
- **The antennae comprises of 11 short and similar segments giving the antennae a horn-like appearance**
- **The mouthparts of the females are short and consist of teeth for cutting and rupturing blood vessels**
- **The thorax is humped, bears three pair of short legs which are black in males but yellow and black in females**
- **The wings are plain with a simple pattern of veins**
- **The abdomen of females of black-flies is largely membranous and oval in shape; and divided into nine (9) visible segments**

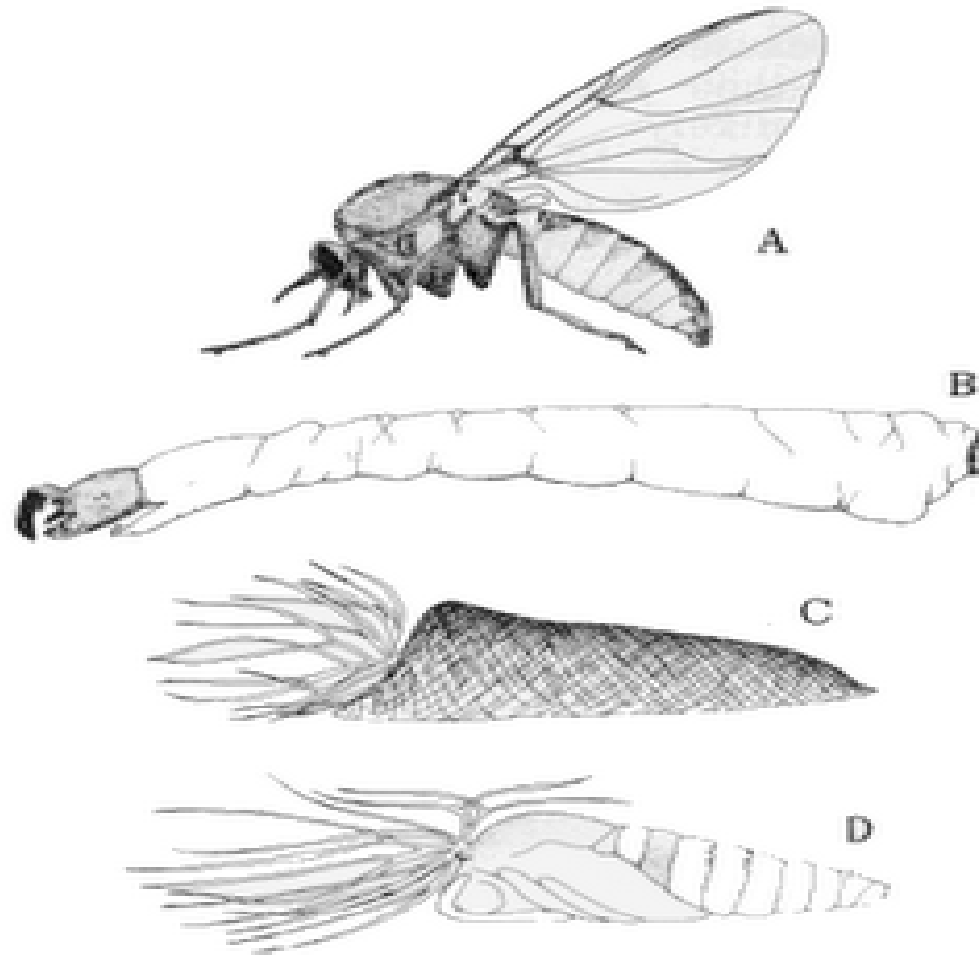
Simuliidae



Morphological features of the adult *Simulium* species

Morphology: *Simulium* species

- **Larva have a fringe of setae on the head for filtering food**
- **They have hook circlet on the last abdominal segment for the attachment to underwater surface**
- **Pupae remain underwater in a cocoon shaped like a pocket**
- **Pupae have characteristics gills which branch in various shapes depending on species**



Black fly. A, Adult. B, Larva. C, Cocoon. D, Pupa.

Life cycle: *Simulium*

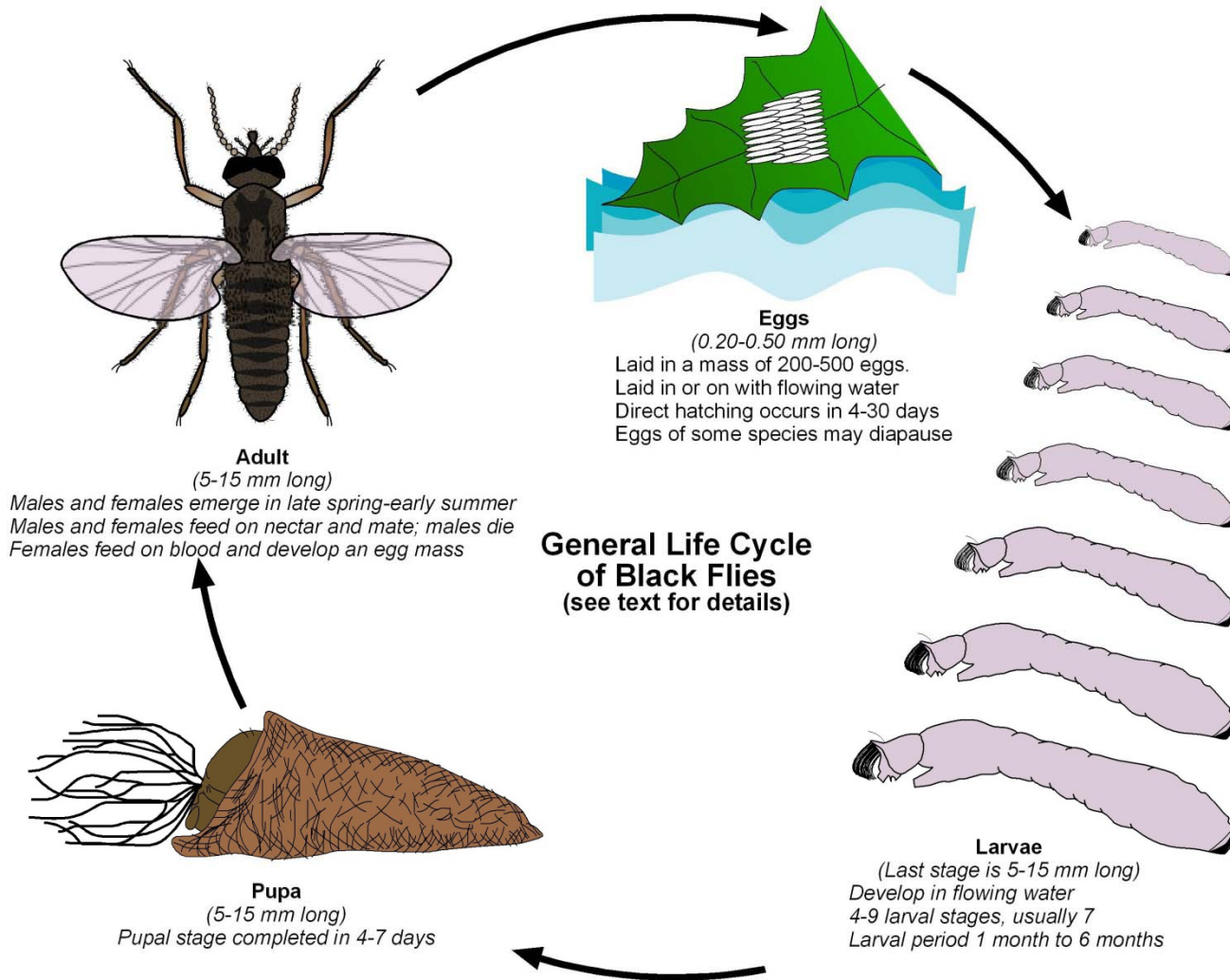
- **Mating occurs in swarms near the larva sites**
- **After mating, females of black-flies suck blood from the host which is essential for ovaries development**
- **Females lay 200 to 800 eggs at the water surface where they rapidly sink**
- **Females of some species land and crawl underwater surface and deposit their eggs in partially immersed vegetation (such as logs and sticks) or rocks**
- **Eggs of *S. damnosum* which are triangular in shape hatch within 1-2 days but in some species it may take 2-4 days.**
- **The aquatic larva of black-flies are commonly found in fast moving well-oxygenated water**
- **The larva attach to objects underwater with a hooked sucker at posterior end of its abdomen**



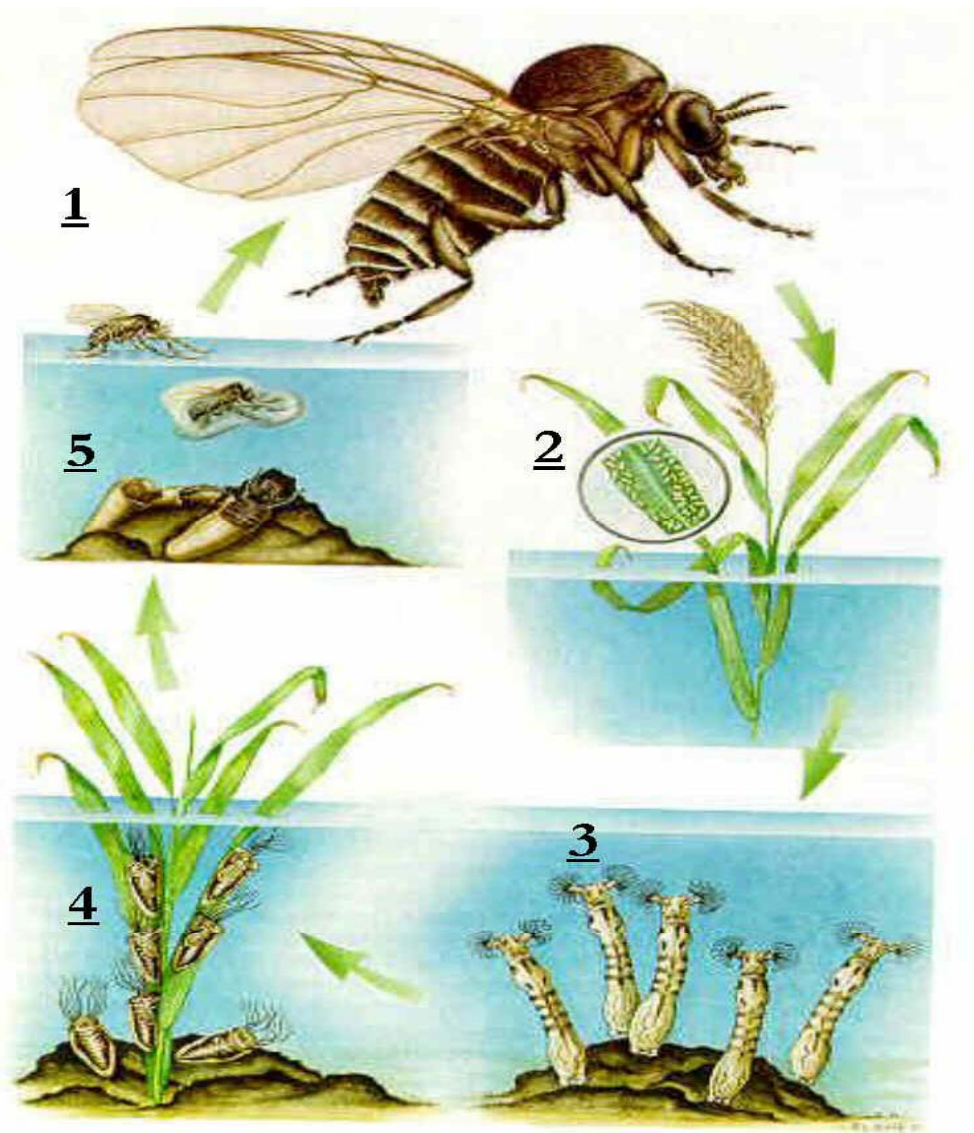
Breeding areas of *Simulium* species

Life cycle: *Simulium*

- There are 6-9 larval instars
- The mature larva is distinguished from other aquatic larva by the presence of proleg below the head armed with small circles of hooklets
- Before pupation, the larva spins a firmly cocoon around itself
- Pupal stage lasts 2-6 days after which adults emerge
- In East Africa, *S. neavei* attaches the larva and pupae to African river-crab of the genus *Potamonautes*



Life cycle of *Simulium* species



Life cycle of *Simulium* species

Adult behavior

- After emerging of the adults, males and females mates and fly away in search for food
- The females fly considerable longer distance of up to 15-20km or more if aided by wind
- Both sex feeds on plants juice, but female of *S. damnosum* and *S. neavei* feeds on blood for ovaries maturation
- Anthropophilic behaviour of *Simulium* species is important for *Onchocerca volvulus* transmission
- *S. damnosum* breeds in fast moving well oxygenated water with food materials and rocks
- In Tanzania, *S. naevi* and *S. woodi* breeds in streams flowing down the Usambara Mountains forests
- *Simuliids* bite their host during the day time
- The females of *Simulium* species which occurs in Africa bites mainly on the legs and the lower part of the body

Medical Importance: *Simulium*

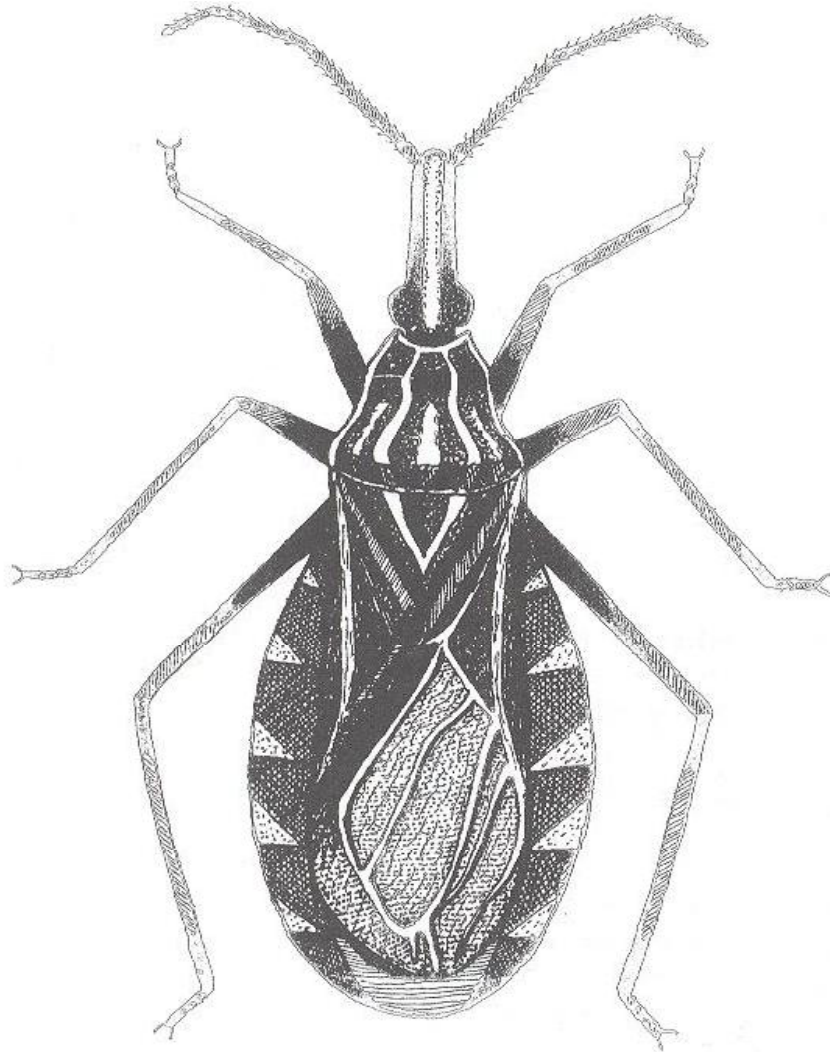
- ***Simuliids* transmits a filarial nematode known as *Onchocerca volvulus* (river blindness) which is characterized by disfigurement and blindness in Africa**
- ***Simuliids* as pest of human, cause painful biting which in sensitized individuals can lead into severe allergic reactions which are characterized by dermatitis**

Control: *Simulium*

- **Environment manipulation focusing in making the breeding habitats unsuitable for *Simuliids***
- **Biological control which involves the use of *Bacillus thuringiensis* H-14 spores**
- **Chemical control: larvae are susceptible to insecticides that act when ingested. The use of Temphos (Abate) which belong to organophosphorus group**
- **The larvicides are applied upstream of the breeding sites by ground application or aerial spray methods**

Family Reduviidae

Triatomine bugs (Kissing bug)



- Belong to family Reduviidae to the subfamily Triatomine and comprise 126 species.
- Principal species of medical importance are *Triatoma infestans*, *T. dimidiata*, *T. brasiliensis*, *Rhodius prolixus* and *Pansrongylus megistus*, all of which spread chagas disease (parasite is *Trypanosoma cruzi*) in central and south America.
- All medically important species are confined in southern USA, south and Central America.
- Triatomines are commonly called **kissing-bags** or cone-nose bugs

External morphology

- External vary in size about 0.5-4.5cm, but most are 2-3cm long
- They have long snout-like head which bear a pair of prominent dark coloured eyes, in front of which are pair of lateral situated, long and thin four segmented antennae (**See first Slide**)

The proboscis sometimes called the rostrum, is relatively thin and straight and , lies closely appressed (lying flat against) to the ventral surface of the head **(14.2a)** when the triatominea take a blood-meal the proboscis is swung forward and downward **(14.2b)**.

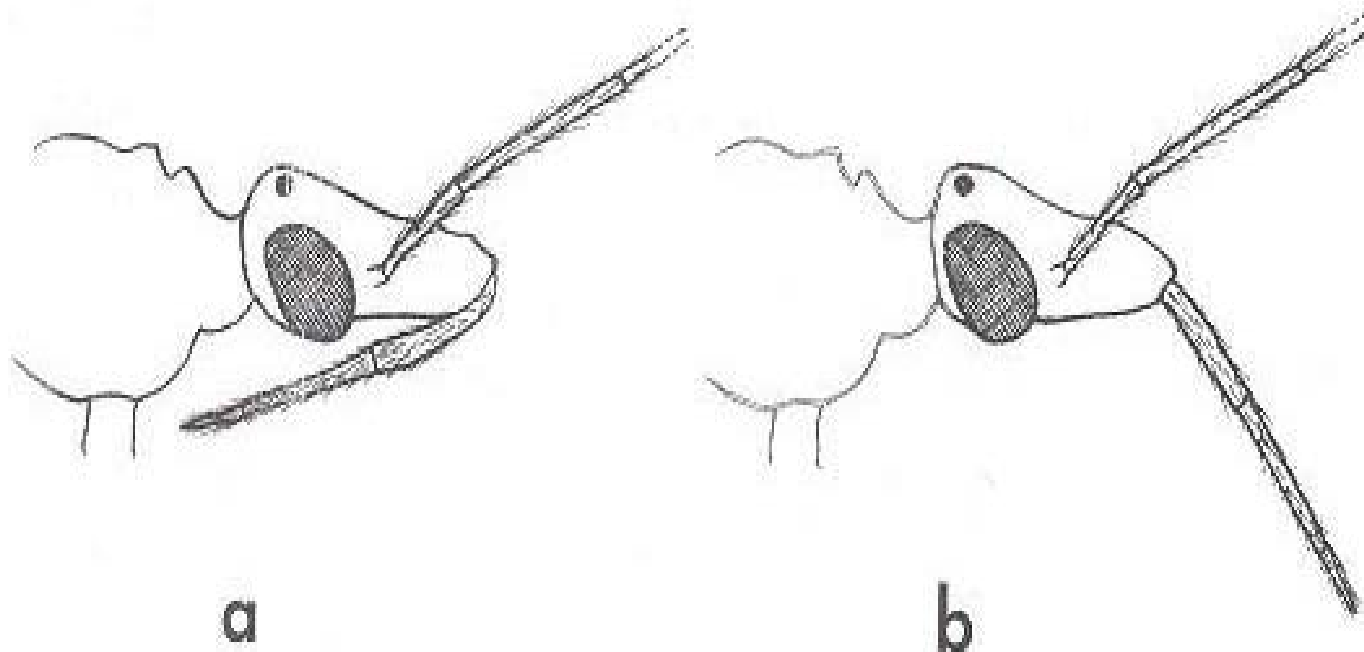


Figure 14.2 Lateral view of the head of *Triatoma*. (a) Proboscis closely appressed to ventral side of head; (b) proboscis swung forwards in feeding position.

- The dorsal part of the first 1st segment of the thorax of the triatominea consists of a very conspicuous triangular pronotium.
- The meso-thorax and meta-thorax are completely hidden dorsally by the folded fore wings, which are called **hemelytra**.

The basal part of each hemelytron is thickened and relatively hard where the more distal part is membranous but when the bug not flying they remain hidden underneath the hemelytra.

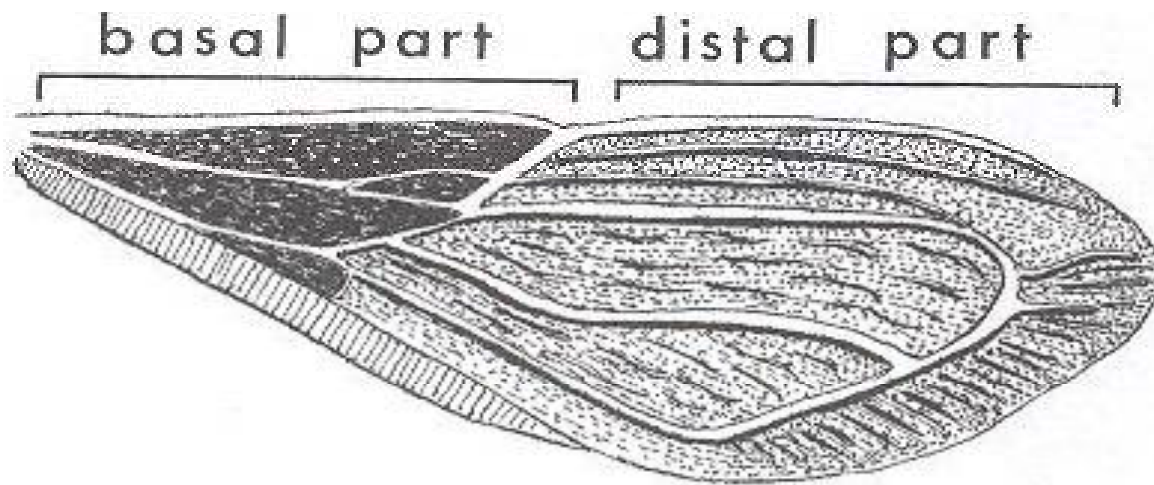


Figure 14.3 Fore-wing (hemelytron) of a triatomine bug showing thickened basal part and more membranous distal part.

- The abdomen is more or less oval in shape but it is mostly covered by the wings, except for the lateral margins which are bent upwards slightly and are visible dorsally.

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Life cycle

- Eggs are deposited in or near the habitation of their hosts, such as cracks and crevices in walls, floor ceilings and furniture of houses, thatched roof houses in rural areas or in slums at the edge of towns.
- Other species feed on birds and deposit their eggs in bird nests and on leaves of the trees.
- Eggs colours are yellow, pink and white depending on species.
- Total number of eggs laid by females varies between 50 to 1000 depending on species, their longevity and the number of blood meals they take.
- Life cycle is **hemimetabolous**

- There are five nymphal instars, each instar requiring at least one complete blood meal before it changes into succeeding one.
- Young nymphs can ingest as much as 6 times their own weight of blood meal.
- The largest bug *Dipetalogast maxima* can take up to more than 4 gram of blood.
- Some hungry nymphs and adult bugs pierce the swollen abdomens and freshly engorged nymph and take a blood meal from without apparently causing any harm

- Nymph and adults of both sexes feed at night on their hosts, feeding is a lengthy process lasting 10-25 minutes.
- When people covered with blankets, they feed on exposed part such as nose and around eyes.
- Bites are painless and do not awake people but some species causes considerable discomfort.
- Life cycle from eggs to adult takes 3-4 months but in cold moments 6-10 months
- Many species feed on wild animals and birds
- Donkey, cattle, goats, horses, pigs, cats, dogs, chicken and human are the domestic hosts.
- Sylvatic species of Triatominae in habit houses built in new areas.

Medical importance

1. Chagas disease

- They transmit *Trypanosome cruzi*, the causative agent of chagas disease, sometimes referred to South American trypanosomiasis.
- Parasite ingested with a blood meal undergoes their entire development within the gut of the bug.

2. Annoyance

Control

- Indoor residual spray using pyrethroids such as deltamethrin, cyfluthrin and Lambda-cyhalothrin.
- Slow release formulation of insecticidal paints based on latex (malathion or fenitrothion).
- House modifications