Insect pests of human and animal health

Mosquito-borne Diseases

<table>
<thead>
<tr>
<th>Disease</th>
<th>Primary vector(s)</th>
<th>Type</th>
<th>Pathogen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dengue</td>
<td><em>Aedes aegypti</em></td>
<td>V</td>
<td>DENV-1, DENV-2, DENV-3, DENV-4</td>
</tr>
<tr>
<td>Dengue haemorrhagic fever</td>
<td><em>Aedes albopictus</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chikungunya</td>
<td><em>Aedes aegypti</em></td>
<td>V</td>
<td>CHIKV (an alphavirus)</td>
</tr>
<tr>
<td></td>
<td><em>Aedes albopictus</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>Culex quinquefasciatus</em> (†)</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Zika</td>
<td><em>Aedes aegypti</em></td>
<td>V</td>
<td>ZINV</td>
</tr>
<tr>
<td>Urban filariasis</td>
<td><em>Culex quinquefasciatus</em></td>
<td>N</td>
<td>Wuchereria bancrofti</td>
</tr>
<tr>
<td>(not present in Malaysia)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rural filariasis</td>
<td><em>Mansonia uniformis</em></td>
<td>N</td>
<td><em>Brugia malayi</em></td>
</tr>
<tr>
<td></td>
<td><em>Mansonia spp.</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Japanese encephalitis</td>
<td><em>Culex tritaeniorhynchus</em></td>
<td>V</td>
<td>JEV (a flavivirus)</td>
</tr>
<tr>
<td></td>
<td><em>Culex gelidus, Culex vishnui</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td><em>Anopheles maculatus</em></td>
<td>P</td>
<td>Plasmodium spp.</td>
</tr>
<tr>
<td></td>
<td><em>Anopheles balabacensis</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pathogen type: V = virus, P = protozoan, N = nematode

Dengue/ Dengue haemorrhagic fever

Table. Cumulative reported number of dengue cases in 2012 and 2011 (for the same time period), by country.*

<table>
<thead>
<tr>
<th>Country</th>
<th>Cumulative No. reported cases</th>
<th>Recent trend**</th>
<th>2012</th>
<th>2011</th>
<th>2012/2011 ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia***</td>
<td></td>
<td></td>
<td>1 458</td>
<td>817</td>
<td>1.8</td>
</tr>
<tr>
<td>Cambodia</td>
<td></td>
<td></td>
<td>41 704</td>
<td>15 761</td>
<td>2.6</td>
</tr>
<tr>
<td>Lao PDR</td>
<td></td>
<td></td>
<td>9 639</td>
<td>3 775</td>
<td>2.6</td>
</tr>
<tr>
<td>Malaysia</td>
<td></td>
<td></td>
<td>21 900</td>
<td>19 884</td>
<td>1.1</td>
</tr>
<tr>
<td>Philippines</td>
<td></td>
<td></td>
<td>168 460</td>
<td>117 944</td>
<td>1.4</td>
</tr>
<tr>
<td>Singapore</td>
<td></td>
<td></td>
<td>4 602</td>
<td>5 309</td>
<td>0.9</td>
</tr>
<tr>
<td>Viet Nam</td>
<td></td>
<td></td>
<td>77 618</td>
<td>64 532</td>
<td>1.2</td>
</tr>
</tbody>
</table>

* Dengue reporting systems vary by country and any change in the surveillance system over time is not reflected in the above figures. Number of reported cases listed for 2011 and 2012 are for the same time period for each year.
**Recent trend is based on the 3 week moving average for countries reporting by week and monthly comparisons for the last complete month for countries reporting by month.
***Australia: *Aedes aegypti* and *Aedes albopictus* are present only in Northern Queensland and Torres Strait Islands.
Chikungunya

Caused by a virus spread by the day-biting Aedes mosquitoes

Symptoms:
- Sudden High fever
- Chilliness
- Severe pain in all joints
- Skin Rash
- Head Ache

Treatment Available At All Corporation and Government Hospitals

Helpline: 25 91 36 86

Health Dept. Corporation of Chennai

Zika

Dengue in Singapore, 2010-2013

Number of cases

Epi Week

Singapore up to 9 March in 2013 (Source: Ministry of Health)
### Comparison of Dengue, Zika and Chikungunya

<table>
<thead>
<tr>
<th>Subject</th>
<th>Dengue</th>
<th>Zika</th>
<th>Chikungunya</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vector</strong></td>
<td>Aedes aegypti</td>
<td>Aedes aegypti</td>
<td>Aedes aegypti</td>
</tr>
<tr>
<td></td>
<td>Aedes albopictus</td>
<td>Aedes albopictus</td>
<td>Aedes albopictus</td>
</tr>
<tr>
<td><strong>Virus name</strong></td>
<td>DENV</td>
<td>ZINV</td>
<td>CHIKV</td>
</tr>
<tr>
<td><strong>Serotype</strong></td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Onset post infection</strong></td>
<td>4 - 7 days</td>
<td>1 in 5 become ill</td>
<td>3 - 7 days</td>
</tr>
<tr>
<td><strong>Rash</strong></td>
<td>+</td>
<td>+++</td>
<td>++</td>
</tr>
<tr>
<td><strong>Headache</strong></td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Joint pain</strong></td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td><strong>Muscle pain</strong></td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td><strong>Low levels of white blood cells and platelets</strong></td>
<td>+++</td>
<td>n/a</td>
<td>+</td>
</tr>
<tr>
<td><strong>Recovery</strong></td>
<td>6 - 7 days</td>
<td>4 - 7 days</td>
<td>&lt; 1 wk</td>
</tr>
<tr>
<td><strong>Severe symptoms</strong></td>
<td>Dengue haemorrhagic fever, dengue shock syndrome</td>
<td>Microcephaly</td>
<td>Long-lasting joint pain</td>
</tr>
</tbody>
</table>

### Malaria

**Symptoms of Malaria**
- **Skin**
  - Chills
  - Sweating
- **Respiratory**
  - Dry cough
- **Muscular**
  - Fatigue
  - Pain
- **Back**
  - Pain
- **Stomach**
  - Nausea
  - Vomiting

### Filarisis

### Japanese encephalitis
**Aedes aegypti**

- Known as Tiger mosquito.
- Container breeder especially man-made containers with clean water in urban/suburban areas.
- Peak biting at the change of light (especially at dawn and dusk).
- Prefer darker colors of black and red.
- Short flight distance (50 - 300 m).

**Aegypti albopictus**

- Known as Asian Tiger mosquito.
- Breeds in containers including natural and artificial containers in urban/suburban and rural areas.
- Peak biting during the change of light (dusk and dawn).
- Prefer dark colors of black and red.
- Short flight distance (50 - 300 m).

**Aedes breeding in construction sites**

**Culex quinquefasciatus**

- House mosquito.
- Breeds in polluted water in drains, septic tanks, pit latrines, oxidation ponds especially in urban & suburban areas.
- Peak biting between 2200 and 0200.
- Prefer darker color.
- Long flight distance.
**Mansonia uniformis**

- Rural species
- Breeds in irrigation ditches and forest swamps where host plants such as water hyacinths are present.
- Larvae and pupae hook to host plant for respiration.
- Bites at night.
- Long distance flight.

**Anopheles maculatus**

- Vectors of malaria.
- Other vectors include An. campestris, donaldi, letifer, sundicus, sinensis and minimus.
- Habitats vary according to species. *An. maculatus* breeds in pools of water in hilly areas in sun-lit area, while *An. balabacensis* breeds in temporary water pools such as animal wallows, wheel tracks, etc.
- Nocturnal biter.
- Long flight distance.

**Treatment methods against urban mosquitoes in SE Asia**

- Source reduction and habitat management
- Thermal fogging.
- ULV.
- Larviciding.
- Biological control.
- Mechanical and physical control.
- Household insecticides (personal protection)

**Source reduction and habitat modification**

- Preventing breeding habitat for vector mosquitoes such as Aedes.
Source reduction and habitat modification

Bamboo holding holes are one of the important Aedes breeding habitat in urban Singapore.

Thermal fogging and ULV

- Thermal fogging and ULV are usually carried out indoor and outdoor during dengue outbreak.
- Pyrethroid-based formulation, or organophosphates are used.

Larviciding

- Larviciding using organophosphates (eg. temephos, fenthion), IGRs (eg. pyriproxyfen) and microbial agent (eg. Bti) against dengue vectors.

Biological control

- Use of fish (Gambusia affinis), normally released into drains and ponds. Cannot be used as a sole control method.
Mechanical and Physical Methods

- Use of bed nets (treated or untreated) and window screen.
- Mosquito ‘traps’

Household insecticides (Personal Protection)

The future of mosquito-borne diseases in SE Asia

- Will likely increase due to the following factors:
- Climatic change has expanded habitats for vector mosquitoes.
- Rapid and uncoordinated urbanization in SE Asia with creation of slums.
- Increasing movement of people between endemic and non-endemic areas.
- Increasing cases of resistance to insecticides.
- The usual ‘reactive’ attitude of developing nations, rather than being proactive against prevention of mosquitoes.

Biting flies
Introduction

➢ Flies – Order Diptera (‘two wings’)
➢ Several important families of biting flies:
  - Black flies (Family Simuliidae).
  - Sand flies (Family Phlebotominae).
  - Biting midges (Family Ceratopogonidae).
  - Horse flies and deer flies (Family Tabanidae).
  - Tsetse flies (Family Glossinidae).
➢ Caused many dreaded diseases of mankind such as Onchocerciasis, Leishmaniasis, Loiasis, African sleeping sickness, etc.

Black flies

➢ Four genera – Simulium, Prosimulium, Austrosimulium and Cnephia.
➢ Simulium is the most important genus because it contains many vectors.
➢ Adult black flies are quite small (1.5 – 4 mm long), stout-bodied and with a humped thorax.
➢ Only females bite.
➢ Eggs are laid in flowing water, about 0.1 – 0.4 mm, more or less triangular in shape.
➢ Habitat can vary from small trickles of water, slow-flowing streams, lake outlets.
➢ There are 6 – 9 larval instars and the mature larva is 4 – 12 mm. They do not swim, but remain sedentary for long periods on submerged vegetation, rocks, stones and other debris.
➢ They are mainly filter-feeders, ingesting, with the aid of large mouthbrushes, suspended food particles.

Simulium sp. 

Black flies

➢ Both male and female black flies feed on plant juices and natural sugar substances, but only females take blood meals.
➢ Biting occurs outdoors during daylight.
➢ Many species are active on cloudy, overcast days, and in thundery weather.
➢ S. damnosum feeds mainly on the legs, while S. ochraceum prefers to bite the head and torso.
➢ Many species of black flies feed almost exclusively on birds and other non-human mammalian hosts.
➢ No species bite human alone.
➢ In many species, sight is important in host location, but host odours may also be involved.
➢ After feeding, blood-engorged females shelter and rest in vegetation until blood-meal is completed digested. This usually takes 2 – 3 days in the tropics.
Black flies

➢ Adult longevity is 3 – 4 weeks.
➢ Females may fly 15 – 30 km to obtain blood meals, but may also be dispersed further by winds.
➢ Medical importance
  a. Annoyance.
  b. Onchocerciasis.

Onchocerciasis

➢ Also called river blindness (non-fatal) disease caused by filarial parasite *Onchocerca volvulus*.
➢ No animal reservoir, so the disease is not a zoonosis.
➢ Occurs throughout West, Central and East Africa, and in South America (southern Mexico, Guatemal, Brazil, Venezuela, Ecuador and Columbia).
➢ Black flies are the only vectors of onchocerciasis.
➢ Their habit of tearing and rasping the skin to rupture blood capillaries when obtaining blood, make them suited for ingestion of skin-borne microfilariae of *O. volvulus*.

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Sand flies

➢ Family Psychodidae (subfamily Phlebotominae).
➢ 700 species of sand flies in 5 genera.
➢ Species from 2 genera (*Phlebotomus*, *Lutzomyia*) are very important as vectors.
➢ *Phlebotomus* can be found in tropical Old World and Mediterranean region, while *Lutzomyia* is found only in tropical New World.
➢ In the Old and New Worlds, sand flies are vectors of leishmaniasis.
Phlebotomus sp.

Sand flies

- Adult sand flies are minute in size (1.3 – 3.5 mm), hairy wings with relatively large black eyes.
- The other blood sucking flies which are as small are biting midges (family Ceratopogonidae) (sometimes also being called sand flies), but these have non-hairy wings.
- Eggs (0.3 – 0.4 mm) are ovoid in shape and normally laid singly at each oviposition (30 – 70 eggs).
- They are deposited in small cracks and holes in the ground, at base of termite mounds, in poultry house, etc.
- They require moist microhabitat with high humidity.
- They are unable to withstand dessication and normally hatch in 6 – 17 days.
- Larvae are scavengers and feed on organic matters.
- They are 4 larval instars and larval development normally takes 19 – 60 days.
- Pupal period is about 5 – 10 days.
- Adults oviposit in about 20 – 40 days after emergence.
- Both sexes feed on plant juices and sugary secretion, but females also suck blood from a variety of vertebrates.
- Biting is usually restricted to crepuscular and nocturnal periods.
- Most species feed outdoors, but a few are also endophagic.
- Adults are weak fliers, and do not disperse more than a few hundred metres.
- Windy weather normally inhibits their flight activities and biting.

Medical importance

- Annoyance – biting nuisance.
- Leishmaniasis
- Bartonellosis – in arid mountainous regions of the Andes in Peru, Ecuador and Columbia. Caused by Bartonella bacilliformis (bacteria) and transmitted by Lutzomyia verrucarum.
- Sand fly fever – viral disease, in Mediterranean region, but extend up to Nile into Egypt and Middle East (vector – Phlebotomus papatasi).
Leishmaniasis

- Parasite – *Leishmania*.
- Disease occurs in three main clinical forms:
  1. cutaneous.
  2. mucocutaneous.
  3. visceral leishmaniasis.
- Basically, parasites (amastigotes) are ingested by female sand flies with a blood-meal and multiply in the gut. They develop a flagellum and attach themselves to either the mid-gut or hind-gut wall. After further development, they become infective metacyclic promastigotes and migrate to anterior part of mid-gut and from there to the oesophagus.
- They will be introduced into a new host during feeding.
- Infective flies probe more often than uninfected ones.
- Most types of leishmaniasis are zoonoses – animals generally are an important reservoir of infection for humans.

Leishmaniasis

- Cutaneous leishmaniasis in the Old World, mainly in arid areas of middle east to northwestern India and central Asia.
- Vectors: *Phlebotomus papatasi* (parasite: *Leishmania major*), *P. longipes* (*L. aethiopica*), *P. sergenti* (*L. tropica*).
- Mucocutaneous leishmaniasis is a severely disfiguring disease found from Mexico to Argentina.
- Vector: *Lutzomyia wellcomei*, *Lutzomyia intermedia* (Parasites: *L. braziliensis*, *L. panamensis*)
- Visceral leishmaniasis (Kala Azar) caused by *Leishmania donovani* in India, Bangladesh, Sudan, East Africa, Ethiopia. Vectors: *P. argentipes*, *P. orientalis*. Dogs and cats are important reservoirs.

Biting midges

- Family Ceratopogonidae (5000 species in over 60 genera).
- The most important genus is *Culicoides* with over 1000 species described.
- They serve vectors and spread *Mansonella perstans*, a filarial worm.
- These parasites are generally considered non-pathogenic to humans.
- Adult Culicoides are known as midges or biting midges, as 'no-see-ums' or 'punkies' in the Americas, sand flies in Australia and 'agas-agas' in Malaysia.
- The adults are very small insects (only 1 – 2 mm).
- The small head has a prominent pair of eyes, and a pair of short five-segmented palps and a pair of relatively long filamentous antennae.
**Culicoides** sp.

- **Biting midges**
  > Males do not take blood meals, while blood-sucking females have small biting mouthparts.
  > Eggs are dark and about 0.5 mm long. They are laid in batches of 30 – 250 on mud surface, wet soil, on decaying leaf litter, humus, manure, in water, etc.
  > There are 4 larval instars and a fully grown larva is cylindrical, whitish and about 5 – 6 mm long.
  > Larvae feed mainly on decaying vegetable matter and occur in a number of different habitats, including fresh- or salt-water marshes and swamps, edges of ponds, etc.
  > Adult of both sexes feed on naturally occurring sugar solutions, but females take blood meals from human.
  > Adults bite at any time, but many species are active in the evenings and the first half of the night.
  > Unlike mosquitoes, tabanids and tsetse flies, they cannot bite through clothing.

**Medical importance**

- **Annoyance.**
- **Filarial infection** – In Africa, *Mansonella perstans* is transmitted to human by *Culicoides milnei* and *C. grahamii*.
- In Mexico, Panama and South America, *Mansonella ozzardi* is transmitted by *Culicoides furens*.

**Horse flies and Deer flies**

- These are large biting flies.
- They belong to the family Tabanidae (4000 species).
- Important genera: *Tabanus*, *Chrysops*.
- *Chrysops* – vector of filarial worm *Loa loa*.
- Tabanids also play a minor role in mechanical transmission of human and animal trypanosomiasis.
- Large flies (6 – 30 mm).
- Males feed only on sugary secretions. Females feed on sugary secretion as well as biting a wide variety of mammals.
- Larval live in mud, rotting vegetation, damp soil, etc and developed for 1 – 2 years.
Horse flies and Deer flies

- Females feed during the daylight hours and are especially active in bright sunshine.
- Most tabanids inhabit woods and forests.
- Adults do not enter the house to feed.
- Because of their large and broad mouthparts, bites from tabanids are deep and painful – wounds inflicted frequently continue to bleed even after the fly is gone.
- *Chrysops* spp. are vectors of loasis caused by a filarial worm (*Loa loa*).
Tsetse flies

- Family Glossinidae.
- 23 species to the genus *Glossina*.
- Vectors of both human and animal African trypanosomiasis (sleeping sickness).
- Important species: *G. palpalis*, *G. fuscipes*, *G. tachinoides*, *G. morsitans*.
- Both males and females tsetse flies bite people and animals.
- Feeding is restricted to daylight hours and vision plays an important role in host location, dark moving objects are particularly attractive.
- Blood-engorged tsetse flies, and unfed hungry flies spend the nights and daytime hours resting in dark and humid sites (about 23 hours a day).

**Glossina** sp.

Tsetse flies cause sleeping sickness in Africa.

- Some 25000 new cases are detected annually.
- 2 species of trypanosomes are causing the sleeping sickness in human – *T. gambiense* and *T. rhodesiense*.

African sleeping sickness (Trypanosomiasis)

- Epimastigotes multiply in salivary gland. They transform into metacyclic trypomastigotes.
- Tsetse fly takes a blood meal (where trypanosomes are transmitted).
- Proyclic trypomastigotes transform into epimastigotes in the tsetse fly's midgut. Proyclic trypomastigotes multiply by binary fission.
- Bloodstream trypanosomes multiply by binary fission in various body fluids, e.g., blood, lymph, and spinal fluid.
- Trypanosomes in blood
- Infected metacyclic trypomastigotes transform into bloodstream trypomastigotes, which are carried to other sites.
- Tsetse fly takes a blood meal (where trypanosomes are transmitted).
- Epimastigotes multiply in salivary gland. They transform into metacyclic trypomastigotes.
Non-biting flies

Introduction
- Non-biting flies are prevalent in the world.
- The house fly is the most common species (*Musca domestica*).
- It belongs to Order Diptera and family Muscidae.
- Cosmopolitan in distribution.
- Medium sized non-metalic about 6 – 9 mm in length, greyish black in colour with 4 broadish stripes on the thorax.
- The antennae consist of 3 segments.
- The mouthparts or probosis of house fly are specially adapted for sponging and lapping up fluids and semi-fluid foods.

Biology and behaviour
- Eyes of male are bigger and are close together.
- House flies breed in a wide range of rotting organic matter, both animal and vegetable, provided it is moist, but not liquid. These includes dung, garbage and waste, organic manure.
- House flies rarely infest meat, compared to blow flies and flesh flies which prefer them.
- They also rarely breed in human excrement, with a few exception.
- They are usually close to their breeding ground, and are seldom found in large numbers more than half a mile away.
- In the tropics, life cycle of the house fly takes about 8 – 10 days at 30°C. It undergoes complete metamorphosis.

Eggs of *Musca domestica*
Larvae of *Musca domestica*

Pupae of *Musca domestica*

Adult *Musca domestica*

Medical importance

- **Virus infections**
  - Poliomyelitis, infectious hepatitis, coxsackie, trachoma.

- **Bacteria infections**
  - Enteropathogenic bacteria such as *E. coli*, *Citrobacter freundii*, *Enterobacter aerogenes*, *Salmonella* sp., *Pseudomonas* sp.
  - The human enterogastric diseases include shigellosis (dysentery and diarrhoea), salmonellosis (typhoid, paratyphoid, enteritis, food poisoning), cholera.

- **Protozoan infections**
  - Amoebic dysentery.

- **Helminthic infections**
  - Pinworm, roundworm, whipworm, hookworm, etc.
Common filth flies in Malaysia
- *Musca sorbens* (Face fly).
- *Fannia* spp. (Lesser house flies).
- Caliphorids (Blow flies).
- Sarcophagids (Flesh flies).

*Musca sorbens* (face fly)
- It breeds in isolated droppings, especially human, dog and cat faeces. It is also known as ‘dog dung fly’.
- It is often annoying and very persistent in settling on human skin, sores, wounds and eyes where it sucks serum and exudates.
- It has been implicated in the spread of trachoma and epidemic conjunctivitis.

*Fannia* spp. (Lesser House flies)
- They breed in wet excreta of domestic animals, man or poultry or wet rotting vegetable matters.
- The adults frequent excrement, garbage and human food.
- They prefer situations which are cooler and more humid when compared to *Musca* species.
- They spend much of the time indoors, where males will circle around lamps.
- They are not abundant in the tropics.

*Fannia* sp. (Lesser house fly)
Calliphorids (blow flies)
- Members of family Calliphoridae.
- Medium to big flies with shiny, metallic green, blue, cooper or black abdomens.
- Breed in liquid or semi-liquid matter of animal origin, including meat, fish, garbage, etc.
- Among the important genera in this family including Calliphora (blue bottle), Chrysomyia, Lucillia.
- The most common blow fly in Malaysia is Chrysomyia megacephala, sometimes called latrine fly. They are about 8 mm in length and with large red eyes.

Calliphora sp.

Lucillia sp.

Sarcophagids (flesh flies)
- They are from the family Sarcophagidae.
- Grey, medium to large size flies (about 10 mm in length).
- Three black stripes on the thorax.
- Viviparous (lay active maggots on breeding medium which includes meat, excrement and decaying matters).
- Common in market and open shops, but seldom enter homes.
- Readily found when a carcass, or dead bodies of animals are around.
Differentiating flies

- *Musca domestica* – 4 stripes on thorax.
- *Sarcophaga* spp. – 3 stripes on thorax.
- *Musca sorbens* – 2 stripes on thorax.

**Introduction**

Fleas are insects that belong to the order Siphonaptera which means ‘wingless siphon’. There are about 2500 species of fleas that belong to 239 genera and only relatively few of them are important to human. 94% of known species bite mammals and the remainder are parasitic on birds. Among the medically important species, *Xenopsylla cheopis* is probably the most significant species of all, which is vector of plague (*Yersinia pestis*), flea-borne endemic typhus (*Rickettsia typhi*).
Life-cycle of flea

Flea ejects faeces composed of semi-digested blood

Biology of fleas (2)

Both sexes take blood meals and are equally important as vectors of disease.
A female flea which is ready to oviposit may leave the host to deposit her eggs in debris in host’s dwelling (e.g. rodent burrows or nests). With species that occur on humans or their domestic pets (cats and dogs), females often lay their eggs in, or near cracks and crevices on the floor, or among dust, dirt and debris.
Fleas rapidly abandon dead hosts to seek out new ones.
They can withstand considerable desiccation and prolonged periods of starvation, up to 6 months when no suitable hosts are present.
On their host, they move by rapid crawling, or by jumping.
Fleas can jump 20 cm vertically, and 30 cm or more horizontally.

Important flea species

Xenopsylla cheopsis (rat flea).
Pulex irritans (human flea).
Ctenocephalides felis (cat flea).
Ctenocephalides canis (dog flea).
Oriental Rat flea
*Xenopsylla cheopsis*

*Pulex irritans* (human flea)

*Ctenocephalides felis* (cat flea)

*Ctenocephalides canis* (dog flea)
Fleas as vectors of diseases

Plague

Flea-borne endemic typhus (Murine typhus)

Cestodes

Plague (1)

The Black death (1347 – 1350) – one of the worst disaster in history of man killed one third of Europe populations – culprit: Xenopsylla cheopsis.

Plague is caused by *Yersinia pestis* (bacilli) and is a primarily a disease of wild animals, especially rodents (not human).

The cycle of transmission of plague between wild rodents are usually amongst gerbils, chipmunks, rats and wild squirrels.

When people such as fur trappers and hunters handle these wild animals, they will get bitten by rodent fleas and become infected with plague.

An important form of plague is urban plague. This refers to situation when plague circulating among wild rodent population was transmitted to commensal rats and is maintained in the rat population by fleas such as *Xenopsylla cheopsis* (Europe, Asia, Africa and Americas), *X. astia* (Southeast Asia) and *X. brasiliensis* (Africa, South America and India).

Plague (2)

When rats live in close association with human, fleas normally feeding on rats may turn to bite on human.

This is very likely when the rats are infected with plague – on the death of the rats, the infected fleas leave their normal hosts and feed on human.

In addition to human infected by bite of fleas which have previously fed on rats, the disease can also be spread from human to human by fleas such as *Xenopsylla* and *Pulex irritans*.

Another method of transmission is by flea’s faeces being rubbed into abrasions in the skin, or coming into contact with delicate mucous membranes.

Plague bacilli can remain infective in flea faeces up to 3 years.

Murine typhus

Murine typhus is caused by *Rickettsia typhi* (bacterium) which is ingested by the flea with its blood meal.

This is a disease of rodents, particularly rats (especially *Rattus rattus* and *R. norvegicus*). Infection is caused by infected faeces being rubbed into abrasions or coming into contact with delicate mucous membranes.

Faeces may remain infective under ideal conditions for as long as 4 – 9 years.

The rickettsia of murine typhus can pass across the flea ovaries, into eggs, then to the larvae (transovarial transmission).
Cestodes

Tape worms *Dipylidium caninum* (in dogs, cats and human) and *Hymenolepis diminuta* (rats & human) can be transmitted by fleas to both rodents and humans.
Eggs of these parasites are passed out through rat or domestic pets’ faeces and may be swallowed by larval fleas feeding on the excreta.
The eggs will hatch, becoming larval worm and then cysticercoids (infective larvae) in adult flea.
Animals become infected by licking their fur during grooming, and thus swallowing infected adult fleas.
Similarly young children fondling and kissing dogs and cats can also become infected.

Lice (Order Anoplura)

Blood-sucking lice on humans comprise of three types – pubic or crab louse (*Pthirus pubis*), body louse (*Pediculus humanus*) and the head louse (*Pediculus capitis*).
Lice belong to the order Anoplura.
Body lice are vectors of louse-borne typhus (*Rickettsia prowazekii*), trench fever (*Rickettsia quintana*) and louse-borne relapsing fever (*Borrelia recurrentis*).
**Pediculosis**

- Presence of head, body or pubic lice on a person is referred to as **pediculosis**.
- The skin of people that habitually harbour large numbers of body lice may become pigmented and tough – **vagabond’s disease**.

**Body louse (Pediculus humanus)**

- Lice have an incomplete metamorphosis (hemimetabolous). The louse that hatches from egg is termed as nymph and resembles a small adult louse.
- Unfed lice die within 2 – 4 days if kept away from human and without blood-meal.
- A heavily infected person may have 400 – 500 lice on the clothing and body.
- Body lice spread by close contact and prevalent under conditions of overcrowding and in situation where people rarely wash or change their clothes.

**Head louse (Pediculus capitis)**

- Life-cycle of head louse is very similar to that of body louse, except that the eggs (nits) are not laid on clothes, but cemented to the hairs of the head (usually at their base).
- Usually, a single egg is laid on each hair.
- Most individuals harbour only 10 – 20 head lice, but in very severe infestations, the hair may become matted with mixtures of nits, nymphs, adults.
- Empty, hatched eggs remain firmly cemented to the hairs of the head.
- Head lice spread by close contact.
- They are also often found in children and women of all ages, compared to in men.
Pubic (crab) louse (*Pthirus pubis*)

- Pubic louse is generally smaller (1.5 – 2 mm) than *Pediculus*.
- There is less differentiation between thorax and abdomen.
- The presence of broad squat body, with large claws and sluggish movements has resulted it to be also called as crab louse.
- Its life cycle is relatively similar to *Pediculus*.
- Eggs take 6 – 8 days to hatch and the nymphal stages last about 10 – 17 days. Females lay a total of about 150 – 200 eggs.
- Unlike head lice, several eggs may be laid on a single hair.
Pubic (crab) louse (*Pthirus pubis*)

- Eggs are cemented to the coarse hairs of the genital and perianal regions of human body.
- They can also be found in other areas of body with coarse hairs such as beard, moustache, eye lashes, etc.
- Their life-cycle from egg to adulthood is about 17 – 25 days.
- Infestation of pubic louse is usually through: sexual intercourse, sleeping with infected individuals (in children), clothing, infested bedding and even rarely from toilet seats.