



Photo 12-6 : *Simulium* sp. (Blackfly)
(Courtesy: CDC/WHO)

Blackflies of genus *Simulium* are vectors of blackflies onchocerciasis in Africa, Mexico, Central and South America. They are infected when they take their meal. The mouth parts of *Simulium* sp are not adapted for deep piercing; so much of their food consists of tissue juices, which may contain numerous microfilariae in infected persons. The first-stage larvae of *Onchocerca* sp migrate from the intestinal tract of the fly to its thoracic muscles. There they moult into the second-stage sausage-shaped larvae, these finally moult to form third-stage filariform larvae. The filariform larvae move to the labium of the fly. Such infected blackflies transmit onchocerciasis to human beings.

Simulium indicum is the Indian species of blackfly.

SANDFLY

Sandflies act as vectors of kala azar, Oriental sore, muco-cutaneous leishmaniasis, sandfly fever and Oraya fever. Sandflies are light or dark brown flies, smaller than mosquitoes. They measure 3 to 5 mm in length, their body and wings are covered by dense hair (Photo 12-7). There are many species of sandfly. Of these the important ones are *Phlebotomus argentipes*, *P. papatasi*, *P. sergenti*, *Sergentomyia punjabensis* and *Lutzomyia verrucarum*. Sandflies have a pair of hairy antennae, a pair of palpi and a proboscis. The thorax bears a pair of upright, hairy wings, and three pairs of long and slender legs. Abdomen has 10 segments. Though winged, sandflies hop about and do not fly.

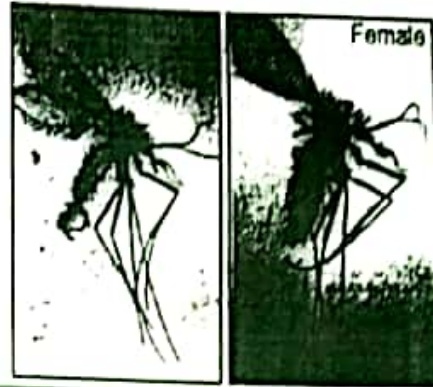


Photo 12-7 : Adult female *Phlebotomus* sp. (Sandfly)
(Courtesy: CDC/WHO)

Life History

Eggs are laid in dark, damp soil near cattle sheds and poultry. Eggs hatch in about 7 days. Larvae are hairy maggots and convert into pupae in 2 weeks. Pupal stage lasts for a week and adults come out afterwards. The life-span of adult sandflies is about 2 weeks. Only the female sandflies bite. Males feed on plant juices. Females need blood meal every third to fourth day for oviposition. Sandflies bite only during night. During day-time they live in cracks and crevices in walls, holes in trees and stables.

- **Visceral leishmaniasis** : The female sandfly needs a blood meal to lay eggs. When it feeds on an infected person, the amastigotes present in the peripheral blood and tissue fluids are sucked. Eventually, the amastigotes reach the mid-gut of the sandfly, where they elongate and develop into promastigotes. The promastigotes multiply by longitudinal binary fission. They migrate to the pharynx and buccal cavity in large numbers. The mature promastigotes block these passages. The process takes 6 to 10 days (extrinsic incubation period).
- This period is synchronous with gonadotropic cycle of sandfly. Hence, during the next blood meal of the sandfly, mature promastigotes are ready to infect a new host.

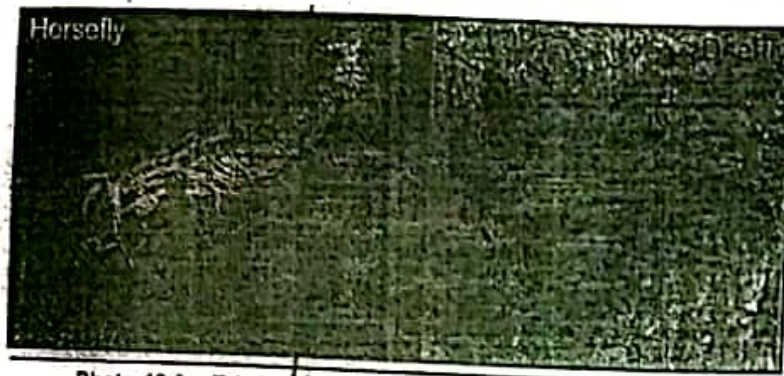


Photo 12-8 : *Tabanus* sp. (Horsefly) and *Chrysops* sp. (Deerfly)

- ♦ **Carrión's diseases**¹: It is caused by *Bartonella bacilliformis* and is transmitted by female sandfly *Lutzomyia verrucarum*. It has 2 clinical forms. Oroya fever is the visceral form that can be fatal; while verruga peruana is the cutaneous, non-fatal form of the Carrión's disease.
- ♦ **Sandfly fever** : It is caused by sandfly virus. It is also known as papatasi fever and three day fever. It is mainly transmitted by *P. papatasi* and *P. sergenti*. The virus can be transmitted transovarially and hence sandflies act as reservoirs of sandfly fever.

Sandfly Control Measures

DDT kills sandflies. DDT spray should be applied to houses, cattle shed, poultry sheds. DDT should also be sprayed in the area of 50 meters around these structures as sandflies generally remain confined to 50 meters from their breeding places. Filling up cracks and crevices in wall and floors is helpful.

HORSEFLY AND DEERFLY

Horseflies and deerflies belong to the family Tabanidae. Several species of Horseflies (like

¹ The disease is named after Daniel Carrión, who inoculated himself with organisms obtained from verruga patient and subsequently developed Oroya fever and died of it.

Tabanus atratus, *T. punctifer* and *T. nigrovittatus*) are pests of humans and livestock. These flies buzz so loudly that they are seldom allowed to land and consequently rarely bite humans. The name deerflies is applied to members of the genus *Chrysops*. Deerflies are usually smaller than Horseflies and have brown spotted wings. Their flight is not as noisy as that of horseflies, so they bite humans more commonly. The bite of Horseflies and deerflies is extremely painful. Their annoyance factor seriously interferes with the use of recreational areas. Field and timber workers may have lowered productivity as a result of harassment by these flies. Deerflies are 9 to 10 mm long. They have wide triangular head bearing long antennae. Mouth parts are adapted for piercing. Thorax bears a pair of broad banded wings. Abdomen is yellow or orange with black stripes (Photo 12-8). Eggs are laid in muddy water. Larvae hatch and drop into the mud. They pupate on drier ground. Development from eggs to adults takes several months. They bite in early morning or late afternoon mostly outdoors.

- ♦ **Loiasis** : *Chrysops* transmit *Loa loa*, the African eye worm. Microfilariae are sucked up by *Chrysops* during their blood meal. They develop into infective larvae in the thoracic muscles of the *Chrysops* and reach its mouth parts in 10 days. Large numbers of infective larvae enter through the sliced wound made by the deerflies in another person during their blood meal to transmit the infection.



Photo 12-17 : *Trombicula akamushi* (Mite)



Photo 12-18 : *Sarcoptes scabiei* (Itch mite).
(Courtesy : CDC/WHO)

during each stage of development. Bedbugs give out a characteristic smell from scent glands located in their thorax. This gives bed-bug infested dwellings a disagreeable odour. Control of bedbugs is possible by application of residual insecticide and a high level of domestic cleanliness.

MITE

Two genera of mites are medically important: *Trombicula* and *Sarcoptes*. The *Trombicula* mites are spider-like (Photo 12-17) and important species are *Leptotrombidium* (*Trombicula*) *deliense* and *L. akamushi*. They are very small (0.55 mm). The adults live in soil. Eggs are laid singly in soil. Larvae hatch out in about a week. The larvae are ectoparasites on vertebrate hosts including human beings. They suck lymph and tissue fluid. After several weeks, the larvae drop off and develop into nymph and adults in soil. The *trombicula* mite larvae transmit scrub typhus (*R. tsutsugamushi*) through their bite. Rickettsia can be transmitted through several generations of mites. Military personnel are at a risk of being infested with these mites. Uniforms treated with permethrin (0.125cm²) afford protection to the personnel during military manoeuvres.

Sarcoptes scabiei (the itch mite) causes scabies. It occurs world wide. Female mite burrows beneath the skin to lay eggs from which larvae emerge and develop into adults in a few days. The whole life cycle takes place beneath the skin.

Parts of the body commonly affected are skin between fingers, elbows, wrists, axillae, male genital organs and breasts. Scabies spreads by direct contact or through fomites like cloths and bed-sheets.

Laboratory Diagnosis of Scabies

Apply a drop of mineral oil on the skin showing fresh mite-burrows and scrape this area of skin. Transfer the scrapping along with the oil on a slide; apply cover glass and observe under $\times 10$ magnification. The female adult mite is 0.3 mm in diameter (Photo 12-18). Eggs containing larva can also be seen. They measure $100 \times 150 \mu\text{m}$.

Treatment

Good scrub and bath; followed by application of either benzyl benzoate, HCH, and sulphur ointment is effective. Cloths and bed-sheet are washed afterwards. Recurrence is common unless all family members (and sexual partners) are treated simultaneously.

TICK

Medically important ticks are either soft ticks or hard ticks. Soft ticks, also called argasid ticks, belong to family Argasidae. While, hard ticks, also called ixodid ticks, belong to family Ixodidae.

CDC / Michael L. Levin T. CDC / Andrew J. Brooks

* Tick hem

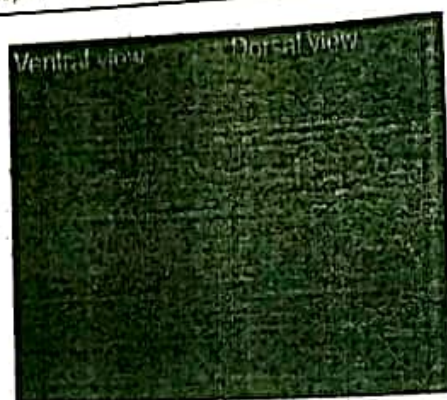


Photo 12-19 : *Ornithodoros moubata* (Soft tick)
(Courtesy : CDC/William L. Nicholson)

Soft Tick (Argasid Tick)

Ornithodoros moubata, *O. tholozani*, *O. crossi* and *O. lahorensis* are medically important as they are the vectors of relapsing fever. The length of an adult soft tick is about 5 mm. They are oval, have 4 pairs of short legs and when viewed from above head is not visible (Photo 12-19). Eggs are laid in cracks and crevices of walls. Eggs hatch in 1 to 3 weeks. The released larvae attach themselves to the host and drop off after blood meal. Larvae then convert into nymphs. Nymphs resemble adult and are blood suckers. There can be upto 8 nymphal

stages; after which adults are produced. The development takes 8 to 12 months. Adult soft ticks can survive for a year or more. Though ectoparasites, they can survive without blood meal for long periods. Both sexes suck blood. They bite only at night. The bite of soft ticks is painful. During day time they reside in cracks in walls.

- **Tick-borne relapsing fever :** This type of relapsing fever is sporadic and is acquired when humans transgress tick infested area. Once infected with *Borrelia duttoni*⁴ (agent of relapsing fever) a tick remains infective throughout life. Ticks serve as reservoirs of *B. duttoni* as borrelia are also transmitted to the next generation of ticks transovarially.
- **Q fever :** *O. turicata* transmits *Coxiella burnetii* to humans. They maintain *C. burnetii* in nature by transmitting it between wild animals. They also act as reservoirs due to transovarial transmission of *Coxiella*.

Hard Tick (Ixodid Tick)

Hard ticks belonging to genera *Dermacentor*, *Haemaphysalis*, *Ixodid* and *Amblyomma* are medically important (Photo 12-20). They act as vectors of tick typhus, viral encephalitis, Kyasanur forest disease, Tularemia, Q fever, Lyme disease and human babesiosis. A hard, chitinous shield called scutum covers the dorsum of hard ticks. They have four pairs of legs and when viewed from above the head is visible. Hard ticks are dark or brightly coloured. Eggs are laid in a single batch after which the female dies. There is only one larval and one nymphal stage. Each stage is blood-sucking and may

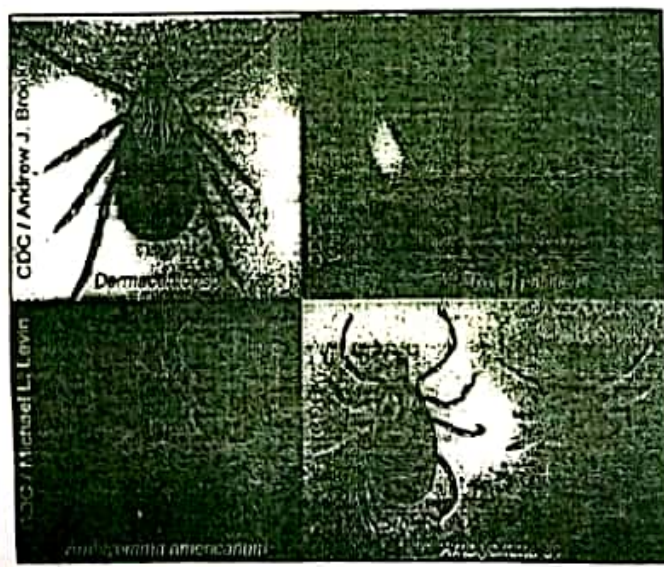


Photo 12-20 : Hard ticks.

⁴ Tick-borne relapsing fever is caused by *B. duttoni* in Africa, *B. persica* in Asia, *B. hispanica* in Spain, *B. parkeri*, *B. turicatae*, *B. hermsi* in North America. *B. venezuelensis* is the causative agent of tick-borne relapsing fever in Central and South America.

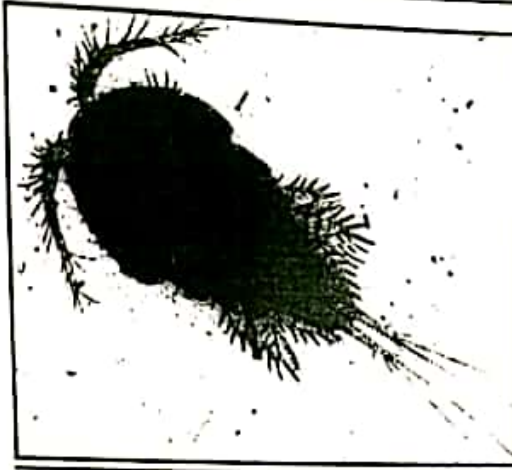


Photo 12-21 : Cyclops (Water flea)

occur on different hosts. Hard ticks can feed on domestic animals like dogs and cattle. Both sexes suck blood. They suck blood during day or at night and cannot withstand starvation.

Control of Ticks and Mites

Insecticides like DDT, dieldrin, lindane and malathion as dusting or spray gives effective control. Dogs and their premises may be freed of ticks by dusting or spraying these agents. Cracks and crevices in wall and floors should be filled. Protective clothing impregnated with repellents like permethrin, diethyl toluamide or benzyl benzoate should be worn while working in tick infested areas.

CYCLOPS

They are also called water fleas. They are seen in fresh water. They measure less than 1 mm in length. They are pear-shaped. Their tail is forked. They have 2 pairs of antennae, 5 pairs of legs and a pigmented eye (Photo 12-21). They swim with a typical jerky movement. *Cyclops* act as intermediate hosts for *Dracunculus medinensis* (Guinea worm). They are also one of the intermediate hosts of *Diphyllobothrium latum* (fish tapeworm) and *Gnathostoma spinigerum*.

- ♦ **Dracunculosis** : *Cyclops* ingest the actively motile larvae of *Dracunculus*

medinensis released by the female worm in water. The larvae penetrate its gut wall to reach the body cavity where they mature into infective third stage larvae in two weeks. Ingestion of such *Cyclops* in contaminated water by human beings leads to *D. medinensis* infection.

- ♦ **Diphyllobothriasis** : Eggs of *Diphyllobothrium latum* hatch and release a spherical ciliated embryo — coracidium in fresh water. *Cyclops* ingest coracidium. Coracidium develops in the coelomic cavity of *Cyclops* into a proceroid larva. The infected *Cyclops* is swallowed by a fish; the proceroid larva then migrates into the fish's flesh and grows into a plerocercoid larva (sparganum). Humans are infected with *D. latum* after consuming such raw or under-cooked fish.
- ♦ **Gnathostomiasis** : Eggs of *Gnathostoma spinigerum* embryonate and hatch to release actively swimming first stage larvae in water. These larvae are eaten by *Cyclops*. The first stage larvae develop into second stage larvae in haemocoel of *Cyclops*. Fish, frog or snake (second intermediate hosts) eat *Cyclops*. The second stage larvae penetrate the intestine of the new host and migrate to muscle or connective tissue, where they moult into third stage larvae. Humans are infected after consuming such raw or under-cooked second intermediate hosts. The third stage larvae do not develop further in human beings and wander in tissues (larva migrans).

Control of Cyclops

Straining water through fine cloth removes *Cyclops*. Boiling water can kill them. Barbell fish and gambusia fish feed on *Cyclops* and they have been used successfully in Karnataka for biological control of *Cyclops*.

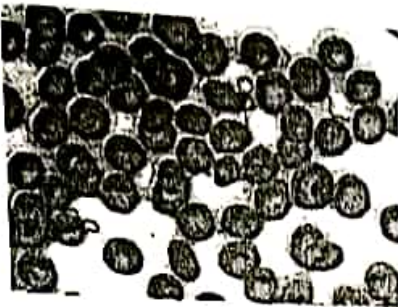


Fig. 30.24: Blood smear showing *Borrelia* in relapsing fever.

Diagnosis.

- Laboratory diagnosis require a screening test ELISA or IFA and if the test is positive, a more specific test is require.
- Observing *Borrelia* in blood smear under microscope (Fig. 30.24).

Treatment. Antibiotic such as tetracycline is used. Even without treatment, death is rare.

Prevention of Tick and Tick Borne Diseases

Prevention of tick borne diseases can be discussed under following headings :

Environmental strategies.

- Control of the population of hosts and other vectors of ticks.
- Exclusion of hosts by fencing and management of the habitats.
- Vegetative modifications to render the environment less suitable for tick survival and for tick hosts.
- Spraying chemical insecticides or acaricides to control ticks. Trizapentadiene compound include one currently used material, amitraz. It is not a skin irritant and degrades rapidly in the environment.

Personal strategies.

- Wearing light clothing so that attached ticks can be easily noticed and removed.
- Protection by wearing long sleeved shirts and trousers.
- Avoiding grassy areas with shrubs that attach ticks.

- Application of lotion containing N, N-diethyl-m-toluamide to the skin (avoiding the face and hands). Repeating use in children must be avoided due to neurotoxic nature of the chemicals.
- Daily checking of ticks and removing them by grasping them with tweezers (so that tick fluid do not enter inside). A hand lense is very useful for checking. Following body parts should be checked carefully :

Under the arms.

In and around the ears.

Back of the knees.

Within hair.

Between the legs.

Around the waist.

- Ticks must feed on humans for several hours before the organisms are transmitted, so prompt removal of ticks can be protective.
- After removing, signs of illness (fever, rash) should be observed and consult a doctor if necessary.

Prophylactic strategies.

It include use of vaccines, which are available for some tick borne diseases. Lyme disease and relapsing fever can be prevented by antibiotics.

Permethrin-impregnated clothing for the prevention of tick bites has been shown effective in reducing tick bites.

Biological control.

Ticks have relatively few natural enemies, but the use of predators, parasites and pathogens have been introduced for tick control. The most effective biological control is the applications of fungi of the genera *Beauveria* and *Metarhizium* and nematodes in the families steinernematidae and Heterorhabditidae.

or hexagonal in shape which is attached to the anterior part of the body. The basal portion (*basis capitulum*) is composed of a broad chitinous ring. This possesses (a) a medianly placed hypostome, ventrally and (b) a pair of chelicerae arising from the dorsolateral aspects of the hypostome. These are placed in the cheliceral sheaths. At the end of each chelicera, two digits known as the *denticles* are attached. The chelicerae are cutting organs. On the ventral surface of the outer portion of the hypostome, there are longitudinal rows of teeth, directed backwards. The pattern and number of the teeth are used in identifying different species. It anchors the skin during feeding of blood. Unless great

TABLE I

Difference between the hard ticks and the soft ticks.

Hard ticks	Soft ticks
1. The scutum covers the entire dorsal surface in the male, and only a small anterior portion in the female	The scutum is absent. So this is known as soft tick
2. The anteriorly placed capitulum projects forward beyond the scutum	The capitulum lies ventrally, and the mouth parts are not visible from above
3. The pedipalps are not capable of movement like legs	The pedipalps are leg-like
4. The spiracular openings are situated behind the basal segments of the fourth pair of legs	The spiracular openings lie behind the 3rd pair of coxal segments
5. Sexual dimorphism is well marked	Sexual dimorphism is absent
6. Spurs are present in coxal segments which assist in classification of the ticks	Coxal segments lack spurs
7. Pulvilli are present	Pulvilli are absent
8. There is only one nymphal stage	More than one nymphal stage is present
9. The female dies after laying eggs. A female may lay several thousands of eggs	No such death occurs. A female lays batches of eggs (numbering 10-100 per batch)
10. They take blood, both at day-time and at night. It takes several days to get congested. The female feeds only once	They attack their prey only at night, and they become engorged within 20-30 minutes
11. They remain ectoparasitic on host for a long time	They hide like bed bugs and emerge from their hiding places at night, and remain ectoparasitic during their short feeding time, after which they leave the host. The larvae are fixed parasites
12. They cannot resist starvation for a long time	They can withstand starvation for one year