

# SBSZY-03

# **Bachelor of Science**

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1

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#### SBSZY-03

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#### **COURSE INTRODUCTION**

Economic zoology deals with the application of zoological knowledge for the benefit of mankind. It is a specialized branch of zoology, which deals with the animal world that is associated with the economy, health and welfare for humans. Economic zoology has been given due to importance incorporating topics like sericulture, lacculture, apiculture, fisheries etc. it will also provide information about economic aspects of culturing animals.

The term "environmental science" refers to a grouping of scientific disciplines, that are all concerned with the physical, chemical and biological characteristics of the surrounding, in which organisms live.

The basic course, Economic zoology and Environmental biology is divided into two blocks.

The first block deals with the Economic zoology and The second block deals with the Environmental biology.

Block -T has 5 units (unit 1 to 5)- This block is concerned with economic zoology of protozoan platyhelminthes, Aschelminthes, artlrropoda, plant and stored paste and role in insectides in their control.

Block-II has 3 units (unit 6 to 8)- It has three units in which you are going to study environmental biology.

#### **BLOCK I: ECONOMIC ZOOLOGY**

This block is concerned with economic zoology, it deals with the protozoan parasitic disease of man and domestic animal and zoonotic significance of protozoa, nematodes and also tick and mites.

*Dracunculus medinensis*, or Guinea worm, is a nematout: that causes dracunculiasis, also known as guinea worm disease.

This block also deals with the Plant and stored grain pests and role of insecticides in their control.

Block-I incorporates 5 units as under (Unit 1-5): -

Unit- I It deals with the Protozoan parasitic diseases of man and domestic animals with reference to zoonotic significance of Entamoeha histolytica, playmodium. The later part of the unit describes the protozoa and soil fertility.

Unit-2 This unit deals with the life cycle and zoonotic significance of *Diphyllobothrium latum* and *Dracunculus medinensis*.

Unit-3 This unit deals with the life cycle and zoonotic significance of tick and mite. The later part of the unit describes the beneficial and harmful insects.

Unit-4 This unit deals with the Plant and stored grain pests and role of insecticides in their control. Interrelationship of mosquito with malaria, yelJow fever, Dengu, Encephalitis and Dermatobia and their prevention and control. The later part of the unit describe the biological control of insect pests.

Unit-5 This unit deals with the Aquaculture its basic concepts, management and economics (including pearl fishery). Aquaculture also known as aquafarming, is the controlled cultivation(farming) of aquatic organism such as fish, crustacations, mollusks, algae and other organisms.

After studying this block, you will be able to:

- explain the zoonotic significance of *Entamoeba histolytica* and *Plasmodium*.
- discuss the zoonotic significance of Diphyllobothrium/atum and Dracuncu/us medinensis.
- discuss the role of insecticides and their prevention and control.
- discuss the basic concepts of aquaculture.

#### UNIT 1. PROTOZOA

#### Structure (A) Protozoa

- 1.1 Introduction Objective
- 1.2 Protozoan parasitic diseases of man and domestic animals with special reference to zoonotic significance of *Entamoeba histolytica*, *Plasmodium*.
- 1.3 Protozoa and soil fertility
- 1.4 Summary
- 1.5 Terminal Question
- 1.6 Answers

Structure (A) Protozoa

#### 1.1 Introduction

Protozoa are small single celled microscopic animals found worldwide in most habitats. Many species are free living, but all higher animals are infected with one or more species of protozoa. There are various species of protozoa in habiting in different part of body of human and animals. The protozoa enjoy a parasitic life in different part which will interfere the normal activity of life and bring about damage to the body part morphologically or physiologically. The parasitic protozoan are found on the external surface of body i.e. ectoparasite or they may enter inside the body of host i.e. endoparasite. Protozoan diseases range from very mild to life threatening. Individual whose defense are able to control but not eliminate a parasitic infection for others. In geographic areas of high prevalence, well tolerated infections are often eradication would lower the individual's immunity to the parasite and result in a high likelihood of reinfection. Many protozoan infections that are in apparent or mild in normal individuals can be life threatening in immune-suppressed patients. Some evidences shows that many healthy persons harbor low numbers of Pneumocystic carini in their lungs. This parasite produces a frequently fatal pneumonia in immune-suppressed patient like AIDS.

There are large number of protozoan that causes various diseases in human are as Entamoeba histolytica, Balantidium coli, Giardia intestinalis, Entamoeba coli, Trichymonas hominis, Entamoeba gingivalis, Trichomonas tenax Trichomonas vaginalis, Trypanosoma gambiense, Trypanosoma rhodesiense Leishmania tropica, Leishmania brasiliensis, Plasmodium vivax Plasmodium falciparum, Plasmodium ovale, Plasmodium malariae, Toxoplasma gondiietc.

The protozoan are not only affecting the human being but they also affect various animals. There are large no of protozoa that affect the animals are Entamoeba histolytica, Giardia, Trichomonas gallinae, Trichomonas gallinarium, Trichomonas foetus, Trichomonas hominis Histomonas maleagridis, Trypanosoma brucei, Trypanosoma evansi, Trypanosoma lewisi, Plasmodium paraecox, Plasmodium verghii, Eimeria tenella, Eimeria mitis, Trypanosoma equinum, Babesia (Piroplasma) bigemina, Balantidium coli, Nosema apis, Haemoproteus Sarcocystis linedemanni etc.

#### **Objectives**

After studying this unit you will be able to

Discuss Protozoa and various diseases caused by them in human and
animals.
Explained the life cycle and zoonotic significance of Entamoeba
histolytica and plasmodium.
Explain the effect of Protozoa on soil fertility.

# 1.2 Protozoan parasitic diseases of man and domestic animals with special reference to zoonotic significance of *Entamoeba histolytica and Plasmodium*.

#### PROTOZOA AND HUMAN DISEASES

The human beings are not only affected by virus, bacteria, fungi, helminthes and arthropods but also by a number of protozoans. The protozoan diseases are more common in tropical and subtropical regions. Large numbers of protozoans are known that cause diseases in human beings and other domestic animals. The protozoans enter into the human body and interfere with normal activities. There is an interaction which takes place between parasite and human system under specific environmental conditions which lead the infection and bring about morphological and physiological damage there in. Nearly all classes of protozoans having parasitic species are found but certain parasites causes some of the dangerous human diseases. According to their locations they are classified into various groups:

#### (1)Parasites of Digestive Tract

(1) Entamoeba histolytica: Entamoeba histolytica is a unicellular trophozoite of about  $25\mu$  inhabiting in the lower portion of small and large intestine of man.

<u>Distribution</u>: Cosmopolitan in distribution. It is epidemic in India, China, South America and Thailand. In India it is more commonly found in Agra, Allahabad, Gorakhpur, Kanpur, Delhi, Mumbai, Kolkata and Chennai where temperature is higher with humid climate.

<u>Disease:</u> Amoebic dysentery, ulceration of colon and in advance stage amoebic abscesses in liver, spleen, heart and lungs. The trophozoites penetrate the wall of the colon, secrete hydrolytic enzymes and feed upon its cells causing the formation of ulcer. These ulcers rupture and discharge blood and mucus into the intestine that passes with stool. In advance stages it reaches to the liver, lung, and brain and causes abscess formation.

<u>Mode of transmission</u>: The transmission of the parasite through the ingestion of quadranucleate cyst with contaminated food and water. The houseflies may transmit cyst while passing from faeces to unprotected food stuff.

**Treatment:** For dysentery emetine injection is given. Some antibiotics are administered *viz*. fumagilin, erythromycin, teramycin, metronidazole, auromycin and chloroquine etc.

#### **Prevention and control:**

- (i) The green vegetable should be washed properly before cooking to ensure that vegetable is free from cysts.
- (ii) The irrigation of green vegetable with probable contaminated water should be checked.
- (iii) Quick and proper disposal of human faeces should be made.
- (iv) Avoiding the passing out of stool on open fields, street or vegetable fields.

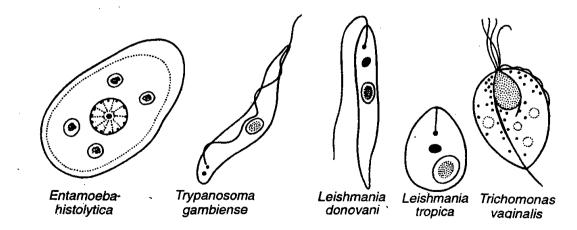


Fig1.1: Some pathogen of parasite of man

(2) Balantidium coli: It lives in the large intestine of man.

**<u>Distribution:</u>** Cosmopolitan, mainly found in India, China and other countries.

<u>Disease:</u> It causes chronic balantidiosis in man characterized by diarrhoea and ulceration of colon.

<u>Mode of transmission</u>: The transmission take place by cystic form which comes outside with the faecal matter of man contaminates the food and water and when this contaminated food and water are taken by man it reaches to the intestine and causes disease.

<u>Treatment:</u> Oral administration or hydrochloride, carbarsone, injection of mercury, aureomycin and terramycin are used for curing the disease.

#### **Prevention and control:**

- (i) Contamination of water and food should be avoided.
- (ii) Contaminated water should not be used for irrigation of vegetable.
- (3) *Giardia intestinalis*: It is found in small intestine of man but sometime it is found in bile duct. The children are more susceptible for infection than adults.

**Distribution:** Cosmopolitan

<u>Disease</u>: Diarrhoea, dysentery because it feed amino acid and vitamin contents of the blood within the intestine which cause intestinal disorder. This disorder causes epigastric pain, abdominal discomfort, loss of appetite, loose motions and headache.

<u>Mode of transmission</u>: The transmission takes place by the ingestion of quadrinucleate cysts with contaminated food and water.

**Treatment:** Oral administration of chloroquin, atebrin etc.

#### **Prevention and control:**

- (i) Water and vegetable should not be contaminated.
- (ii) Before cooking, vegetables should be washed properly.
- (4) Entamoeba coli: It is found in the colon of man.

**Distribution:** Cosmopolitan, commonly found in India, Pakistan and Australia.

<u>Disease:</u> Diarrhoea but there is no clearcut evidence that this species is pathogenic.

<u>Mode of transmission</u>: Indirect *via* contaminated food and water containing cyst.

**Treatment:** Broad spectrum antibiotics are useful.

#### **Prevention and control:**

- (i) Faecal matter should be disposed properly.
- (ii) Water and vegetable should be properly checked from contamination.
- (iii)Food and drinks should be protected from houseflies and cockroaches.
- (5) Trichymonas hominis: It is found in the ileo-caecal region of intestine of man.

**Distribution:** Cosmopolitan

**Disease:** Diarrhoea and dysentery

<u>Mode of transmission</u>: The transmission takes place by ingesting cyst with contaminated food and water.

**Treatment:** Broad spectrum antibiotics are useful.

#### **Prevention and control:**

- (i) Proper disposal of faecal matter.
- (ii)Before eating or cooking food, hands should be washed properly.
- (2) Parasites of mouth:
- (1) *Entamoeba gingivalis*: It is found in pus pocket between gums and teeth and also infected tonsils.

<u>**Distribution**</u>: Cosmopolitan. Nearly 70% of the population is infected by this parasite.

<u>Disease</u>: Pyorrhea, the disease is diagnosed by cerological test, hemen glutation, complement fixation, neurobutoglioccos test and demonstrated by artificial culture, immunobutaceum.

Mode of transmission: Direct by mouth kissing or feeding in same bowl.

**Treatment:** Broad spectrum antibiotics are useful.

#### **Prevention and control:**

- (i) By avoiding kissing of infected person.
- (ii) Healthy and infected persons should not eat in same bowl.
- **(2)** *Trichomonas tenax*: It is also found in mouth, in tartar, and unhealthy gums of man.

**Distribution:** It is less common than *E gingivalis*.

**Disease**: Pyorrhea

Mode of transmission: Infection occurs by kissing.

**Treatment:** Broad spectrum antibiotics are useful.

#### **Prevention and control:**

(i) By avoiding kissing of infected person.

(ii) Healthy and infected person should not eat in same bowl.

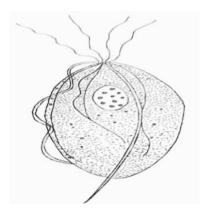


Fig1.2: Trichomonas tenax

#### (3) Parasites of genital tract:

(1) *Trichomonas vaginalis*: It inhabits in female genital tract particularly in vagina. It is also found in male genital tract and prostrate gland.

**<u>Distribution</u>**: Cosmopolitan

<u>Disease</u>: It causes vaginitis in women. The disease is characterized by burning sensation, annoying itching and frothy vaginal discharges.

<u>Mode of transmission</u>: It takes place by direct contact or sexual intercourse by males, who act as intermediaries.

<u>Treatment:</u> Arsenic and iodine drugs and antibiotic auromycin and tetramycin are used. Clotrimazole vaginal gel are also applied in vagina with the help of applicator gives relief.

#### **Prevention and control:**

- (i)Female affected by this protozoan should avoid sexual intercourse.
- (ii)Self prophylaxis should be maintained.

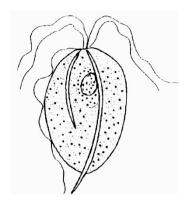


Fig1.3: Trichomonas vaginalis

#### (4) Parasites of Blood and lymph:

(1) *Trypanosoma gambiense*: It is found in lymph node and in later stage it reaches to cerebrospinal fluid.

<u>Distribution</u>: Central Africa Disease: Gambian fever or African sleeping sickness

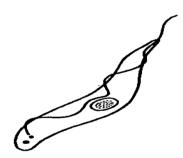


Fig1.4. Trypanosoma gambiense

Mode of transmission: The parasitic protozoan is transmitted by the biting of tse-tse fly or *Glossina palpalis*. When this fly feeds on the blood of an infected man, it suck up a few trypanosomes which undergo several changes in its alimentary canal and give rise to short, stumpy forms. If such infected fly bites a man, the parasites are injected into his blood and it develop a fever called gambia fever, later it penetrates into the cerebrospinal fluid and causes damage to the brain and makes the patient lethargic which is characteristic of the sleeping sickness. The major symptoms of sleeping sickness are arthritic pains, weakness, disturbed vision, anaemia and syndrome.

<u>Treatment</u>: Nytamine, suramine, pentamine, phyraquinine, germania, and lomidine drugs are administered.

#### Prevention and control:

(i) The habitat of tse-tse fly can be destroy by spraying of insecticides.

- (ii) Human beings should protect themselves by the biting of tse-tse fly.
- (iii) Person infected in this region must not move to uninfected region.
- (2) *Trypanosoma rhodesiense*: It is also found in lymph node and in later stages it reaches to cerebrospinal fluid.

Distribution: South east Africa

<u>Disease:</u> Rhodesian or East African sleeping sickness. When tse-tse fly Glossina *morsitans* bites a man, this protozoa enters into the blood and start multiplying by binary fission. At this stage they enter into lymph node (a secondary site of infection) and cause toxication resulting into death after about one month. In few cases this infection reaches the central nervous system and produce lesions which are characteristic of third stage of infection so called as sleeping sickness.

**Mode of transmission:** By the biting of tse-tse fly *Glossinamorsitans*.

**Treatment:** Suramine, germania, nytamine are used, intramuscular injection of lomidine or antrypol also gives relief.

#### **Prevention and control:**

- (i) Habitat of tse-tse fly can be destroyed by spraying of insecticides.
- (ii)Personal prophylaxis means human beings should protect themselves by the biting of tse-tse flies.
- (3) *Trypanosoma cruzi*: It is found in blood. It also inhabits in gonad, heart muscles, brain, and spinal cord.

**Distribution:** Central and South America

**Disease:** American trypanosomiasis or chaga's disease.

<u>Mode of transmission</u>: The transmission of this infection takes place by the faeces of bugs *Tritoma megista* into the wound caused by the biting and feeding of this bug and the patient vigoursly rubs this region. By this disease the cardiac muscles are easily affected and death occurs due to heart failure.

<u>Treatment:</u> Primaquine and puromycin contain 20% of arsenic and 5% of sulphur are used for relief of this disease. Nitrofuranzone is also effective.

#### **Prevention and control:**

- (i) The place where these bug inhabit should be destroyed.
- (ii) Personal prophylaxis must be maintained.

**(4)***Leishmania donovani*: It is found in leucocytes and in the endothelial cells of lymph glands, blood capillaries, spleen, liver and bone marrow.

**Distribution:** South America, North Africa and India

**Disease:** Kala-azar or dumdum fever or visceral leishmaniasis. The disease is characterized by enlargement of liver and spleen. The patient become lean and thin and darkening of the skin. The disease can be diagnosed by blood count i.e. WBC demonstration of parasite in bone marrow, spleen, aldehydic test, cerological test and complement fixation.

<u>Mode of transmission</u>: The transmission takes place by the biting of sandy fly (*Phlebotomus argentipes*).

<u>Treatment</u>: Antimony compound are more effective in treatment. Urea stibamine, aminostiburea, neostibosan, solistibosan, sodium-antimony-gluconate, pentamide isothionate are most effective drugs, diamidines are also used which give good results.

#### **Prevention and control:**

- (i) The habitat of sand flies should be destroyed.
- (ii) Personal prophylaxis should be maintained.
- (5) *Leishmania tropica*: It lives in the endothelial cells of mammals.

<u>Distribution</u>: Central and western India, some places of central Africa, the shores of Mediterranean countries like Syria, Arabia and Iraq etc.

<u>Disease</u>: Oriental sore or Delhi sore or cutaneous leishmaniasis. The infection is limited to a lesion of the skin and subcutaneous tissues which turn into ulcerating wound. The disease is diagnosis by blood examination, culture in triple N medium, demonstration of parasite from the scrabs taken from ulcer.

<u>Mode of transmission</u>: It is transmitted from host to host by biting of sand fly i.e. *Phlebotomus*.

<u>Treatment</u>: Antimony compound, Berberine sulphate, Atebrine sulphates are injected by regular cleaning and dressing of the boils. Dihydroemetine orally in doses of 100 mg daily for 10-21 days has given satisfactory result.

#### **Prevention and control:**

- (i) Human beings are protected by preventing the biting of sandy fly.
- (ii) The boils should be regularly cleaned and dressing should be done.
- (iii)Personal prophylaxis must be maintained.

**(6)** *Leishmania brasiliensis*: It is found in reticulo-endothelial cells, later migrate to nasal cavity i.e. muco-cutaneous junctions, mouth and pharynx.

**Distribution:** Brazil, Argentina, South American countries.

**Disease:** Espundia or American leishmaniasis. The disease is characterized by producing multiple sores over large areas of the skin and oro-nasal mucosa. Ulceration occurs in nasal cavities, mouth and pharynx. The bacterial infection causes fever, mucositosis pain, anaemia etc.

<u>Treatment</u>: Muscular injection of antimony drugs, potassium antimony tartarate are injected, cleaning and dressing of ulcer.

#### **Prevention and control:**

- (i) The population of sand flies should be controlled.
- (ii) To avoid the biting of sand fly.
- (iii) The boils should be regularly cleaned and dressed.

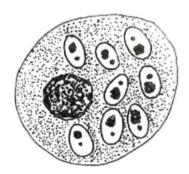


Fig1.5: Leishmania brasiliensis

(7) Plasmodium vivax: It is found as intracellular parasite of the red blood cells of man.

**<u>Distribution</u>**: India, China, USA and South Africa.

**Disease:** Benign tertian malaria, fever occurring every 3<sup>rd</sup> day. One or two days before the onset of fever the patient suffers from nausea, constipation, headache, muscular pains and sometime insomnia. The tongue become thickly coated, the mouth become dry and the appetite is lost. The patient feels pains in the joints and chilliness all over the body after that the periodical attack of fever after every 48 hrs. Co-inciding with the liberation of merozoites. "Haemozoin" pigments and toxic substances are released in blood at the end of each erythrocytic schizogonous cycle. Each attack of fever shows three successive stages. During the cold stage the patient become nauseous suffer from headache and severe chills with acute shivering.

**Mode of transmission:** The *Plasmodium* is transmitted through the biting of female anopheles mosquito. Man is the principal host and mosquito is secondary or intermediate host. When female anopheles having sporozoites of Plasmodium in her salivary gland bites a man it releases into the blood stream of human being. The sporozoites enter into the parenchyma cells of the liver and multiply to form cryptozoites and metacryptozoites. These attack erythrocytes and signet ring form condition is found, which changes into amoeboid condition. Schizonts later on produce merozoites by multiple fission. They attack fresh RBC. From merozoites several gametocytes are formed which can be differentiated into macro or female and micro or male gametocytes. They remain in blood of man. When a female anopheles mosquito bites a man, it suck up with blood. These microgametocytes and macrogametocytes, which form microgametes and macrogametes respectively. Fusion of these gamete results in the formation of Ookinite or zygote. Within the Oocyst in the wall of stomach of mosquito, by repeated nuclear divisions, numerous sporozoites are formed, which reach the salivary glands of the mosquito.

<u>Treatment</u>: Various drugs like quinine, totaquine, camoquine, chloroquine, pentaquine effective against malaria

#### **Prevention and control:**

- (i) Killing the mosquitoes around human dwellings by spraying effective insecticides.
- (ii) Filling up the stagnant water bodies and ditches where mosquito breeds.
- (iii) Spraying surface of ponds with kerosene oil or with insecticides which kill larvae and pupae of mosquitoes. The fish like *Gambusia*, *lebistes*, *Fundulus*, *Minnow* are introduced, which feed on larvae and pupae of mosquito.
- (iv)By the use of insect repellants, nets and netting of windows of the house prevent mosquito entry.
- (8) *Plasmodium falciparum*: It is also found in the RBC of man.

**<u>Distribution:</u>** It is very common in tropical region.

**Disease:** Malignant tertian malaria, fever occurring after 2<sup>nd</sup> days i.e. after 36 to 48 hrs. Infection by *P. falciparum* causes more death due to pernicious malaria and black water fever. In pernicious malaria, blockade or thrombosis of visceral capillaries is caused by agglutination of parasitized red blood cells. Death may result when the capillaries of brain, spleen, lungs, etc. become plugged with pigments parasites and masses of infection corpuscles. In black water fever, there is wholesale destruction of the patient's erythrocytes due to heamolysis, accompanied by fever and passing haemoglobin in urine.

**Mode of transmission:** Indirect through the bite of female anopheles.

Treatment: Drugs like quinine, chloroquine, quinacrine hydrochloride are more effective for *P. falciparum*. Primaquine sterilizes the gametocytes of *P. falciparaum*.

#### **Prevention and control:**

- (i) Filling up the pond, ditches where mosquito breeds to prevent breeding.
- (ii) Spraying surface of ponds with kerosene oil or with insecticides which kill larvae and pupae of mosquitoes. The fish like *Gambusia*, *Lesbistes*, *Fundulus*, *Minnows* must be introduced which feed on larvae and pupae of mosquito.
- (iii) Killing the mosquitos in human dwelling by spraying them with insecticides.
- (iv) By the use of insect repellents, nets, screening of windows of the house.
- (9) Plasmodium ovale: It also inhabits the RBC of man.

**Distribution:** Western African countries and South America.

**Disease:** Ovale or mild tertian malaria, fever occurring 3<sup>rd</sup> day or after every 48 hrs.

Mode of transmission: Indirect through the bite of female anopheles.

<u>Treatment</u>: Drugs like quinine, totaquine, chloroquine, amodiaquin, plasmoquine, resochin are used.

#### **Prevention and control:**

- (i) Filling up the pond, ditches where mosquito breeds to prevent breeding.
- (ii) Killing the mosquito in human dwellings by spraying them with DDT.(iii) By the use of insect repellants, net screening of windows of the house to preventsmosquito entry.
- (iv) Spraying surface of ponds with kerosene oil or with insecticides which kill larvae and pupae of mosquitoes. The fish like *Fundulus*, *Gambusia*, *Lebistes*, *Minnow*, are introduce which feed on larvae and pupae of mosquito.

(10) Plasmodium malariae: Inhabiting RBCs of man.

**<u>Distribution</u>**: Tropical and temperate zone

<u>**Disease:**</u> Quartan malaria fever, occurring every 4<sup>th</sup> day i.e. after 72 hrs. Death rate is low. Chronic infection may result in lethal kidney condition.

**Mode of transmission:** Indirect through the bite of female anopheles.

<u>Treatment</u>: Drugs like quinine, atebrin, camoquin, chloroquine, plasmoquine, mepacrine, paludrin for the treatment of malaria.

#### Prevention and control:

- (i)Filling of the pond, ditches where mosquito breeds by draining swampy place toprevent breeding.
- (ii)Spraying surface of ponds with kerosene oil or with insecticides which kill larvae and pupae of mosquitoes. The fish like *Fundulus*, *Gambusia*, *Lebistes*, *Minnows*, are introduce which feed on larvae and pupae of mosquito.
- (iii)Killing the mosquito in human dwellings by spraying them insecticides.
- (iv)By the use of insect repellents, net, screening of windows of the house preventmosquito bites.
- (11) *Toxoplasma gondii*: Inhabit in blood stream of human beings. The parasite may reach to other organs such as brain, spinal cord, eyes, lung, liver, spleen, heart muscle, skeletal muscle.

**Distribution:** European countries, Middle East, USA, Australia and Sri Lanka.

<u>Disease:</u> Toxoplasmosis and its symptoms include hydrocephaly, and chorioretinitis. Infection occurring in early months of pregnancy results either in abortion or still birth of the foetus.

<u>Mode of transmission</u>: Infection occurs *via* cysts either through contamination with cat faeces or ingestion of flesh containing cysts.

<u>Treatment</u>: Pyrimethamine with sulphadiazine has been found to give effective results.

#### **Prevention and control:**

- (i)Humans normally become infected either by direct ingestion ofoocysts from a cat or by eating raw or undercooked meat. Cooksor butchers thathandle raw meat are particularly at risk.
- (ii) Children may become infected by playing near cat litter tray. So they are suggested to play in a clean place.



Fig1.6: Toxoplasma gondii

#### PROTOZOA AND ANIMAL DISEASES

The protozoa are not only affecting the human beings but they also affect various animals. There are various species of protozoan inhabiting in different part of body of domestic and wild animals. The protozoa enjoy a parasitic life in different part which will interfere the normal activity of life and bring about damage to the body part, morphologically or physiologically. The parasitic protozoa are found on the external surface of body i.e. ectoparasitic like *Hydramoebahydroxena* and *Ichthyophthirius* of fish or they may enter inside the body of host i.e. endoparasite e.g. *Plasmodium&Trypanosoma* species. The different protozoans are described as follows:

(1) Entamoeba histolytica: It is commonly found in cattle, dog, chicken etc. It enters into the intestine by contaminated food and water. In intestine the parasite penetrate the intestinal wall causing ulcer and feed upon tissue, cell, RBCs and secrete histolytic enzyme. The infection by E. histolytica results in amoebic dysentery.

(2) Giardia: This flagellated protozoan commonly found in intestine of cattle, dog, rabbit etc. It causes diarrhoea.

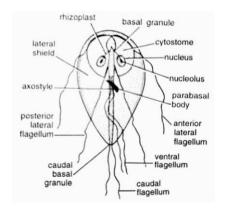


Fig1.7: Giardia

- (3) *Trichomonas gallinae*: It is found in epithelial lining of the oesphagus and crop of pigeons, turkey, fowls etc. It may also infect liver and lungs. It causes necrotic nodules in these organs.
- (4) *Trichomonas gallinarium*: It is found in epithelium of lower intestine of turkeys and fowls. It is also found in liver. It causes similar to black head disease.
- (5) *Trichomonas foetus*: It is found in the urinogenital system of cattle, horse and sheep. It causes abortion, delayed conception and inflammation of preputial sacs. It is transmitted by sexual intercourse.
- **(6)** *Trichomonas hominis*: It is found in ileo-caecal region of monkeys, cats and dogs. It causes diarrhoea and dysentery.
- (7) *Histomonas maleagridis*: It is found in the caecum and liver of fowls and turkeys. It causes black headed disease.
- (8) *Trypanosoma brucei*: It is found in blood and lymph node of domestic animals like horse, cattle, monkey, dogs and pigs. It is also called maldi cadius of horse. It causes Nagana disease which is similar to sleeping sickness. The mode of transmission is by biting of tse-tse fly, *Glossina morsitans*.
- **(9)** *Trypanosoma evansi*: It is found in the blood of horse, dog, camel, cattle and elephant. It causes very serious disease called surra. The mode of transmission is by flies *Tabanus* and *Stomoxys*.
- (10) Trypanosoma lewisi: Inhabiting in rats and is transmitted by fleas. It causes serious disease.
- (11) *Trypanosoma hippicum*: It is found in horses and mules. It causes Murina or Deren gadera disease. It is transmitted by flies.
- **(12)** *Trypanosoma equiperdum*: It is found in blood or genital mucous membrane of horse. It causes dourine or horse syphlis, a disease of sex organs. It is transmitted by direct in coitus or sexual intercourse.
- (13) *Plasmodium cyanoniolgi*: It is a parasite found in monkey and buffalo. It causes malaria.
- (14) Plasmodium paraecox: It is found in bird. It also causes malaria. The mode of transmission is by biting of mosquito Culex fatigans.
- (15) Plasmodium verghii: It is found in rat. It also causes malaria in rat.
- (16) *Eimeria tenella*: It is found in sheep, cattles, chickens and several birds. It causes a fatal disease of chicken called caecal coccidiosis. It causes due to extensive destruction of the caecal epithelium with sloughing off the walls and

severe haemorrhage. This symptom include bloody droppings, pale face and shanks, bloody vent and enlarged distended with blood or with yellowish grey cheese like ceres.

- (17) *Eimeria mitis*: It attacks the anterior part of the ileum of adult birds.
- (18) *Eimeria stiedae*: It is found in rabbit. It causes liver coccidiosis. It attacks the cell lining of bile ducts.
- (19) Eimeria bovis: It is found in the intestine of the cattle.
- (20) Eimeria canis: It is found in the small intestine of dog.
- (21) Eimeria schubergii: It occurs in the centipede Lithobius.
- (22) Eimeria falinum: It is found in cat.
- (23) Eimeria intricate: It infects sheeps and goats.
- (24) *Eimeria truncate*: It is found in the kidney of goose. It causes death.
- (25) *Trypanosoma equinum*: It is found in horses of South America. It causes diseases known as Mal de caderas. The mode of transmission takes place by tabanid fly.
- **(26)** *Babesia (Piroplasma) bigemina*: It is found in red blood corpuscles in cattle. It causes haemoglobin fever, red water fever. It is also known as Texas fever in which large no of RBCs are destroyed. The mode of transmission is by biting of vector female tick *Boophilus annulatus*.
- (27) Babesia equi: It is found in RBC of horse. It causes jaundice and sometimes paralysing hind limbs. The mode of transmission takes place by ticks.
- (28) Babesia rodient: It is found in rodents.
- (29) Babesia felis: It is found in cat.
- (30) Babesia motas: It is found in goat.
- (31) *Babesia canis*: It is also found in RBC of dog. If causes anemia, malignant, jaundice, fever in dog. It is transmitted by biting of ticks.
- (32) Balantidium coli: It is found in colon of pigs and chimpanzees. It causes dysentery.
- (33) *Nosema apis*: It is found in the intestinal epithelium and malpighian tubules of honey bees. It causes muscular disease in them.

- (34) *Isopora*: Some species have been found in dogs and cats. It causes diarrhoea and other discomforts. It is transmitted by Oocyst through contamination.
- (35) *Haemoproteus*: It is found in the RBC, endothelial cells or blood vessels of birds.
- (36) *Sarcocystis linedemanni*: It is found in the striped muscle fibres of sheep's oesophagus. It causes degeneration of muscles.

#### Life cycle and zoonotic significance of Entamoeba histolytica

The life cycle of *Entamoeba histolytica* is monogenetic i.e. complete inside in a single host. The transmission from host to host takes place through the cyst by the contaminated food and water. It has following steps.

(i) **Multiplication**: The young trophozoites secrete protolytic enzyme which dissolve the mucosa and submucosa of intestinal wall and than trophozoites enter into the intestinal wall and start feeding RBC. It also divides by binary fission. This causes abscesses and bleeding ulcers.

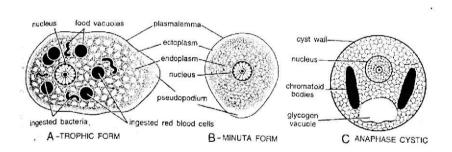


Fig1.8. Entamoeba histolytica. Structure of three stages of life cycle.

- (ii) Cyst formation: A few tissue dwelling trophozoites from the ulcers are liberated into the lumen of the intestine. These are small, rounded and less active and are known as precystic forms. Their endoplasm develops two chromatoid bodies and large number of glycogen vacuole but the red blood corpuscles disappear. These secrete thin delicate colourless and transparent cyst. Inside the cyst the nucleus divide twice to form quadrinucleate cyst. This cyst contain chromatid bodies and glycogen vacuoles. The cyst may attain a size varying from  $5 20\mu$ . This cyst came out through the faeces. Thefresh cyst are green refractile and appears as shining spheres. The cysts come out of host before maturity and complete their development outside the body. These can live outside the body for a number of weeks till they get new host.
- (iii)**Transmission of cyst into fresh hosts**: The cyst enter the fresh host through the contaminated food and water or by the cyst deposit on food by birds, flies and cockroaches.

- (iv) Excystation and development: On reaching the small intestine the cyst wall dissolve by the action of trypsin and the quadrinucleate metacystic form emerges out.
- (v) **Metacystic development**: Each metacyst with four nuclei divides by binary fission and produces eight uninucleate amoeboid trophozoites which invade the intestine wall.

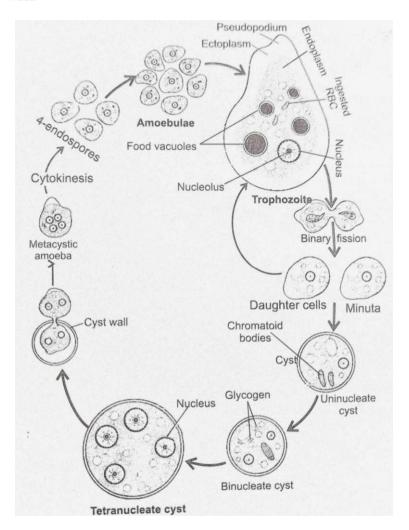


Fig1.9: life cycle of Entamoeba histolytica

#### **Zoonotic significance**

#### **Pathogencity**

The condition caused due to infection by *Entamoeba histolytica* in man are collectively termed (i)Amoebiasis: Diarrhoea- loose motions, (ii)Dysentery – loose motions with blood, (iii)Hepatitis – infection of liver (iv)liver abscesses – pus in liver.

(i)Amoebic dysentery: Infection is confined to the intestine only. Blood and mucus are passed with the stool. Those who are infected for the first time,

trophozoites dissolved tissues and causes ulcer. Patient shows repeated motion and stool gives foul smelling.

Trophozoites may even invade muscular and serosa, colon wall become perforated in the abdominal cavity to cause peritonitis which may result in death. It must, however be stated that 90% infected persons remain symptomless and do not suffer with dysentery.

(ii)Chronic intestinal amoebiasis: In person with strong body resistance or those who have suffered dysentery. The patient usually suffers from diarrhoea, pseudo-constipation, abdominal pain, headache, nausea, loss of appetite, nervousness, fatigue etc. in due course, these symptoms become quite insignificant that the person continue to lives his normal life without problem. The parasites continue to live, grow and pass out along with faeces of hostman who serve as a carrier of the disease.

(iii) Abscesses: Trophozoites, sometimes reach through blood circulation, organs like liver, brain, spleen, gonads, destroy tissues and from abscesses.

#### **Prevention and Treatment**

The following preventive measures should be followed strictly.

- (i) Washing hands before taking meals and after toilet.
- (ii)Protection of food and water from flies and cockroaches.
- (iii)Proper sanitation of roads streets and open drains.
- (iv)Purification of drinking water.
- (v)Proper disposal of sewage
- (vi)Avoiding the use of raw vegetables which should be first soaking in potassium permanganate.
- (vii)Chemical treatment of human faces.

Iodine compound and Arsenic compound in amoebic dysentery. Metronidazole and chloroquin are used to treat amoebiasis. The important drugs are Abodogyl, Amibactin, Amicline, Biomebic, Dependal, Diodoquin, Metrogyl, Tridazole, TDF-forte.

#### Life cycle and Zoonotic significance of Plasmodium

*Plasmodium* completes its life cycle in two hosts i.e. man and the female anopheles mosquito. Hence it is a digenetic parasite. Man is the primary hosts and the mosquito is intermediate or secondary host or vector.

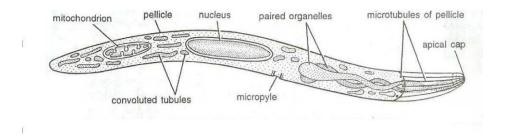


Fig1.10. Plasmodium: structure of sporozoite

**Life cycle in man**: Life cycle of *Plasmodium* in human being occurs in three stages, *viz*.

- (i) Pre-erythrocytic cycle
- (ii) Exo-erythrocytic cycle
- (iii) Endo-erythrocytic cycle

Pre-erythrocytic cycle: The life cycle in human beings begin with the biting of female anopheles mosquito. When a mosquito bites a man it introduces a little amount of saliva which contains the parasite into the blood of man. The parasite introduced is known as sporozoite. The sporozoites are spindle shaped and is covered with pellicle. It bears a large nucleus in the centre. For about 30 minute it swims actively in the blood and then disappears from the blood. Further sporozoites enter in the liver cells where it feeds and grows and become spherical in shape. The parasite in this state is called cryptoschizont. The cryptoschizont undergoes a special kind of asexual reproduction known as schizogony, during which the nucleus of cryptoschizont divides into 1000 daughter nuclei. This event is followed by the division of cytoplasm into about 1000 pieces. Each piece of the cytoplasm encloses a single daughter nucleus. The resulting daughter cells are known as cryptomerozoites, which are released into the liver after the rupture of hepatic cells.

[Sporozoites  $\rightarrow$  cryptoschizont  $\rightarrow$  schizogony  $\rightarrow$ cryptomerozoites]

**Exo-erythrocytic cycle:** Cryptomerozoites enter fresh hepatic cells, where they grow and increase in size and become spherical in shape. Now the parasite in this state is called metacryptoschizont. These metacryptoschizont undergoes schizogony resulting in thousand daughter individuals known as metacryptomerozoites and these are released by the rupture of liver cells.

[cryptomerozoites \rightarrow metacryptoschizont \rightarrow schizogony \rightarrow Metacryptomerozoites]

The pre-erythrocytic cycle and the exo-erythrocytic cycle are completed within 8 days. After this period the metacryptomerozoites enter the blood circulation. Up to this stage there will no any symptoms of malaria.

Endo-erythrocytic cycle or Erythrocytic cycle: This cycle occurs within the erythrocyte (RBC). The metacryptomerozoite penetrates the erythrocyte. Inside erythrocyte the parasite become rounded. This stage of parasite is called trophozoite, which grow in size and increases. Further a small vacuole gradually increases in its volume. As it increases in size, its nucleus is pushed towards one side. At this stage the parasite looks like a ring known as signet ring. Some times after the vacuole disappears and the parasite develops many pseudopodia. Now the parasite is in the amoeboid stage. It feeds on the contents of the RBC. The parasite secretes digestive enzymes which break the haemglobin of erythrocytes into heme and globin. Globin is digested and used as food by the parasite. The haem is converted into toxic pigment called haemozoin, which remains scattered in the cytoplasm of parasite. Again when feeding stops, the pseudopodia disappear and the parasite becomes rounded and this stage is known as schizont, which bears a single nucleus and haemozoin pigments in the cytoplasm.

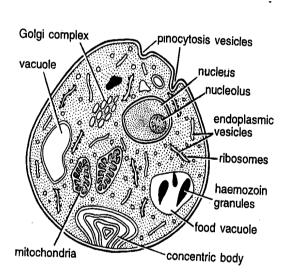


Fig1.11: *Plasmodium:* Ultra-structure of trophozoite in RBC under electron microscope

Further the schizont undergoes schizogony, in which nucleus divides into 12 to 24 daughter nuclei which occupy the periphery of the schizont. By this time the cytoplasm divides into as many fragments as there are nuclei. Each fragment of cytoplasm encloses a single nucleus. The cytoplasm which the nucleus develops into the next stage of the parasite called merozoites. These merozoites one arranged like petals in a rose flower that is why this stage is called rosette. The merozoites are released into the blood by the rupture of RBC. The erythrocytic cycle takes 48 hours for completion. The merozoites again attack fresh erythrocytes and the cycle is repeated many times until almost all the RBCs are attacked. After many generations, the merozoites entering the RBC, increase in size and becomes rounded. They are now called gametocytes. Some gametocytes are smaller in size and their nuclei are larger in size and these are

known as microgametocytes or male gametocytes, whereas others are larger in size but with smaller nuclei known as megagametocytes or female gametocytes.

For further development the gametocytes must enter into the gut of female anopheles mosquito.

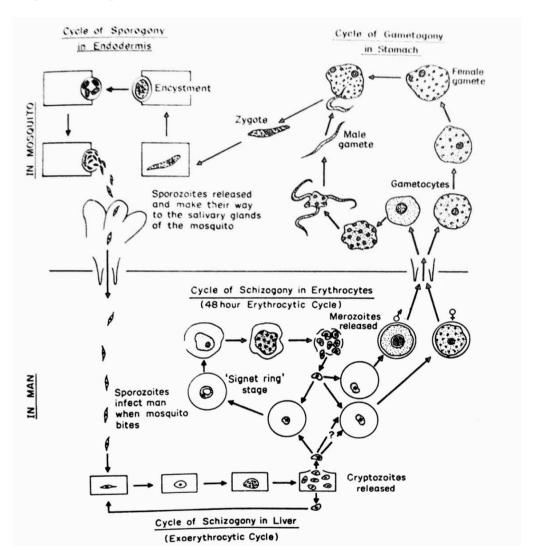


Fig1.12: Life cycle of *Plasmodium vivax* 

**Life cycle mosquito (Cycle of Ross):** The life cycle of *Plasmodium* in mosquito was first described by Sir Ronald Ross, so this cycle is called the cycle of Ross. When a female anopheles mosquito sucks the blood of man the gametocytes enter the gut. The erythrocytes are digested and the gametocytes are released. The megagametocyte is re-organized and becomes a female gamete or megagamete.

In microgametocyte the nucleus divides into 6 to 8 daughter nuclei. The daughter nuclei are arranged in the periphery of the gametocyte. The cytoplasm grow out into 6 to 8 long thin flagella like structures. Each nucleus moves into

flagellums like structure, which is now called microgamete. The microgametes break off from the microgametocyte by vigorous movements. The formation of microgamete from microgametocyte is termed as exflagellation. These microgametes exhibit gliding movement inside the lumen of the gut. The megagametocyte gives out a small cytoplasmic projection known as fertilization cone. When a microgamete comes into contact with the megagamete, it penetrates through the fertilization cone and now the two gametes fuse together. This phenomenon is known as syngamy or fertilization and the resulting structure is called synkaryon or zygote.

The zygote is non-motile, diploid and spherical shaped cell but soon it becomes elongated and spindle shaped showing gliding movement. At this stage the parasite is called as Ookinete. The Ookinete penetrates the wall of the gut and comes to lie beneath the outer layer of the gut wall. Here it becomes spherical and secretes a cyst wall around it. Now the parasite is known as oocyst, which grows by absorbing nutritive materials from the mosquito through the cyst wall. As a result it increases in size. The fully grown oocysts are observed as projection on the surface of the gut. The oocyst now undergoes a special kind of asexual reproduction called sporogony, during which the nucleus of oocyst divides into about 1000 daughter nuclei. The cytoplasm also becomes divided into about 1000 pieces. Each nucleus becomes encircled by a piece of cytoplasm. The resulting individuals are called sporozoites. Each sporozoites is spindle shaped body and they are released into the body cavity at mosquito by the rupture of the oocyst and the outer layer of the gut wall. They further enter the salivary gland.

For further development the sporozoites must be introduced into the blood of man. When female anopheles mosquito bites a man, it introduces a small amount at saliva to prevent the blood coagulations. Along with the saliva the sporozoites are also introduced into the blood of man and the cycle is repeated.

#### **Zoonotic significance**

#### **Pathogenecity**

- (1)P. vivax causes malaria, mild symptoms appear early i.e. loss of appetite, nausea and sometimes sleeplessness, headache, muscular pain and aches in joints.
- (2)Major symptoms appear on an average after and about 14 days of initial infection. It starts when the merozoites along with toxins are liberated into blood. These toxins are deposited into spleen, liver and beneath the skin. Malaria fever starts because of the accumulated toxins. The patient suffers from chills, shivering and high temperature with convulsions followed by profuse sweating. The fever lasts from 6 to 10 hours, and then it comes on again after every 48 hours coinciding with the liberation of new generation of

merozoites. Due to repeated and simultaneous schizogony, large number of erythrocytes is destroyed & increasing amounts of toxins into the blood, this cause anaemia and spleenic enlargement.

- (i)Rigor stage (Chill or cold stage): The patient feels a terrible chill and shivering, rapid pulse and breathing.
- (ii)Febrile stage (High temperature or hot stage): Shivering is about one hour or soon the body temperature of patient rises to 104<sup>0</sup> to 105<sup>0</sup> F. This stage is lasting 1 to 4 hours.
- (iii) Defervescent stage (Sweating stage): After few hours, profuse sweating starts, temperature of body steadily drops and the patient feels healthy.

**Anaemia :** It develops because of destruction of erythrocytes in large number. The infected erythrocytes become fragile, hence easily rupture and damaged.

**Spleenomegaly:** Enlargement of spleen is one of the important physical signs in malaria. Enlarged spleen releases lysolecithin, a lytic substance, which damages erythrocytes. To neutralize this substance, the parasites produce antibodies called haemolysin which haemolyse the normal erythrocytes.

#### Prevention and control

**Prevention:** It includes the precautions by which we protect ourselves from mosquitoes bite. These measures are simple but very effective in the control of malaria.

- 1. Keep hands and feet covered in the evening by using gloves and socks.
- 2. Applying some insect repellent to the exposed parts of the body at night so that mosquitoes do not bite.
- 3. Sleep under mosquitoes nets to avoid mosquito bite.
- 4. Use mosquito repellent coils.
- 5. Anti-malarial drugs should be taken regularly to escape the attack of malaria. These drugs are quinine, chloroquine, plasmoquine, camoquine, pamaquine etc.

**Control of mosquitoes:** Anopheles female mosquitoes are the carrier vectors which transmit infection from man to man. Therefore, control of mosquitoes is very effective measure for control of malaria and it is achieved by using the following measures.

1. Fill up all ditches, ponds and pools with earth so that mosquitoes may not find water to breed. Drainage water system should be underground and closed.

2. Destruction of larvae and adult mosquitoes by spraying with insecticides such as Malathion or other insecticides, oil, parish green etc. Thin oil film on the water surface prevents respiration of larvae pupae and they die.

#### **Biological Control:**

- 1.Larvae and pupae of the mosquito can be destroyed by larvaevorous fish such as *Gambusia*, *Lebistes*, *Minnows* etc.
- 2.The walls of the building should be sprayed with DDT, BHC insecticides which repel the mosquitoes and ultimately reduced the population of mosquitoes.
- 3.Remove the unnecessary vegetation from and around the houses which are hiding places for adult mosquitoes.
- 4. Destruction of mosquitoes can be achieved by sterilization male mosquitoes.

## 1.3 Protozoa and Soil fertility

The soil micro-fauna consists of protozoa and nematodeswhere as the microflora consists of bacteria, fungi and algae. Protozoa are the most abundant of the soil invertebrate fauna. The soil protozoa are cosmopolitan in distribution and found in practically all soils, their population being maximum in about 30 cm of the top soil. The size of soil protozoa vary for e.g. soil dwelling amoebae measure less than 20  $\mu$  in diameter and the ciliate *Colpoda steinii* measures 30 – 60  $\mu$ . The typical numbers of protozoa in soil vary widely from a thousand per teaspoon in low fertility soils to a million per teaspoon in some highly fertile soils. Fungal dominated soils (e.g. forests) tend to have more testate amoebae and ciliates than other types. In bacterial dominated soils flagellates and naked amoebae predominate. In general high clay contents soils contain a higher number of smaller protozoa (flagellates and naked amoebae), while coarser textured soils contain more large flagellates, amoebae of both varieties and ciliates.

Sandow (1927) examined soil sample from arctic, temperate, subtropical and tropical zone. He has recorded about 250 species of protozoa consisting of flagellates, ciliates, amoebae and certain rhizopodes from soil. The soil conditions which favour the growth of crop also favour the growth of protozoan population in soil. They seem to be very much dependent on soil fertility as well as on the rate at which energy containing materials, synthesized by plants is added to the soil, any increase in the available organic matter capable of supplying energy at onceincreases the number of protozoa more

especially the amoebae in the soil. There also appears to be some correlation between the number of protozoa and the type of vegetation growing in the soil.

Moisture level plays a major role for increase or decrease of protozoan population in soil. It also affects the movement and other physiological activities of protozoa. Irrigation of arid soil stimulates considerably, the development of protozoa. In dry soil, they pass their lives in cyst stage which transformed into active stage after first showers of rain or when soil get optimum amount of moisture. Flagellates are generally dominant in the soil e.g. *Monas* sps, *Boda* sp and *Euglena viridis*. They are tolerant to low moisture conditions as well e.g. *Carcomonas curassicauda*.

Bacteria form the staple food of protozoans as a whole. Most of the soil protozoans are predators of bacteria and theyappear to be a close relationship between number of bacteria and the number of protozoans presents in the soil. Next to H<sub>2</sub>O, O<sub>2</sub> and CO<sub>2</sub>, nitrogen is the major plant nutrient needed in largest quantity by crops. With the increase of bacteria in the soil, the efficiency of soil gradually slows downs as when their number goes up too much, they start utilizing nitrate- nitrogen for their body building and start competing with the crop plants for food and consequently results in the decrease of soil fertility. In such an eventually the protozoans comes to the rescue of crops and reduce the number of bacteria by catching and eating them, thus an equilibrium is set between the population of bacteria and protozoa in the soil so that the fertility of soil is not reduced.

Protozoa are small single celled microscopic animals play an important role in mineralizing nutrients making them available for the use by plants and other soil organisms. Protozoa have low concentrations of nitrogen in their cells than the bacteria they eat. The bacteria eaten by protozoa contain too much of nitrogen for the amount of carbon protozoa need. They release excess nitrogen in the form of ammonium NH<sub>4</sub><sup>+</sup>. This usually occurs near the root system of a plant. Bacteria and other organisms rapidly take up most of the ammonium.

The protozoa prey upon the denitrifying bacteria e.g. *Pseudomonas denitrificans*, *P stutzeri*, *Micrococcus denitrificans* and thus lower down the process of denitrification in the soil.

The protozoa prey upon the pathogenic bacteria and thus help in the biological control of certain bacterial diseases of plants. Nasir (1923) and Cutler and Bal (1926) observed increased fixation of  $N_2$  by the Azotobacter in the presence of ciliates protozoa like *Colpidium* and *Colpoda* sps. Harvey and Greaves (1941) recorded increased fixation of  $N_2$  in the presence of even dead protozoa. It appears that growth of Azotobacter is contained in the body of amoebae and consequently the increase in  $N_2$  fixation. There is increased production of  $CO_2$  and  $NH_3$  by bacteria in the presences of amoebae and ciliates.

Some protozoans utilize organic food and can digest materials like lignin and cellulose in the alimentary canal of animals. *Trichonympha*, azooflagellate, lives in the alimentary canal of termites which by themselves are unable to digest cellulose, the main constituent of their food present in wood. This protozoan ingests wood particles by means of enzyme and converts cellulose into soluble carbohydrates and thus enables the termites to utilize cellulose, the termite, without the help of these protozoans is incapable of digesting cellulose. These protozoa are very useful for fertility as they play important role in the decomposition of cellulose of soil organic matter.

So it is therefore necessary to encourage the predominance of useful species of protozoans and the destruction of harmful types of bacteria by the introduction of particular species of protozoans in the soil, so that it increases the fertility of soil.

#### SAQ 1.

Complete the following sentences by inserting appropriate words in the blanks.

- (i)Kala- azar disease is transmitted by -----.
- (ii) Glossina palpalis is a vector -----
- (iii)Sleeping sickness in man is caused by ------
- (iv)The protozoan causes the black water fever -----.

## 1.4 Summary

In this unit we have discussed protozoa and the diseases caused by them. We have discussed various diseases caused by protozoan in human and animals in very detailed manner. We have also discussed life cycle &zoonotic significance of *Entamoeba histolytica*, *Plasmodium*. We have also discussed protozoa and their effect on soil fertility in detailed.

## 1.5 Terminal Question

Q1. Explain the life cycle of Entamoeba histolytica.

Q3. Explain the Protozoa and soil fertility.

#### 1.6 Answers

#### SAQ 1 (i) Sand fly

- (ii)Gambia fever
- (iii)Trypanosoma
- (iv)Plasmodium falciparum

#### **Terminal Question**

#### Ans 1.

The life cycle of *Entamoeba histolytica* is monogenetic i.e. complete inside in a single host. The transmission from host to host takes place through the cyst by the contaminated food and water. It has following steps.

- (i)Multiplication: The young trophozoites secrete protolytic enzyme which dissolve the mucosa and submucosa of intestinal wall and than trophozoites enter into the intestinal wall and start feeding RBC. It also divides by binary fission. This causes abscesses and bleeding ulcers.
- (ii)Cyst formation: A few tissue dwelling trophozoites from the ulcers are liberated into the lumen of the intestine. These are small, rounded and less active and are known as precystic forms. Their endoplasm develops two chromatoid bodies and large number of glycogen vacuole but the red blood corpuscles disappear. These secrete thin delicate colourless and transparent cyst. Inside the cyst the nucleus divide twice to form quadrinucleate cyst. This cyst contain chromatid bodies and glycogen vacuoles. The cyst may attain a size varying from  $5 20\mu$ . This cyst came out through the faeces. The fresh cyst are green refractile and appears as shining spheres. The cysts come out of

host before maturity and complete their development outside the body. These can live outside the body for a number of weeks till they get new host.

- (iii)Transmission of cyst into fresh hosts: The cyst enter the fresh host through the contaminated food and water or by the cyst deposit on food by birds, flies and cockroaches.
- (iv)Excystation and development: On reaching the small intestine the cyst wall dissolve by the action of trypsin and the quadrinucleate metacystic form emerges out.
- (v)Metacystic development: Each metacyst with four nuclei divides by binary fission and produces eight uninucleate amoeboid trophozoites which invade the intestine wall.

#### Ans 2

Infection with plasmodium causes intermittent fevers which are known as malaria. Each of 4 species causes a characteristic fever and the diseases are as follow:

Plasmodium vivax: Vivax malaria

Plasmodium ovale: Ovale malaria

Plasmodium malariae: Quartan malaria (Malariae malaria)

Plasmodium falciparum: Falciparum malaria (Black water fever)

Malaria shows following symptoms:

- (i) Headache
- (ii) Shaking chillness
- (iii) Rise in body temperature as high as 106 °F at an interval of 48 hours.
- (iv) Muscular pain and ache in joints
  - (v) Sweating
  - (vi) Anaemia
  - (vii) Constipation

Control of human Malaria:

Malaria can be control and prevented by applying following methods:

- (i) Chemotherapy Treatment and cure of the disease by medicine.
- (ii) Chemoprophylaxis Prevention of infection by medicine.
- (iii) Protection against adult mosquitoes

- (iv) Destruction of larvae of mosquitoes.
- (v) Removal of breeding place of mosquitoes.

#### Ans 3

The soil microfauna consists of protozoa and nematodes where as the microflora consists of bacteria, fungi and algae. Protozoa are the most abundant of the soil invertebrate fauna. The soil protozoa are cosmopolitan in distribution and found in practically all soils, their population being maximum in about 30 cm of the top soil. The size of soil protozoa vary for e.g. soil dwelling amoebae measure less than 20  $\mu$  in diameter and the ciliate *Colpoda steinii* measures 30 – 60  $\mu$ . The typical numbers of protozoa in soil vary widely from a thousand per teaspoon in low fertility soils to a million per teaspoon in some highly fertile soils. Fungal dominated soils (e.g. forests) tend to have more testate amoebae and ciliates than other types. In bacterial dominated soils flagellates and naked amoebae predominate. In general high clay contents soils contain a higher number of smaller protozoa (flagellates and naked amoebae), while coarser textured soils contain more large flagellates, amoebae of both varieties and ciliates.

# UNIT 2. PLATYHELMINTHES & ASCHELMINTHES

# Structure (A)Platyhelminthes

2.1 Introduction

Objectives

2.2 Life cycle and Zoonotic significance of Diyphyllobothrium latum

#### Structure (B) Aschelminthes

- 2.3 Introduction
- 2.4 Life cycle and Zoonotic significance of Dracunculus medinensis
- 2.5 Summary
- 2.6 Terminal Question
- 2.7 Answers

# Structure (A) Platyhelminthes

# 2.1 Introduction

The term Platyhelminthes (Greek word Platy mean flat and helmins mean worm) was first proposed by Gegenbaur (1859) for the flat worms. Platyhelminthes are triploblastic, bilaterally symmetrical, dorso-ventrally flattened, accelomate flatworms with organ grade of body organization. These animals are devoid of a definite anus, without skeletal and respiratory as well as circulatory systems. It contains flame cells or protonephridia with mesenchymal cells representing mesoderm filling up spaces between various organs.

#### General characters

- (1)Platyhelminthes animals are free living, commensal or parasitic forms.
- (2)Body is bilaterally symmetrical and dorso-ventrally flattened triploblastic worms i.e. body is derived from three embryonic germ layers ectoderm, mesoderm and endoderm.
- (3)Body shape is generally worm like but varies from moderately elongated flattened shape to long flat ribbon and leaf like.

- (4) They are small to moderate in size varying from microscopic to extremely elongated forms measuring up to 10 -15 meters.
- (5) The anterior end of the body is differentiated into the head.
- (6)The ventral surface bearing mouth and genital pores is well marked in turbellarians but is less marked in trematodes and cestodes.
- (7)Hooks, spines and suckers are the adhesive organs. Adhesive secretions are common in parasitic forms.
- (8)Muscular system of mesodermal origin having longitudinal, circular and oblique muscle layers below epidermis.
- (9) Digestive system is totally absent in Acoela and tapeworms but in other flatworms it consists of mouth, pharynx and blind intestine (anus absent).
- (10)Skeletal, respiratory and circulatory system are absent.
- (11)Nervous system is primitive ladder like. It consists of a pair of anterior ganglia with longitudinal nerve cords connected by transverse nerves.
- (12)Sense organs are simple. Eye spots or photo receptors are in free living forms.
- (13)Sexes are united (hermaphrodite) with few exceptions.
- (14)Egg mostly devoid of yolk. Yolk produced separately by yolk or vitelline glands.
- (15)Internal fertilization may be cross or self.
- (16)Development direct or indirect. Usually indirect in endoparasities with a complicated life cycle involving many larvae and hosts.

# **Objectives**

After studying this unit you will be able to

discuss the life cycle and zoonotic significance of Diphyllobothrium		
<u>latum</u>		
Explain the general characters of phylum Aschelminthes		
Discuss the life cycle and zoonotic significance of <u>Dracanculus</u>		
medinesis.		

# 2.2 Life cycle and Zoonotic significance of Diyphyllobothrium latum

*Diphyllobothrium latum* is one of the largest and most injurious parasite of the intestine of man. It is also known as the "fish tapeworm" or "broad tapeworm".

It is distributed in Russia, Central Europe, America, Central Africa and Japan. Adult worm harbours in the ileum (small intestine) of man but it also lives in dog, cat and other fish eating mammals.

**Morphology:** The adult *Diphyllobothrium latum* is yellowish-grey in colour with dark markings centrally due to egg filled uterus. The adult measures 3 to 10 metres in length. The scolex i.e. head is elongated and spoon shaped and measures 2 to 3 mm in length and 1 mm in width. Scolex has two slit like bothria i.e. groove situated on the dorsal & ventral surfaces. However, there are no rostellum and hooks. The neck is thin and unsegmented and is comparatively longer than head. Neck is followed by proglottids i.e. segments which may be 3000 to 4000 in number. The proglottids are greater in width than length. A mature proglottid measures 2 to 4 mm in length by 10 to 20 mm in width and they equipped with male & female reproductive organs.

The terminal proglottids become shrunken and empty due to the constant discharge of eggs through the uterine pore and further these dried up segments separates from rest of the body in short chains and passed out *via* hosts faeces. The adult worm may survive for a period of 5-13 years.

There are 3 genital pores comprising of the openings of vas deferens, vagina and uterus, situated close to one other. The ovary is bilobed. The uterus is large and remains coiled in the center of each proglottid in the form of a rosette. The eggs are passed out in the host's faeces in great numbers. The eggs are oval and slightly brown in colour, measuring 70  $\mu$ m in length and 45  $\mu$ m in breadth. The characteristic feature of egg is that bears an inconspicuous operculum at one end with a small knob at the other end. A single egg produces a single larva i.e. coracidium. *Diphyllobothrium* eggs are not infective to man.

The larval stages are passed first in water and then in the respective intermediate host. There are 3 stage of larval development i.e.

- Coracidium develops from egg in water
- Procercoid larva found inside a copepode crustacean cyclops which is first intermediate host too.
- Plerocercoid larva found in fresh water fishes which act as second intermediate host.

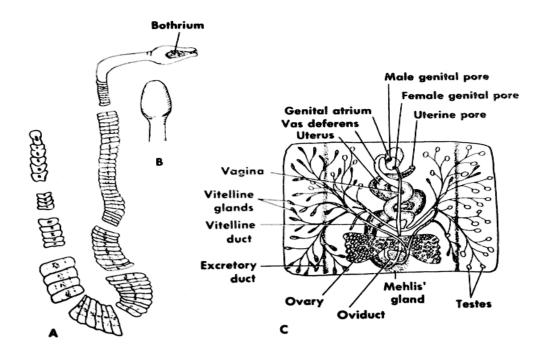


Fig 2.1: *Diphyllobothrium latum* (A)Adult worm, (B)Flat side of scolex, (C)Mature proglottid

**Life cycle:** Diphyllobothrium latum or the fish tape worm passes its life cycle in one definitive host i.e. man, dog and cat, however man is the optimum host and two intermediate hosts is cyclops and second intermediate host is freshwater fishes like salmon. trouts, etc. The operculated eggs are liberated *via* faeces of definitive host in water. A ciliated spherical embryo with 6 hooklets known as coracidium develops within each egg shell about in 1 to 2 weeks. The coracidum measures 40-55 μm in diameter. Mature coracidium escapes into the water and ingested by a first intermediate host cyclops. Further inside the intestine of cyclops, the coracidium loses its cilia and the supporting cuboidal cells and pierces through the intestinal wall and comes to rest inside the body cavity and about in 21 days. It is transformed into an elongated solid structure with a caudal spherical appendage containing 6 row useless hooks. It is now known as procercoid larva. First intermediate host cyclops containing procercoid is in its turn ingested by second intermediate host i.e. fish.

The procercoid larva measuring 50 mm in length, inside intestine of fish, pierces gut wall and rests into the liver or muscles or voluminous fat in the mesentery and proceeds to develop further and within 3 weeks, the procercoid larva changes into a plerocercoid larva otherwise known as sparganum.

The plerocercoid larva now looses its spherical caudal appendage and there is a clear depression at the anterior end representing inverted head of the future adult worm. The plerocercoid larva is white, flattened marked by irregular wrinkles. The smaller sparganum measuring 6 mm in size lie straight in the fish

flesh whereas the larger forms measuring 2 cm in length remain curved and twisted.

As regards the infection of man and further development of adult worm. It is obvious that plerocercoid larva is infective to man. The sparganum cannot be destroyed by pickling, salting or smoking. Therefore consumption of insufficiently cooked fish or raw flesh of fish makes man infected. Again inside the intestine of man the plerocercoid larva grows into adult worm and after having attained sexual maturity in about 5 to 6 weeks begins discharging eggs further passed *via* feacal matter. Thus cycle is repeated again.

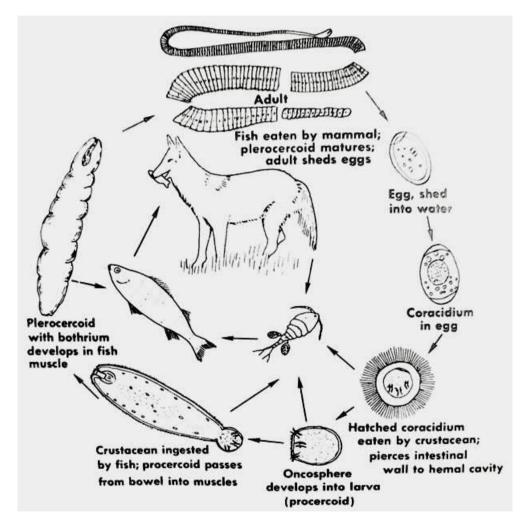


Fig 2.2: Life cycle of *Diphyllobothrium latum* or fish tape worm

# Zoonotic significance:

The infection of *Diphyllobothrium latum* in human beings is known as diphyllobothriasis which is due to consumption of imperfectly cooked infected fish containing sparganum. The symptoms include gastrointestinal disturbance and anaemia. The diagnosis includes microsurgical examination of faeces containing operculated eggs and proglottids having distinct featured uterus and position of genital pores. Treatment includes specific antihelmintics *viz* 

dichlorphen, niclosamide etc. which give good results. However, prevention is always better than cure and prophylaxis involves

- Personal prophylaxis in endemic area i.e. consumes properly cooked fish only.
- Prevent pollution of water through efficient and proper disposal of sewage.
- In endemic places dog, cats, foxes and other canines maintain the infection as these all feed

on debris of fish. So to check infection this practice must be stopped.

# SAQ 1.

Complete the following sentences by inserting appropriate words in the blanks.

- (i)Platyhelminthes are called as -----
- (ii)Digestive system of platyhelminthes is lack of -----
- (iii) The disease caused by *Diphyllobothrium latum* ------
- (iv) The larva of *Diphyllobothrium latum* is infective to man ------

# **Structure (B) Aschelminthes**

# 2.3 Introduction

The term Aschelminthes was proposed by Grobben (1990), in place of the older name Nemathelminthes. Different views put by zoologists about the classification of nematodes. Some author has designated a separate phylum Nemathelminthes, which includes or does not includes Acanthocephala and Nematomorpha. Recently, nematodes have been grouped in a class Nematoda and phylum Aschelminthes.

#### **General Characters**

- (1) They are commonly known as round worms.
- (2)Round worms have elongated, cylindrical and vermiform body with tapering at both ends.
- (3) Triploblastic animal with bilaterally symmetrical.
- (4)Body is segmented and not distinguished into regions.
- (5)Body colour is white or with a yellowish tinge due to absence of pigment.

- (6)Male is generally smaller than female, caudal end is generally straight in females but coiled males.
- (7)The body is covered by tough, resistant cuticle which moulted during growth period throughout life.
- (8)The digestive system is complete. Mouth present anteriorly while anus posteriorly.
- (9) The respiratory and circulatory systems are absent.
- (10)Nervous system consists of brain or circumenteric nerve-ring with anterior and posterior nerves.
- (11)Poorly developed sense organs in the forms of small papillae and amphids.
- (12)Excretory system of glandular organs i.e. canals, protonephridia and flame cells are absent.
- (13)Sexes are separate. Testes and ovaries are tubular or coiled.
- (14) They are ova-viviparous, oviparous or viviparous.
- (15)Life cycle is complicated may be with or without intermediate host.
- (16) Four larval stages in life history, third larval stage is infective.

# 2.4 Life cycle and Zoonotic significance of *Dracunculus* medinensis

It was first discovered by Gallander in 1743 and Linnaeus in 1758. It is the most spectacular human helminthes parasite. It is widely distributed in tropical countries like South Africa, Saudi Arabia, Afghanistan, Pakistan, Coastal and Western India (Rajasthan, Maharashtra, Assam, and Orissa) and South Eastern USSR.

It is found in deeper subcutaneous tissue of man and other mammals specially at the lower extremities which frequently come in contact with water. The life history of *Dracunculus medinensis* includes the primary or definite host i.e. man or any other mammal and an intermediate host mainly cyclops.

**External morphology:** The individual which are unisexual shows sexual dimorphism. Both male and female worm are filiform, elongated, cylindrical, long cord like body, surface smooth. The anterior end of the worm is blunt. The posterior end of male is sharply curved, conical and exhibit a pair of pineal spicules protruding from the pineal aperture. The males are comparatively

shorter than the female measuring 4 cm in length and 0.4 mm in diameter. The females are very-very long measuring 60 - 100cm in length and 1.5 - 1.7 mm in diameter. Only adult females or mature females filled with young once has been occurs in deeper subcutaneous layer. The males are found in young stage and disappear soon after copulation.

In young female the posterior end shows two pairs of spinous projection known as macrones. More over mid-ventrally there is a transverse slit like vulver opening with bulging lips. In mature female the posterior end shows only one projection a subterminal anal aperture and the vulver opening usually degenerates. The posterior end of male is sharply curved and two additional female spicule and the pre and post genital papillae are also visible.

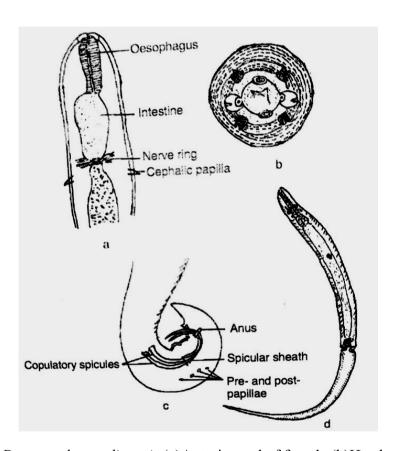


Fig2.3: *Dracunculus medinensis* (a)Anterior end of female (b)Head of worm (c)Posterior end of male (d) Larva of *Dracunculus medinensis* 

**Reproductive system**: Individuals are unisexual i.e. male and female reproductive organs are separate. Reproductive organs are elongated. Male reproductive organ consist of a long coiled thread like unpaired testis whose surface epithelium is continuous into tubular long elongated sperm duct, that enlarges posteriorly forming muscular seminal vesicle that before opening into rectum form a highly muscular ejaculatory duct. The spicules are considerably long slender, thread like 0.5 to 0.7 mm in length. The spicules lodged in

spicular pouches, pre and post anal aperture are helping in copulation. This shows Monaric condition. The female reproductive system consists of a pair of thread like elongated coiled ovaries whose surface epithelium is continued to oviduct which are elongated tubular structure joining to sac like muscular uteri. The oviduct before opening to uteri forms a small dilated seminal receptacle that receives the sperm. The uteri unite in the distal end forming a common uterus and finally vagina. The mode of origin of sex cell in *Dracunculus medinensis* is telogonic i.e. germ cell originate from the large terminal cell. The germ cells originating from large terminal cell grow up into the gametogonia in the growth zone.

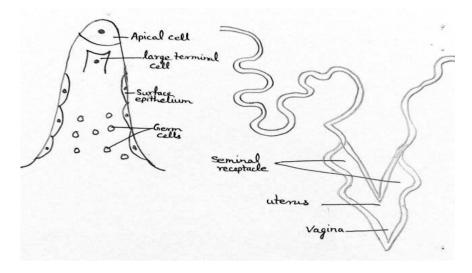


Fig2.4: Female reproductive system

**Life cycle:** The most spectacular human helminth parasite living in the subcutaneous layer of man or any other mammal also includes an intermediate host mainly cyclops. It can be studied under the following heading

- (i)Copulation and fertilization
- (ii)Egg
- (iii)Cleavage or segmentation
- (iv)The juvenile worm
- (v)Infection to secondary host
- (vi)Infected larva
- (vii)Infection to final host i.e. primary host
- (i)Copulation and fertilization: During copulation the posterior end of young male coils around the mid-ventrally vulver opening of the female and pineal spicules help in bring the male and female aperture in close contact. Pre

and post anal genital papilla help the male in griping firmly the female. The ejaculatory duct and the sperm duct and the spermatid fluid is poured into female genital tract. After copulation the male disappears. The sperm reaches the seminal receptacles of female where fertilization takes place.

(ii)Egg: After fertilization, a fertilization membrane appears surrounding the fertilized ovum forming a thin chitinous shell just to the inner side of the shell. The ovum itself gives rise to a lipid membrane which is also very thin and delicate. The outer albuminous coat or proteinous coat is completely absent. The chitinous shell as well as lipoid layer are very delicate and thin as compared to oviparous nematodes. As the egg gives rise to young juvenile worm that hatches within the material uterus. The egg itself is oval in shape and the outer surface is very smooth.

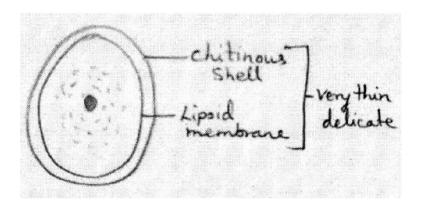
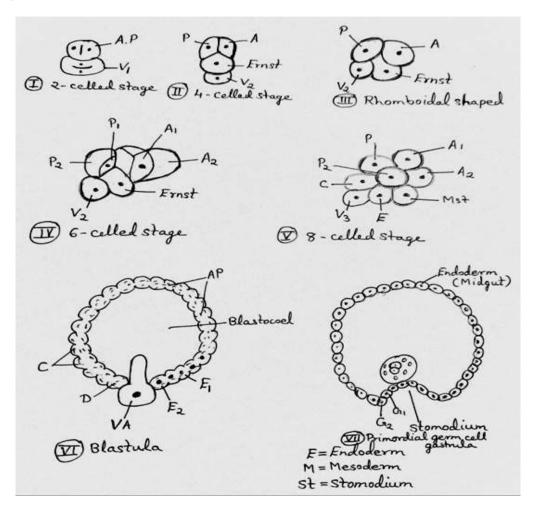


Fig2.5: Fertilized Egg

(iii)Cleavage or segmentation: Cleavage starts soon after fertilization when the eggs move towards the uterus. Segmentation is holoblastic or total and determinate. The first cleavage is transverse to the egg axis. The fertilized ovum divides transversely into a dorsal cell AP and ventrally cell V. The dorsal cell AP divides vertically forming an anterior cell A and posterior cell P. The ventral cell V also divides forming an upper cell Emst and lower cell V<sub>2</sub>. The four celled embryo is 'T' shaped. The cell soon re-arranged themselves as the upper cell Emst comes lie near to V<sub>2</sub> giving rise to a 4-cellede rhomboidal embryo. AP cell soon divides into an anterior mst and posterior E cells. V2 cell also divides giving rise to V<sub>3</sub> and C-cells. V<sub>3</sub> cell again divide giving rise to V<sub>4</sub> and D cells. The V<sub>4</sub>cell soon forms G<sub>1</sub> and G<sub>2</sub> cells of the primordial germ cells. The offsprings of AP cell from the ectoderm. The desendence of mst cell giving rise to mesoderm and the desendence of D and E cells also contributes in the formation of endoderm. Cleavage results into a coeloblastula which is anterio-posteriorly elongated and somewhat dorsi-ventrally flattened. Soon due to epiboly, the ectodermal cells or ectodermal side grow downwards with the result that the ventral cells are pushed inwards or rather invaginate into the blastocoels, resulting into the formation of a gastrula. Gastrula elongates and

the invaginated mass that consist of elongated flattened stomodium endoderm or midgut and the mesodermal cell which are completely trapped within the ectodermal cells. As the gastrula furtherelongates stomodium comparatively closes. The gastrula now elongates rapidly until of form an elongated cylindrical juvenile worm which is surrounded by delicate thin fertilization membrane. The eggs containing the juveniles stuff the uteri where the young juvenile hatches.



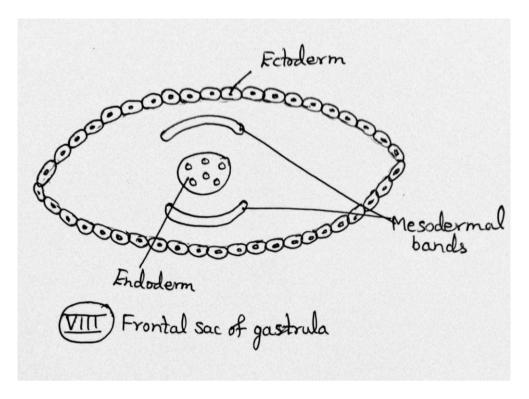


Fig2.6: Stages of cleavage or segmentation

(iv)The juvenile worm: The juvenile worm that hatches within the maternal uterus is delicate, elongated, cylindrical, curved worm and has a very long filamentous tail at the time when uterus of female is completely stuffed with juvenile worm. Gravid female migrate to most superficial layers of skin where she secrete from its anterior end, a toxic liquid that form a blister just beneath the epidermis. The blisters are formed in the extremities of the primary host that frequently come in contact with water. When the blisters come in contact with water, they burst and forms ulcers. The female (gravid) as soon as comes in contact with water contract with a jerk expelling a cloud of juvenile worms, during discharge of juvenile the wall of the uterus as well as body ruptures. After the discharge the female perishes and the young juvenile worms swims in water in search of secondary host mainly Cyclops. The juvenile worm measure 6 mm in length having a long filamentous tail. Except for reproductive organs it looks like as an adult worm. Blisters are formed in the extremities i.e. limbs within 8 – 12 month of infection.

(v)Infection to secondary host: The juvenile worms swim in water in search of its secondary host mainly cyclops and unless and until swallowed by the secondary host, the juvenile worm perishes. After being swallowed by cyclops the juvenile worm reaches the stomach and intestine within 6 hours. The juvenile worm after piercing through intestinal wall reaches the body cavity, where it undergoes moulting.

(vi)Infected larva: After reaching the body cavity of cyclops the juvenile worm moulds twice and within 16-18 days it changes into infective stage or infective larvae. The infective larvae are uniform, vermiform, cylindrical measuring  $240-260~\mu$  in length. The infective worms are very much similar so that of juvenile worm except that the tail become shorter.

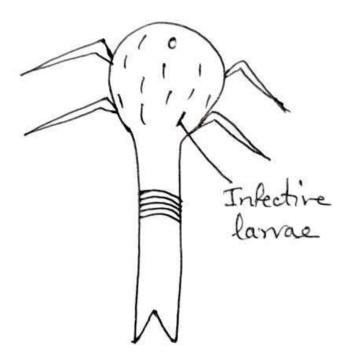


Fig2.7: Cyclops with infected larvae

(vii)Infection to final host i.e. primary host: The infection to definite or primary host takes place due to consumption of contaminated water containing cyclops with infective larvae. After reaching the stomach the cyclops digested and infected larvae come out and pierce through the wall of stomach and duodenum they reach or migrate to the retino-peritoneal cavity to develop into the adult worm. Later on taking position in deeper subcutaneous tissue.

The infective larvae take about 1 years of time to reach the gravid female stage. The infection by *Dracunculus medinensis* causes "Drancunculosis".

# Zoonotic significance:

# Diagnosis

- (1)After the formation of blister the presence of parasite can be diagnosed by hyper sensitization test injection *Dracunculus* antigen.
- (2)Detection of embryos.
- (3)Intradermal test.

- (2)By X-ray examination.
- (3)Blood examination

**Pathogenesis**: Infection with *Dracunculus medinensis* in humans is known as guinea worm disease or Dracunculosis. Guinea worm infection causes itchiness, asthma, eosinophilia, nausea, vomiting, diarrhoea etc. There effects are due to toxic substance produced by the parasite. These might also be septic infection as a result of contamination by secondary organisms drawn in by the female worm at the time of retraction. The presence of parasite sometimes become fatal if proper care is not taken.

**Prevention**: Infection can be treated with nitrothiazole compound ambilhar which showed good results and parasites were killed by treatment with this drug. As regards prophylaxis the infection can be prevented by breaking link of the man-cyclops – man chain as

- Drinking water should be filtered or boiled.
- Prevention of pollution of drinking water by infected persons.
- Eradication of vector i.e. cyclops by chemical treatment ofwater.

**Treatment:** Elliott in 1942 reported excellent result from intra muscular infection of phenothiazene. Emulsified in olive oil into a number of places closes to the worm. Antihelminth drug like vitreothiozol compounds are also useful or effective extraction of worm by winding it out by (on) a stick with a few scientific refinements is also found to be affective.

## SAQ 2.

Complete the following sentences by inserting appropriate words in the blanks.

- (i) Aschelminthes are called as -----
- (ii) The primary host of *Dracunculus medinensis*-----
- (iii) The intermediate host of *Dracunculus medinensis*-----
- (iv) The disease caused by *Dracunculus medinensis*-----.

# 2.5 Summary

In this unit we have discussed general characters of phylum platyhelminthes. We have also discussed life cycle of *Diphyllobothrium latum*and zoonotic significance of ina very detailed manner.

In second unit of this chapter we have discussed general characters of phylum Aschelminthes. We have also discussed life cycle &zoonotic significance of *Dracunculus medinensis* in a very detailed manner.

2.6 To	erminal Question
Q1. Ex	plain the Zoonotic significance of Diphyllobothrium latum.
	valain the Convletion and fartilization of Dygawawkus
medine	xplain the Copulation and fertilization of <i>Dracunculus</i> nsis
Q3. Exp	plain the juvenile worm of <i>Dracunculus medinensis</i> .
2.7 A	nswers
SAQ 1	(i) Flat worms
	(ii)Anus
	(iii)Diphyllobothriasis
	(iv)Plerocercoid
SAQ 2	(i) Round worm
	(ii)Man
	(iii)Cyclops
	(iv)Dracunculosis

- **Ans 1.**The infection of *Diphyllobothrium latum* in human beings is known as diphyllobothriasis which is due to consumption of imperfectly cooked infected fish containing sparganum. The symptoms include gastrointestinal disturbance and anaemia. The diagnosis includes microsurgical examination of faeces containing operculated eggs and proglottids having distinct featured uterus and position of genital pores. Treatment includes specific antihelmintics *viz* dichlorphen, niclosamide etc. which give good results. However, prevention is always better than cure and prophylaxis involves
- Personal prophylaxis in endemic area i.e. consumes properly cooked fish only.
  - Prevent pollution of water through efficient and proper disposal of sewage.
- In endemic places dog, cats, foxes and other canines maintain the infection as these all feed

on debris of fish. So to check infection this practice must be stopped.

- **Ans 2:** During copulation the posterior end of young male coils around the mid-ventrally vulver opening of the female and pineal spicules help in bring the male and female aperture in close contact. Pre and post anal genital papilla help the male in griping firmly the female. The ejaculatory duct and the sperm duct and the spermatid fluid is poured into female genital tract. After copulation the male disappears. The sperm reaches the seminal receptacles of female where fertilization takes place.
- **Ans 3** The juvenile worm that hatches within the maternal uterus is delicate, elongated, cylindrical, curved worm and has a very long filamentous tail at the time when uterus of female is completely stuffed with juvenile worm. Gravid female migrate to most superficial layers of skin where she secrete from its anterior end, a toxic liquid that form a blister just beneath the epidermis. The blisters are formed in the extremities of the primary host that frequently come in contact with water. When the blisters come in contact with water, they burst and forms ulcers. The female (gravid) as soon as comes in contact with water contract with a jerk expelling a cloud of juvenile worms, during discharge of juvenile the wall of the uterus as well as body ruptures. After the discharge the female perishes and the young juvenile worms swims in water in search of secondary host mainly Cyclops. The juvenile worm measure 6 mm in length having a long filamentous tail. Except for reproductive organs it looks like as an adult worm. Blisters are formed in the extremities i.e. limbs within 8-12 month of infection.

# **UNIT 3. ARTHROPODA**

# Structure (A) Arthropoda

3.1 Introduction

**Objectives** 

- 3.2 Life cycle and Zoonotic significance of Representation Tick and Mite
- 3.3 Beneficial and Harmful insect
- 3.4 Summary
- 3.5 Terminal Question
- 3.6 Answers

#### Structure (A) Arthropoda

# 3.1 Introduction

Arthropoda (Gr. Arthros-Jointed, podas-foot/appendage) is the largest group of the animal kingdom. They have undergone an adaptive radiation for aerial, aquatic, terrestrial and parasites environment found in every ecological niche. Arthropods are bilaterallysymmetrical and metamerically segmented animals. It is only invertebrates phylum to have forms capable of flight.

#### General characters

- (1)Body is bilaterally symmetrical, triploblastic and metamerically segmented.
- (2) The segments are functionally modified and grouped into 2 or 3 divisions.
- (3) The jointed appendages are modified to perform various functions.
- (4)Body is divisible into three regions i.e. head, thorax and abdomen or having two region i.e. cephalothorax and abdomen.
- (5) Head is distinct and bears well developed sense organs.
- (6)True coelom reduced and largely replaced by a blood filled haemocoel.
- (7) Muscles are mostly striated and usually capable of rapid contraction.
- (8) Having complete digestive system with mouth and anus as well as mouth parts adapted for various modes of feeding.

- (9) Circulatory system is open type with a dorsal often many chambered heart, arteries and blood sinuses or haemocoel.
- (10)Respiration by general body surface, gills, trachea or book lungs.
- (11)Excretory organs are green glands or malpighian tubules.
- (12) Nervous system with a dorsal nerve ring and double ventral nerve cord.
- (13)Sexes are generally separate and sexual dimorphism is often exhibited by several forms.
- (14)Fertilization is internal. Development is usually indirect through larval stages.
- (15)Parental care is also often well marked in many arthropods.

#### **Objectives**

After studying this unit you will able to

	Discuss the life cycle and zoonotic significance of ticks and mites.
П	Discus the beneficial and harmful insects

# 3.2 Life cycle and Zoonotic significance of Representation Tick and Mite

## **Tick**

Ticks are ectoparasite feed on blood and tissue fluids of many vertebrates such as reptiles, birds, mammals and human. They transmit a large no of disease agents like viruses, rickettsiae, bacteria, protozoa and nematodes. Ticks can cause great damage during feeding by removing blood, damaging the skin at the site of feeding and causing tick paralysis in humans or other animals. The most serious disease transmitted by ticks are texas cattle fever, relapsing fever and Rocy mountain spotted fever.

Ticks are minute creatures but larger than mites. There is no external visible segmentation and prosoma (cephalothorax) is fused with opisthosoma (abdomen). Ticks are provided with blood sucking mouth parts with re-curved teeth adapted for piercing. Respiration take place by trachea spiracle is located behind third or fourth pair of coxae.

The ticks are classified into two families hard ticks belong to family Ixodidae and soft ticks belong to family Argasidae. The hard ticks have a hard dorsal plate or scutum and the mouth parts are clearly visible from above. Soft ticks have a leathery body but no hard plate on the dorsal part of the body and the

mouth parts are located ventrally and are not visible from above. Hard and soft ticks can bite humans and causes painful itching lesions.

The common ticks are *Argas* (fowl tick), *Dermacentor* (dog tick), *Ixodes* (sheep tick), *Boophilus* (cattle tick). *Argas* is a poultry tick, it carries a spirochaete which causes relapsing fever in poultry. *Dermacentor* is a dog tick of brown colour parasitic on domestic animals and man, it causes a dangerous tularemia and relapsing fever. *Ixodes* is a sheep tick, it transmits a virus which causes tick fever in sheep and domestic animals and it also causes encephalitis in man. *Boophilus* is a cattle tick, it inoculates *Boophilus annulatus* a protozoan into the blood which causes Texas fever or red water fever in cattle which proves fatal.

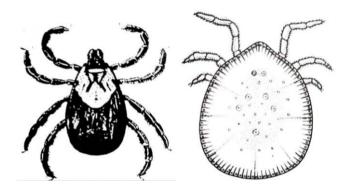


Fig3.1: Female Dermacentor Fig3.2: Argas

#### Life cycle & Zoonotic significance of tick

#### Cattle Tick (Boophilus microplus)

The *Boophilus* mainly attacks the cattle but it is also found on horses, mules deer, goat and sheep. The tick have a four stages in their life cycle i.e. egg, six legged larva, eight legged sexuallyimmature nymph and eight legged sexually mature adult. Usually a blood meal is necessary for the larva to molt to become a nymph and another blood meal is needed for the nymph to molt before becoming an adult. The cattle tick is responsible for spreading of cattle fever, tick fever, texas fever from sick individual to healthy ones. After maturity the *Boophilus microplus* (cattle tick) attains a length of about 0.1 mm. *Boophilus microplus* is olive green to bluish grey in colour. They are bean shaped with hard and wrinkled skin. The larvae are smaller provided with 3 pairs of legs, where as nymph and adult have 4 pairs of legs.

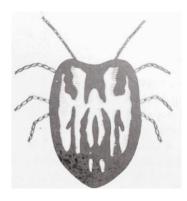


Fig3.3: Boophilus microplus

#### Life cycle

Sexes are separate and the adults show distinct external sexual dimorphic character. Copulation takes place on the body of host with exception where it takes place away from host. Male secretes pheromone during feeding which attracts female tick. Male grasps female in such way that ventral surfaces of both become opposed. Male inserts its copulatory organ into female gonophores and then the spermatophore is inserted. Then female feeds on the blood of host and becomes engorged. The male die after mating.

The life cycle of cattle tick includes four stages i.e. egg, larvae, nymph and adult. After mating female lays eggs in the soil, cracks and crevices of building. A single female lays about 200 eggs in clusters. The eggs hatch into six legged larvae after 2 to 6 week. The larva are present in bushes and attach themselves to a host as cattle passes. These larvae start feeding blood meal and get molt into eight legged sexually immature nymph. The nymph again feed bloody meal from same infested cattle and molt to change in adult. Now again mating take place on the host's body (cattle) and adult drop to the soil surface to lay egg for another generation. The single life cycle needs about 60 days.

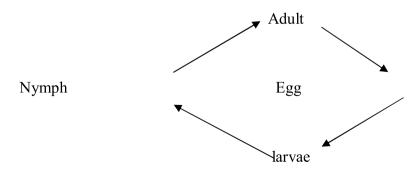


Fig3.4: Life cycle of Cattle Tick (Boophilus microplus)

#### Zoonotic significance

#### **Pathogenecity**

Ticks are hazardous to man and his domestic animals. Since they suck the blood of host, cause injuries to host and damage the skin. They also transmit various diseases in vertebrate mammals including man. Following are the important harmful effects caused by ticks on their hosts.

- **1.Mechanical damage :** Bites of certain ticks cause severe mechanical damage or injuries to the hosts and underlying tissues. This cause local inflammation, oedema and severe irritation. They may perforate the ear drums of horses, cattle. The sick animals show decreased milk yield and reproductive efficiency. Poultry birds also reduced egg and meat production.
- **2. Tick host anaemia :** This results due to loss of blood in the host by sucking of the blood by ticks. The hosts show pale and watery blood and definite reduction in haemoglobin. Heavily infected hosts generally show the anaemia.
- **3. Tick host paralysis:** The bite of certain ticks results in paralysis of the host. The species of *Demacentor*, *Argas*, *Ixodes*, *Hyalomma* etc. cause paralysis in cattle, sheep, dog, poultry and even in man. The paralysis sets in the host after the female tick begins feeding. The causative agent is a neurotoxin however, all the females do not secrete neurotoxins and hence they do not cause paralysis. It is known that a single female tick can paralyse a 1000 pound bull by the time she is only partially engorged. The paralysis of limbs and respiratory muscles result into death of the animal.

**Tick toxins and venoms:** The secretion of some irritant during the bite. For biting of soft tick *O. moubata*. in Africa causes severe swelling and irritant. *Ixode ricinus* secretes an anticoagulant during feeding that prevents clotting of blood at the site of the bite and prevents coagulation of blood within the alimentary tract of the tick. It is suspected that most ticks secrete such a substance and this may include the toxins.

Due to tick toxins, the common disease called sweating sickness occurs in cattle in which there is profuse exudation of serum on skin. In our country, cattle and sheep also die due to the toxic substances of ticks called tick toxicosis.

**Symptoms:** The symptoms of tick fever are high fever, reddish discolouration of urine, enlargement of spleen, loss of flesh, arched back and dropping ears. The protozoan *Boophilus annulatus* is responsible for this disease which destroys the red corpuscles of the blood. Thus, this disease is caused by a protozoan parasite but only the ticks are responsible for the spread of this disease. The germs of texas fever are carried through the eggs of diseased ticks which infect the new individual.

#### Prevention and control:

- 1. Spray the animal houses periodically with acaricides or tickicides.
- 2.Seal the cracks and crevices in the poultry houses and spray them periodically.
- 3. Construct the tick proof animal houses.
- 4. Treat the infected animals with acaricides periodically.
- 5.Use the tickicide impregnated ear tags, ear bands and neck bands for domestic pets and prize animals which protect them from tick infection.
- 6. For human beings, protective clothing should be used.
- 7. Avoid visiting or walking on tick infested areas or places.
- 8. Pasture rotation method is effective to combat ticks in which ticks are exterminated by starving.

#### **Treatment**

By using drops of kerosene and chloroform on the ticks which are few in number can be removed manually. If heavy infestation is there on the body of hosts, they can be treated with acaricide or tickicide, using spray or dusting powder. Infected animals can be given dip or plunge bath of proper tickicide formulations. Arsenicals, DDT, BHC, gammexane, Diazinon, Phosolone, Butacarb (Carbamates) like tickicides are used.

#### **Mites**

Mites are a member of order Acarina of arthropodawith eight legs in adult stages. They are the major agriculture pest. They are smaller than ticks and are predaceous, parasitic and scavengers. They are found everywhere like in fresh water, sea water, hot water, in soil, on vegetation, in plant galls, under stones in debris, on dead animals etc. Mites arevarying in size ranging from 0.5 to 2.0mm in length, sac like animals without body divisions and abdominal segmentation. Mouth parts produce a head-like structure, the gnathosoma that bears a pair of chelicerae and a pair of pedipalps. Legs are 4 pairs. The whole body bears long pointed spines which are sensory in function. Respiratory organs are absent or there are tracheae. Sexes are separate. Some species are parasites of insects, farm animals, birds and even on man. Some of the most important mites are Mange mite (*Sarcoptesscabiei*), Follicle mite (*Demodex folliculorum*), Sheep Scabe mite (*Psoroptes equiovis*), straw itch (*Pyemotes ventricosus*), chiggers (*Eutrombicula alfreddugesi*) etc.

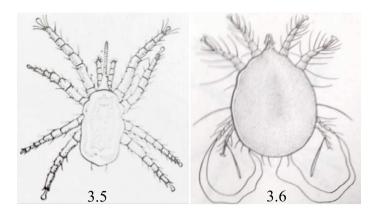


Fig3.5: Dermanyssus gallinae Fig3.6: Psoroptes equivis

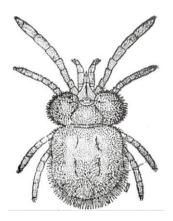


Fig3.7 : Chigger (Entrombicula sp)

Mange mite commonly infects men, horses, goats and sheeps. The size of mange miteis 0.3 to 0.4 mm in length with an oval sac like body in which the first and second pairs of legs are widely separated from the third and fourth pairs. The mouth parts at the anterior end have chelicerae and palpi and the anus is at the posterior end. The skin has fine wrinkles on the dorsal side with a number of prominent blunt spines and many backward projecting triangular points. The scabies mite causes intense itching and rash particularly at night.

The follicle mite (*Demodex folliculorum*) is a microscopic, eigar shaped creature with eight stumpy legs and an annulate abdomen. They are found in hair follicles and sebaceous glands, particularly on the nose and face and probably infest over half of middle aged adult. The infestation is usually asymptomatic but may be associated with black heads. The mites may be squeezed out of hair follicles often by pressing a slide against the nose.

Chiggers attack on men, poultry, domestic animals, snakes, frog etc. Mite larvae appears as tiny reddish dots attached to skin, usually in areas where clothing is tight such as ankles at the top of socks or skin touched by belts or elastic bands. Sensitive individuals react to the secretion of the larvae with

swollen itching areas at the sites of attachment which persist for days. Scratching may lead to secondary infections. The six legged larvaehave characteristic branched, feather like hairs. The eight legged nymphs and adult are non-parasitic vegetarians.

The straw or hay itch mite (*Pyemotes ventricosus*) is a parasite of insect larvae which infest straw, hay, grains, wood and other plant products. These mites may attack people who handle these products such as people sleeping on hay or crawling under houses infested with wood borers, and may cause severe itching and rash. Adult mites have a characteristic club shaped hair between the first and second pairs of legs. In gravid female the abdomen becomes enormously enlarged resembling a small pearl.

The mites of the family Dermanyssidae are normally parasites of rodents or birds, but they attack people causing dermatitis. The people raising domestic fowl may suffer from attack of the chicken mites (*Dermanyssus gallinae*), northern fowl mite (*Ornithonyssus sylviarum*) or tropical bird mite (*Ornithonyssus bursa*).

Grain and cheese mites are frequently found in tremendous numbers in flour, grain, cheese and derived fruits particularly when humidity and temperature are high. Some of these mites may causes dermatitis among persons who handle these infested foods.

# Life cycle and Zoonotic significance of Mange mite (Sarcoptes scabiei)

The mange mite (*Sarcoptes scabiei*) generally infects men, horses, goats, buffaloes and sheep. The mange mites are minute whitish creatures, scarcely visible to the naked eye. They are nearly round and the cuticle is delicately sculptured with numerous wavy parallel lines, pierced here and there by stiff projecting bristles or hairs. They have no eyes or tracheae. The mouth parts consisting of a pair of chelicerae and a pair of three jointed triangular pedipalps are attached to a capitulum or gnathosome in the front of the body. The four pairs of short stubby legs are found of which the third pair in the male and third and fourth pair in the female end in the form of bristle which are as long as the body. The skin is pale coloured and striated. In the human mange mite, the male is less than 0.25 mm in length and the female is about 0.3 to 0.4mm in length. The eye and tracheae are absent. Just after mating impregnated female excavate thin tortuous tunnel in the epidermis especially where the skin is delicate and thin. The tunnels measures a few millimeters to over an inch in length. The daily excavations of mite amount to 2 or 3 mm.

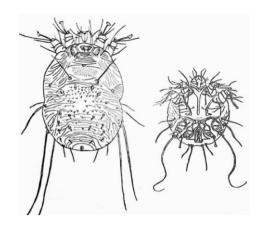


Fig3.8: Sarcoptes scabiei

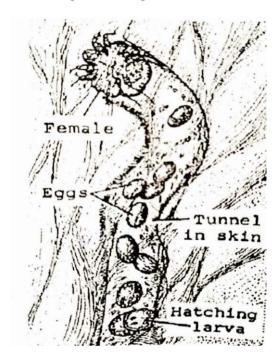


Fig3.9: Tunnel of female Sarcoptes scabiei in human skin with discharged eggs in stages of development

#### Life cycle

The itch mite (*Sarcoptes scabiei*) spends its entire life cycle on the host. The life cycle of *Sarcoptes scabiei* involves four stages i.e. egg, larva, nymph and adult. The young females start to dig new burrows in which mating takes place. After mating the males die. The female after mating enters the galleries made in the skin and lay eggs. The eggs are about 160  $\mu$  long and are laid in the burrow at the rate of 2 or 3 a day. The total female lay eggs are about 35 to 50. After laying eggs female dies. The egg hatches in a few days into six legged larvae. The larvae leave the burrow, come to the surface and bore into the hair follicles. In 2 – 3days larvae are transformed into nymphs. When the larvae moults, it acquires in a additional pair of legs. The six legged larvae will transfer in 2 or 3 days into eight legged nymphal stage. This nymphs build

burrows for themselves and molt twice, after second moulting becoming adult male and female mites. The duration of the two nymphal periods is 3 to 6 days. The entire life cycle of the mites is completed in 8 to 14 days. The adult live about 4 weeks and may infest new hosts on contact.

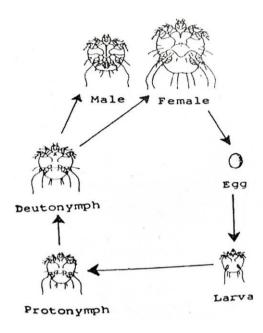


Fig3.10: Life cycle of itch mite (Sarcoptes scabiei)

# Zoonotic significance

# **Pathogenecity**

- 1.Burrowing and feeding of mites cause unbearable itching (the chief symptom of the disease). The mites secrete and extremely irritating poison, which together with their tunneling causes itching of scabies. The trouble is more in winter, but some of the mites live on the body the year round, unless treated.
- 2. Infested person rubs and scratches the body vigorously. The infection spreads over the entire body. The skin becomes inflamed pimply, scurfy with only scattered hairs remaining. Later, large, dry, cracked scabs form on the thickened skin. Hard pimples about the size of pinhead containing yellow fluid form over the affected skin and as these are scratched, they usually become infected and cause large ugly sores and scabs.
- 3. The venom introduced by the feeding of mites may greatly depress the individual and disturb the health.

#### **Transmission**

- 1. Scabies is contagious. Transmitted by close contact with infested people.
- 2. Since the mites crawl about over the body chiefly at night, infection usually occurs by occupying the same bed with one who has the itch.

3. The use of the same towels and clothing with a victim spreads the disease.

### **Control Prophylaxis**

- 1. Avoid contact with infested individuals. Do not use towels clothing comb, blanket of the infested individuals.
- 2. Infested individuals should be isolated from the rest of the household as much as possible.
- 3. Underwear, outer clothing, bed clothing, towels etc. used by the patient should be sterilized by super heating.

#### **Treatment**

Before applying any sarcopticide patient should take bath with soap and hot water. Sarcopticide be applied to the entire body. The individual should not bath for 24 hours following treatment. Clothes of the patient should be sterilized. A single treatment usually eliminated the infection. However, application may be repeated after one week if necessary.

The following formulation diluted one parts to five parts of water is effective.

Benzyl benzoate -68 parts by weight, DDT-06 parts by weight, benzocaine – 12 parts by weight, Sorbitan monocleate – 14 parts by weight, HCH (Lindane) in coconut oil, Tetmosol (5% solution) and sulphur ointment are the effective sarcopticides.

#### SAQ 1.

Complete the following sentences by inserting appropriate words in the blanks.

(i)Cattle tick is responsible to transmit of
(ii)Fowl tick is responsible to transmit of
(iii)Itch disease is caused by
(iv)The hair follicle mite is

# 3.3 Beneficial and Harmful insect

The phylum Arthropoda constitute the dominant group of invertebrates. They are most widely distributed, most powerful and are useful as well as dangerous to mankind. The phylum arthropoda having class insecta which have large number of insects. Insect's attacks to man and other domestic animals by causing various diseases, destroy properties and crops. So insects are of great

importance to man. Some insect are beneficial to man but most of them are injurious directly or indirectly.

- **(A) Beneficial insects**: The insects not only provide us honey, silk, lac etc. but they are also beneficial to us by several other ways. These are as follows:
- (1)Commercial products: There are large no of insects are known that produce a variety of products that are used by human being. These products have good market value. These are as follows:
- (a) *Honey bee*: Some species of honey bee like *Apis mellifera, Apis cerana* produces million tons of honey every year. The honey is used by man for several purposes. From honey bee we also obtain bee wax from its comb, which are of great economic values. The honey as well as are utilized for various medicinal purpose. The honey bee brings about cross pollination of many fruits and flower.

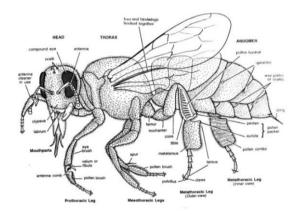


Fig3.11: Honey Bee Apis mellifera

**(b)** *Lac insects*: The lac is produce by *Tachardia lacca* or *Laccifer lacca*. The insect secrete lac in the form of protective covering by the integumentary glands of female. The lac is used in the manufacture of shellac. The lac is used by jewelers and goldsmiths in making gold ornaments like bracelets, armlets, and necklaces. It is also used in manufacturing of toys, buttons, pottery and artificial leather. It is also used as sealing wax.

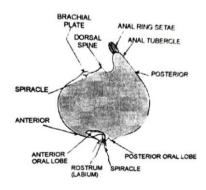


Fig3.12: Lac insect (adult female)

(c) Cochineal insects: The cochineal insect Dactylopius and Coccus cacti of Mexico are found on cacti. The dried bodies of females of this insect are used for making cochineal dye.

(d) Silk moth: The silk can be commonly obtained from different species of silk moth are Bombyx mori, Attacua ricinii, Antheraea assama and Antheraea paphia in different part of world. The larva of the silkworms spin cocoon of raw silk. The silk fiber is reeled off and used for making silk. The true silk fetches a good market value.



Fig3.13: Silk moth

**(e) Beetles:** The beetles *Lytta* and *Mylabris* are used for making cantharidine from their dried elytra. The cantharidine is a powerful aphrodisiac (a medicine of sexual drive).

**(f)** Gall insects: Gall insects are helpful in the manufacturing of tannin. The tannin is used in the process of tanning hides and in the manufacture of permanent durable inks.

(2) Insect as food: Insects are also used as food by human being and other animals. The insects have high nutritional value, rich in protein, higher content of vitamins and minerals which make an important supplement to the diet. In African children suffering from protein deficiency disease, is supplemented with insect as a source of protein. The grasshopper, termites, silkworm, migratory locusts, ants, caterpillars, diving beetles, cicadas and eggs of water boatman are frequently eaten in various parts of world.

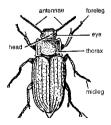


Fig3.14: Meal worm beetle

The large number of insect is also being eaten by animals. Many fresh water fish feed on a various insects like larvae of mayflies, stone flies, blood worms,

caddish flies, mosquito larvae, midge larvae and aquatic beetles larvae. The frogs, toads, lizards, few birds, bats, moles, shrews, pangolins, hedgehog etc. feed on variety of insects.

- (3) Medicinal values: The larvae of flies such as *Lucilla* and *Phormia* are used in healing such wounds of bones which do not respond to medicine, the larvae are put in wound of bones and bone marrow, they clear away suppurating and dead tissues prevent bacterial growth and excrete allontion which heals the wounds. The stings of honey bees have remedial value for disease such as rheumatism. Bee venom has also been used in the preparation of antivenom to counter act snake bite. Honey is also applied to cure ulcers. The bee wax is used as a base for ointments. The cochineal insects contain carminic acid, coccerin, myrestin, fat and fatty acids and are used in the treatment of neuralgia and whooping cough. Blowfly larvae are used in treating decay of tissues. Cantharidine oil obtained from blister beetle use as hair restorer. The body obtained from the coccons of silk moth *Bombyx mori* is used for checking profuse menstruation and in treating leucorrhoea and chronic diarrhoea.
- **(4) Scavengers:** Some insects are scavengers as they feed upon the waste material such as dead bodies and debris of plants and animals and they prevent decay and obnoxious odours. Some ants and larvae of some flies can devour entire animal carcasses. The silver fish (*Lepisma*), termites, housefly, blowfly, maggots, dung beetle, carrion beetles, fleas, cockroach and many larvae are very useful scavenger as it feeds on all kinds of debris and domestic refuses.

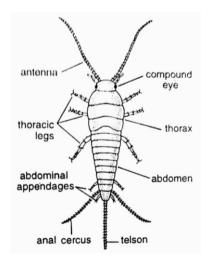


Fig3.15: Silver fish*Lepisma* 

(5) **Predators:** Some insects feed upon and destroy a large number of injurious insects and these are useful as predators. The larvae and adults of *Chilomenes*, a lady bird beetles feed on aphids which infect cotton plants. *Novius*, a lady bird beetle destroys scale worms, which are pest of orange and lemon trees. *Calasoma*, a ground beetle preys upon many kind of lepidopterus larvae, which

destroy cereals and cotton. The *Epicauta*, is a blister beetle, it deposit egg where locust occur, the larvae on hatching enter egg capsule of locusts and eat up masses of eggs. *Stagomantis*, is voracious feeder, it feeds on flies, grasshoppers and caterpillars, which are injurious to crops. Some other species have also been utilized in biological control of insect pest are *Chrysopa* species, *Chrysoperela* species, *Coccinella*, *Septempunctata* and *Cheilomenssexmaculata* are used against aphids. *Rodolia cardinalis* used against cotton cushion scale, *Episyrphus* species and *Syrphus* species are used against aphids.

- (6) Parasitoids: Some insect parasitize injurious insects. They usually lay eggs in the bodies of larvae and adults of harmful insects, upon hatching young come out from the eggs and finally kill their hosts. Chaloids and Icheumon flies are parasitic forms which lay eggs in cocoon and larvae of Phytophaguous lepidoptera. The larvae of Tachina and related flies are parasites of lepidopterus larvae such as army worms which are injurious to cereals. Certain hymenopterus larvae and carnivorous wasps feed upon aphids in large numbers. Some of the other parasitoids have been utilized in biological control of insect pest are Leptomastixdactylopii against citrus mealy bug and Planococcus citri, Encarsiapemiciosi and Aphytis diaspidis against san jose scale, Trichogramma brasiliensis against Pectinophora gossypiella and Helicoverpa armigera on cotton, Trichogramma embryophagum and Trichogramma cacoeciae against Cydia pomonella, Trichogrammaachaeae and Trichogramma chilonis against the cotton bollworm, Telenomus proditor against castor semilooper Achaea janata.
- (7) Music, art and ornamentation: Insect are also welcomed by people for their music, art and as the fine articles of ornamentation. Some poet such as Shelley, Dickens, Rinsky have written about insects in their poems. In Japan, cicadas and crickets are placed in small cages and their songs are liked by peoples. The beautifully decorated body and wings of butterflies and beetles gives good ornamentation.
- **(8)Pollination of flower:** The insects are great importance to agriculture as they are the pollinating agents of various plants. The honey bees, wasps, butterflies etc. are well known pollinating agents. The bees while visiting flowers to collect honey pollen and nectar transmit pollen from flower to flower and bring about pollination.

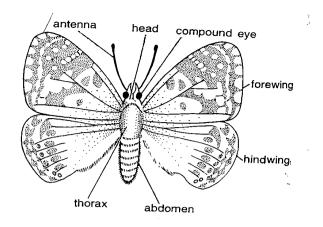


Fig3.16. Butterfly

**(9) Biological research:** Insects are also used in fundamental biological research. The *Drosophilia melanogaster* has been extensively used as a research tool in genetics.

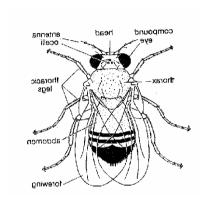


Fig3.17. Drosophila melanogaster

In bug *Rhodnius prolixus*, several experimental and developmental endocrine works has been carried out. Insects also have been used as the experimental animals in studies of behaviours, reaction of environmental factors, in testing the toxicity of insecticides etc. *Tribolium, Calliphora, Musca, Apis, Aedes, Phormia, Periplaneta* etc. are insects which are frequently used in these experiments. Insects are also used as indicators of soil and water pollution.

- **(B) Harmful insects:** There are large no of insects are known that causes great damage to mankind. They affect plants, fruits and stored grains. They also affect to human and domestic animals and thus causes serious diseases. These can be discussed as follow:
- **(i)** *Injurious to plant, fruit and grains:* Many insects attack leaves, stems, buds, flowers, seeds, fruits, barks, woods, roots, vegetables, stored products, wool, feathers, cigars, tools etc. They are mostly belonging to the Coeloptera, Diptera, Lepidoptera and Hemiptera. Each and every part of plants can be affected by various insect. Some are discussed below -

#### (a) Pest of paddy:

- (i) Rice bug or Rice Gandhi bug (*Leptocorisa varicornis*): It is mainly feed on paddy but has also been found feeding on millets, maize, bajra, jowar, rai, sugarcane and some grasses. It causes severe damage to paddy crop.
- (ii) Rice weevil (*Sitophilus oryzae*): The rice weevil is a serious pest of rice, maize, barley, jowar and sorghum. The larva is more destructive than adult.
- (iii) Rice moth (*Corcyra cephalonica*): The larva of rice moth is responsible for damaging grains of rice and maize.
- (iv) Paddy stem borer (*Scirpophaga incertulas*): Mainly pest on paddy but also found in millet, sugarcane, wheat and maize. The stem borer larvae tunneling in the stems and feed on the soft tissues causing injury to the paddy crop.
- (v) Rice striped borer (*Chilo suppressalis*): The main host is paddy but also found in pearl millet, sorghum, wheat etc. The larva is mainly responsible for damaging crops.
- (vi) Rice grasshopper (*Hieroglyphus banian*): The nymphs and adults of rice grasshopper eat up the growing shoots of rice plants and thus preventing the formation of grains.
- (vii) Rice hispa (*Diceladispa armigera*): Rice is the main host but in its absence it affects on sugarcane. The adults and larvae feed on the green portion of the leaves.
- (viii) Rice swarming caterpillar (*Spodoptera mauritia*): Rice are main host, others are sugarcane, cotton and grasses. The swarming caterpillar causes severe damage to the rice plants in nursery beds. The caterpillar move from one field to another field and it destroy whole crops.
- (ix) Indian rice leaf hopper (*Nephotettix*): The rice leaf hopper attack rice in a very large number and it feed the entire leaves.

## (b) Pest of wheat:

- (i) Wheat weevil (*Khapra* beetle): The larva of this beetle is responsible for the damage of wheat.
- (ii) Pink stem borer (*Sesamia inferens*): This stem borer attacks the cereal crops. It also attacks sugarcane, maize, jowar etc. The caterpillar after hatching bore into the stem and causes death of shoot.

#### (c) Pest of pulse:

- (i) Gram cutworm (*Agrotis ypsilon*): Gram cut worm damage gram, pea, potato, mustard, wheat, maize, ground nut. The adult damage the crops by cutting the stem either above or below the ground resulting in falling of the plant.
- (ii) Hubner (*Heliothis armigera*): It is important pest of gram and red gram. The pest feeds on young pods, foliage and seed resulting in reduction in yield of grams and red grams.
- (iii) Pulse beetle (*Callosobruchus chinensis*): It is a serious pest of stored gram and cowpea but also feeds on beans, lentil, arhar and other pulses.
- (iv) Mung dhora (Callosobruchus analis): It is a pest of mung, mash, peas and cowpeas.

## (d) Pest of cotton:

- (i) **Spotted bollworm** (*Earias vitella*): The main host is cotton but they also attack lady finger, okra and shoe flower. The caterpillar of this worm attack on flower, bud and boll of cotton and it completely damage the crops.
- (ii) Pink bollworm (*Pectinophora gossypiella*): Cotton is the main host. The caterpillar is the only infective stage which bores the flowers, buds, shoots and bolls of cotton.
- (iii) Red cotton bug (*Dysdercus cingulatus*): The bug sucks cell sap of green bolls of cotton and leaves. If the attack is severe, bolls open badly and the lint is of poor quality.
- (iv) Aphis: It is a serious cotton pest in India, the pest attack cotton plants in large number causing the plant to wilt and die.
- (v) Cotton boll weevil (*Anthonomous*): These are very injurious to cotton and destroy cotton ball.

#### (e) Pest of vegetable:

- (i) Potato tuber moth (*Phthorimaea operculella*): The potato tuber moth attack both in field as well as in storage. The caterpillars are responsible for the damage of crop.
- (ii) Potato cutworm (*Gnorimoschema*): It feeds on potato leaves and cuts off the stems, while the larvae eat the potato in the field and stores.
- (iii) Red pumpkin beetle (*Raphidopalpa foveicollis*): It feed cucurbitaceous vegetable i.e. pumpkin (*Cucurbita pepo*), tinda (*Citrullus vulgaris*), cucumber, melon etc.

- (iv) Cabbage butterfly (*Pieris brassicae*): They feed on cabbage cauliflower, turnip, sarson, toria, and other crops. Only the caterpillar causes irreparable damage to cabbage. They feed on the leaves of cabbage and cauliflower and thus destroy them.
- (v) Hadda beetles (*Epilacha*): Hadda feed on different solanaceous vegetable plants like brinjal, potato, tomato and bitter gourd.
- (vi) Brinjal shoot & fruit borer (Leucinodes orbonalis): It feed on brinjal.
- (vii) Melon fruit fly (*Dacus cucurbitae*): It is most destructive fruit fly of musk melon and pumpkins and also found damaging other cucurbitaceous vegetable like cucumber, torai, tomatoes and karela.
- (viii) Painted bug (Bagrada cruciferarum): It feed mustard, rapa and other cruciferous plant like cabbage, cauliflower and radish etc.
- (ix) Mustard sawfly (*Athalia proxima*): It feed mustard, cabbage, cauliflower, tori, turnip, radish and other cruciferous plant.

## (f) Pest of sugarcane:

- (i) Sugarcane leaf hopper (*Pyrilla perpusilla*): The nymphs and adults of sugarcane leaf hopper, suck the cell sap of succulent leaves of sugarcane by their rostrum.
- (ii) Sugarcane root borer (*Emmalocera depressella*): It is the major pest of sugarcane. This pest causes heavy damage to the young sugarcane. They feed voraciously on the stem below the soil surface.
- (iii) Sugarcane shoot borer (*Chilo infuscatellus*): The caterpillar of this shoot borer damage to sugarcane.

#### (g) Pest of fruits:

- (i) Mango leaf hopper (*Idiocerus atkinsoni*): They feed only on mango. The nymphs and adults both are destructive stages which suck the cell sap of young shoots, flowers, buds or entire inflorescence which dry and fall off.
- (ii) Lemon butterfly (*Papilio demolous*): These are only found in citrus. The caterpillars cause destruction of the citrus plants. They feed on the fresh leaves and terminal shoots.
- (iii) Banana weevil (*Cosmopolites sordiclus*): Banana is the only host of this pest. The weevils destroy the corm tissues and attack the seedling.
- (iv)Singhara beetles(Galerucella birmanica): Singhara is the only host of this pest. Beetles and grubs both are destructive stages which feed on leaves of singhara plant.

# (h) Pest of Tea:

(i) Tea mosquito bug (*Helopeltis atonii*): The main host is tea plant. The nymphs and bugs both are destructive stages which puncture the leaf to suck the juice from plant.

# (i) Pest of coffee:

- (i) Coffee shoot hole borer (*Xylosandrus compactus*): They feed on coffee plants. The adults and larva both causes infestation.
- (ii) Coffee stem borer (*Xylotrechus quadripes*): It fed on the stem of coffee. The larva causes infestation which bores into the coffee stem forming tunnels inside the shoot.

# (j) Pest of coconut:

(i) Rhinoceros beetle (*Oryctes rhinoceros*): It feed on coconut and date palm. The adult causes infection to the coconut tree.

# (k) Pest of Jute:

- (i) Jute semilooper (*Anomis sabulifera*): It feeds on the apical leaves and buds of jute. The caterpillar feed on the foliage.
- (2) <u>Injurious to man and domestic animals</u>: A large no of insects are known that causes disease in man and other domestic animals. It causes diseases but also acts as a vector and play a major role in transmitting disease from one host to another host.

# (a) House flies (Musca domestica):



Fig3.18. Musca domestica

Thehousefliesareveryannoyingtohumanandother animals. It carries a large no of diseasecausing typhoid fever, cholera, anthrax, tuberculosis, leprosy, diarrhoea and dysentery. It also acts as intermediate host for parasitic tapeworms or transmitting eggs of helminthes e.g. *Hymenolepis*, *Echinococcus* etc.

# (b) Mosquitoes:

The mosquito suck the blood of man and transmitting a number of diseases. The female of *Anopheles* act as a carrier of malarial parasite and causing malariain human being. *Culex* is a carrier of nematode *Wuchereria bancrofti* causes elephantiasis in man. *Aedes* transmit viruses causing dengue fever and yellow fever in human being. Thus mosquitoes are very dangerous for human health.

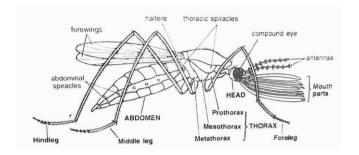


Fig3.19. Culex female

**(c) Sand flies:** The sand flies are blood sucking insect and only female fly suck the blood. The female fly act as vectors of several diseases like Kala-azar was transmitted by sand fly (*Phlebotomus argentipes*). Oroya fever, verruga fever and three day fever are also transmitted by sand flies.

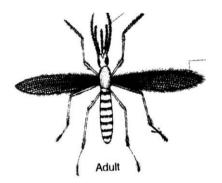


Fig3.20: Sand fly

- (d) Wasps (*Polistes herbraeus*): Wasps inflict the human beings by their sting and causes pain.
- **(e)Human louse** (*Pediculus humanus*): Human louse transmits several diseases such as relapsing fever, typhus fever, french fever. They suck the blood and causes annoying, itching and irritation.

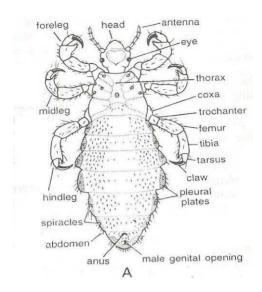


Fig3.21: Human louse (Pediculus humanus)

**(f) Bed bug (***Cimex***):** Bed bugs are blood sucking ecto-parasite. They feed human being at the time of sleeping. They bite by their piercing mouth parts causing itching and irritation. They are the carriers of numbers of diseases like Kala-azar, plague, typhoid etc.

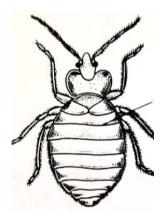


Fig3.22: Bed bug (Cimex)

- **(g) Fleas** (*Xynopsylla*): Transmit several diseases to human like bubonic plague and murine endemic typhus. The biting causes irritation and itchy skin lesions.
- **(h) Black flies (***Simulium* **sps):** Black flies suck blood of cattles. The flies attack orifices of the body entering the ears, nostrils etc. and their punctures produce an inflammatory fever.
- (i) Horse flies (*Tabanus*): The female of horse flies suck the blood of horse and cattle. The flies transmit anthrax, tularemia, and surra disease.

- (j) Warble fly (*Hypodema lineate*): Warble flies are the pest of cattle, sheep and goats. The larva lives in tissue of the hides of cattle and seriously affecting their health.
- (k) Screw worm fly (*Cochliomyia hominivorax*): The screw worm is a pest of cattle. They develop open wounds on their bodies as with dehorning, castration. The females oviposit on these wounds and developing larva feed directly on flesh and wound exudates.
- **(I)** Chicken louse (*Menopon*): The chicken louse suck blood and causes destruction of fowls.
- (m) Sheep tick (*Melophagus*): The sheep tick sucks the blood of their host and often causes haemorrhage.
- (n) Bot fly (*Gasterophilus*): Bot fly lays eggs on hair of horses and the larva enters the stomach in large number and causes disease.
- **(o)** Louse flies (*Hippobosca*): Louse flies are pest of cattle and dog. They suck blood of their hosts and often cause haemorrhage.
- (3) <u>House hold pests</u>: There are large no of pests are known that bring about damage of our stored food material, cloths, carpet, furniture, books etc. These are as follow:
- (a) Cockroach: The bread, chocolate, sugar, honey, fat, oil damped book, vegetable and potatoes etc. are polluted by cockroach. They are also responsible for transmitting of various diseases like typhoid, dysentery & tuberculosis.

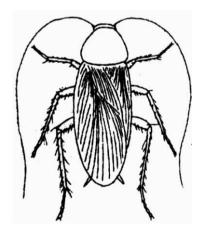


Fig3.23: Cockroach

**(b) Ants:** The several species of ant usually destroy sugar and sugary material. They also feed meat, butter, cheese and other protein food kept in kitchen.

- **(c) Furniture beetles** (*Anobium punctatum*): The furniture beetles usually destroy wooden materials which is used in constructing of house, furniture, packing boxes etc. The larva of these beetles bore into the solid wood and make tunnel, which completely damage the furniture.
- (d) Silver fish (*Lepisma saccharina*): The silver fish attack on starch containing food, clothes, rayon fabrics, binding of books. They also destroy old books and old manuscripts.
- **(e) Meal worm beetle** (*Tenebrio*): The larva of meal worm beetle eats meal, flour and stored grain such as rice.

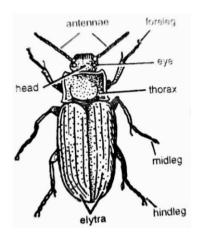


Fig3.24: Meal worm beetle

**(f)** Carpet beetle (*Anthrenus*): The carpet beetle is a scavenger eating decaying animalmatter but its larva destroy carpets and preserved biological specimens.

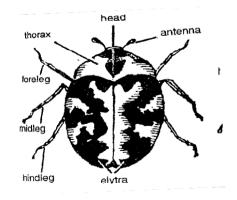


Fig3.25:Carpet Beetle

(g) Clothes moths (*Tinea, Tineola, Trichophaga*): The cloth moth lay their eggs on warm clothes, the larva on hatching eat and destroy clothes. They also feed on furs, carpets and dry fruits.

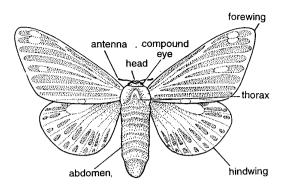


Fig3.26. Moth

- **(h) Book louse** (*Liposcellis transvallensis*): The book louse are pest of books. They bring about damage of old manuscripts.
- (i) White ants (Termite): The white ants damage to furniture and wood work of building, books, carpets etc. They make a tunnel in timber and completely consumed them.

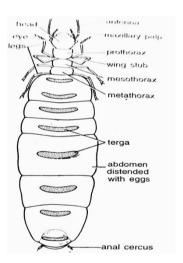


Fig3.27. Termites

(4) <u>Poisonous insect</u>: There are large number of insects and their larva which secretes poisonous substance which bring about diseases in men and domestic animals. The honey bees and wasps sting into human body to inject poison which cause local swelling and irritation.

# SAQ 2.

Complete the following sentences by inserting appropriate words in the blanks.

- (i) The honey is generally produced by -----.
- (ii)Lac is produced by -----

(iii) The caterpillars are responsible for the damage of potato crop
(iv)The pest feed on brinjal is
3.4 Summary
In this unit we have discussed general character of class arthopoda. We have also discussed about various types of ticks and mites found in different animals and human being and life cycle and zoonotic significance of it.
In second part we have discussed about beneficial and harmful insects. There are various insect which are very useful to us like honey bee, lac insects, silk insects, beetles, gall insects, insect used in research also. We have also discussed about insect which are very harmful to human, other animals and plants, they damage entire plant include leaf, stem, fruits etc. in a very detailed manner.
3.5 Terminal Question
Q1. Explain the life cycle of cattle tick.
Q2. Explain the damage caused by mange mite.
Q3. Explain the medicinal values of insects.

# 3.6 Answers

- **SAQ 1** (i) Boophilus annulatus
  - (ii)Spirochaeta anserina
  - (iii)Sarcoptes scabiei
  - (iv)Demodex folliculorum
- **SAQ** (i) Apis mellifera
  - (ii) Laccifer lacca
  - (iii)Phthorimaea operculella
  - (iv) Leucinodes orbonalis

Ans. 1 The life cycle of cattle tick includes four stages i.e. egg, larvae, nymph and adult. The adult male and female mating, After mating female lays eggs in the soil, cracks and crevices of building. A single female lays about 200 eggs in clusters. The eggs hatch into six legged larvae after 2 to 6 week. The larva are present in bushes and attach themselves to a host as cattle passes. These larvae start feeding blood meal and get molt into eight legged sexually immature nymph. The nymph again feed bloody meal from same infested cattle and molt to change in adult. Now again mating take place on the host's body (cattle) and adult drop to the soil surface to lay egg for another generation. The single life cycle needs about 60 days.

Ans. 2 The burrowing, especially the feeding of mites causes extreme itching which is the main symptom of the disease. The tunnels are parallel to the skin surface and can be observed as delicate grey thread lines beneath the skin, between fingers and toes, on external genitalia, behind knee and in prolonged cases, all over the body except the head. *Sarcoptes* mange causes different types of damage in different hosts *viz.*, on buffaloes and cattle in the perineal region and the neck, on horses in thin skinned area, on pigs around the eyes and ears, on camels in the groin, flanks, belly, legs, head, back and neck. The hard pin-headed pamples provided with yellow fluid are formed on the affected part which after scratching cause the formation of large sores and scabs. The entrance of venom and nervous strain caused due to the feeding of the mites depresses the host resulting into weakness.

Ans. 3 The larvae of flies such as *Lucilla* and *Phormia* are used in healing such wounds of bones which do not respond to medicine, the larvae are put in wound of bones and bone marrow, they clear away suppurating and dead tissues prevent bacterial growth and excrete allontion which heals the wounds. The stings of honey bees have remedial value for disease such as rheumatism.

Bee venom has also been used in the preparation of antivenom to counter act snake bite. Honey is also applied to cure ulcers. The bee wax is used as a base for ointments. The cochineal insects contain carminic acid, coccerin, myrestin, fat and fatty acids and are used in the treatment of neuralgia and whooping cough. Blowfly larvae are used in treating decay of tissues. Cantharidine oil obtained from blister beetle use as hair restorer. The body obtained from the coccons of silk moth *Bombyx mori* is used for checking profuse menstruation and in treating leucorrhoea and chronic diarrhoea.

UNIT 4. Plant and stored grain pest and role of insecticides in their control, Interrelationship of mosquito with Malaria, Yellow fever, Dengue, Encephalitis and Dermatobia, their presentation and control, Biological control of insect pests

4.1 Introduction

Objectives

- 4.2 Plant and stored grain pests and role of insecticides in their control
- 4.3 Interrelationship of mosquito with Malaria, Yellow fever, Dengue, Encephalitis and Dermatobia, their presentation and control
- 4.4 Biological control of insect pests
- 4.5 Summary
- 4.6 Terminal Question
- 4.7 Answers

# 4.1 Introduction

After the green revolution in 1970, India emerged in a new dimension where the production of high yielding varieties of various cereals like wheat, rice, maize etc. take place. These high yield varieties make huge production of cereals. The Food and Agriculture organization of United nation has estimated that one third of all food grown is lost to pests and diseases either from the growing crop in the field or in store after harvesting. This shows that losses from disease organism as well as pest, it may be safely claimed that at least half these losses are due to insects. In a world in which many people still go hungry, insects thus still claim more than their fair share.

# **Objectives**

After studying this unit you will be able to-

Discuss the life cycle, dawage, prevention and control of various insect
which damage plants and stored grain.
Discuss the prevention and control of healaria, yellow fever, dengue
encephalitis and dermatobia.
Explain the biological control of insect pests

# 4.2 Plant and stored grain pests and role of insecticides in their control

# Plant and stored grain pests

Insect pests can define as a large number of insect species that are adapted to feed over a variety of plants and animals ruthlessly causing a severe damage to our live are called as pests. The pest can damage to agriculture crops, domestic animals and public health. Some of the insects are like stored grain pest, house hold pest etc. Some of the pests are responsible for transmitting of vectors of pathogen in plants and animal population. The pest may be of serious, moderate depending upon its capacity to increase in number and a degree of destruction of a crop and economic loss. There are large number of insect pest are present which are responsible for the damaging of Plant and stored grain. These are described as follows

(1)Red pumpkin beetle (*Raphidopalpa foveicollis*): It is most destructive pest of all cucurbit vegetables. It is widely distributed in Asia, Africa, Australia and Southern Europe. In India it occurs in every state. The red pumpkin beetles are oblong, 5 - 8 mm breadth. The body of beetle is brilliant orange red coloured on the dorsal side while black on the abdomen. The abdominal region is covered with whitish soft hairs.

**Life cycle :** After mating female lays eggs singly or in batches in moist soil around the base of host plants. A single female laid 300 eggs. The eggs take 6-15 day of incubation period. From egg hatches dirty white coloured larva or grub. The larva or grub bores into the roots and stems and later into the leaves and fruits lying on the ground. They undergo 4 moult at intervals of 3-7 days. The mature larva enters the soil and pupates in a whitish, water proof earthen cell. The pupal period is 7-15 days. From pupa adult emerges. The life span of adult is 5 days. The adult hibernate in November and reappear by the end of April.

**Damage:** The damage is caused mainly by the adult beetles which feed extensively on the leaves, flowers and fruits making holes and causing death of the plant or retardation of growth. The leaves of young plants, when badly eaten, dry up. The grubs bore inside the roots and sometimes into the stem and fruits. The mature plant withers gradually if a number of grubs attack the roots.

#### **Prevention and control:**

(i) Field sanitation, clean cultivation,

- (ii)Collection and destruction of the beetles.
- (iii)Use of 5% aldrin into the soil against grubs.
- (iv)Dusting the foliage with 4% carbaryl or 1% lindane.
- (v)Spraying 0.05% malathion against the adult beetles.

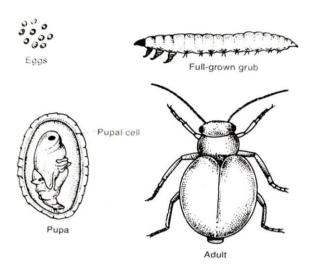


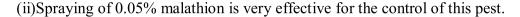
Fig4.1: Life cycle of Red pumpkin beetle (Raphidopalpa foveicollis)

(2) Lemon butterfly (*Papilio demoleus*): Lemon butterfly is a highly destructive pest of citrus in India. It is also found in Africa, Taiwan and Japan. In India it is disturbed all over the country. It is usually a minor pest of mature trees but is devastating in nurseries and on small trees. It is large size measuring about 2.8 cm in length and 9.4 cm on wing expansion. It has black coloured head and thorax regions, where as creamy yellow coloured abdomen. The wings are dull coloured with yellow marking on them. Antennae are black and club shaped.

**Life cycle:** After mating female lays eggs singly or in small groups of 2-3 on the under surface of leaves and shoots. Each female lays nearly 180 eggs in this life. The eggs are minute, spherical and white colour turning grey on maturity. The eggs take 3-6 days of incubation period. From egg hatches larva. The larva has five instars, the first three are brownish black with white patchesand the last two are greenish with brown and grey markings. The larva becomes full grown in 13-26 days. The larva undergoes to pupates on the plants. The pupa is yellowing green or brown colour and is 3 cm long. The pupation period is 7-24 days. From pupa adult emerges out.

**Damage :** Defoliation caused by the caterpillars to citrus plants is often serious. They feed on the leaves from the margin inwards to the midrib. Seedlings and young plants suffer the most.

(i) Hand picking of the caterpillar and pupae from small orchards in the initial stages of infestation and removing alternative host plants.



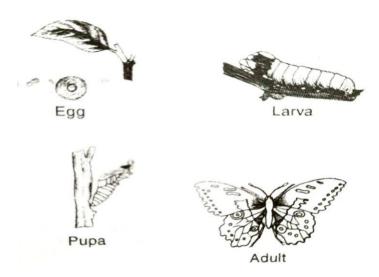


Fig4.2: Life cycle of Lemon butterfly (*Papilio demoleus*)

(3) Castor semilooper (*Achaea janata*): The castor semilooper is a serious pest of castor in the larval stage and is also a serious pest of citrus in the adult stage. In India it is found throughout the country. The adult is a greyish brown moth with way lines on the forewings and black and white blotches on the hind wings.

**Life cycle:** After mating female lays singly on tender shoots and leaves. The eggs are elongated and bluish green colour. The eggs take 3-4 day of incubation period. From egg hatches into larva. The larva feeds on the leaves of the castor plant and is full grown in about 2 weeks. The larva is white or green with a light brown posterior region. There are 4 instar larva, each taking 2-4 days. The full grown caterpillar is about 7 cm long and brownish black in colour with pale white stripes. The larva under go to pupates in soil or in leaf folds. The pupal period is 10 days. After pupal period moth emerges and feed on citrus fruits by piercing the skin and feeding on the juice.

**Damage :** The caterpillar is a voracious leaf- eater of castor, starting from the margins, eating inwards and leaving behind only the mid-ribs and the stalks. Maximum damage is caused by the second and third instar caterpillars, with the excessive loss of foliage, the seed yield is drastically reduced.

- (i)Collection and destruction of the larva.
- (ii)Dusting with 5% BHC.

(iii)Spraying with 0.05% endosulfan or 0.1% carbaryl.

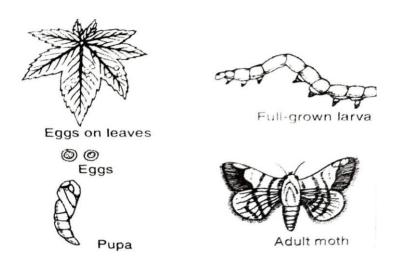


Fig4.3: Life cycle of castor semilooper (Achaea janata)

(4)Brinjalshoot and fruit borer (Leucinodes orbonalis): It is a serious pest of brinjal but sometime it also affect potato plants. It is distributed in South Africa, Germany, Malaysia, Srilanka and India. In India it is found nearly every state. This moth is of about 20 mm across spread wing. The wings of moth having small hairs along the apical and anal margins. There are pink brown patches over the dorsal surface of the forewing. The head and thorax are dark brown colour.

**Life cycle :** After mating female lays 150 - 250 eggs of white colour on the underside of leaves, buds, calyces of the fruits. The eggs may be laid single or in cluster of 2 - 4 eggs. After 3 - 6 days of incubation period, eggs are hatches into caterpillars or larva. The larva undergoes 5 stages of different instars. The larval period is 14 - 20 days. The first instar tiny caterpillar bores the petiole, tender stem or fruit or flower buds and entire larval development occurs inside the stem or the fruit. The fully grown caterpillar is pale white with violet spots arranged in linear fashion on the body. The fully grown caterpillar comes out of their feeding tunnel and pupate amongst the fallen leaves forming boat shaped cocoon. The pupal period is 7 - 11 days after which adult moth emerges out. The whole life cycle is completed in 20 - 43 days. The life span of moth is 2 - 5 days only.

**Damage:** The larvae are internal feeders of the stem causing shoots to bend down and wither. One fruit may be infested by large number of larvae. Sometime due to heavy infestation the whole crop is destroyed by the borers.

- (i)Removal and destruction of infested fruits and bended shoots.
- (ii)Cropping of tomato and potato by rotation.

(iii)Cropping of a variety with long tubular fruits in the place of that with spherical fruits.

(iv)Spraying with 0.1% carbaryl, quinalphos, endosulfan, chlorpyriphos at regular interval of 7-10 days.

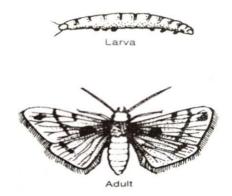


Fig4.4: Life cycle of Brinjal shoot and fruit borer (Leucinodes orbonalis)

(5)Paddy stem Borer (*Tryporyza incertulas*): It is a serious pest of paddy occurs during winter with heavy rains. It is cosmopolitan in distribution. In India it occurs in Bengal, Orissa, and Tamil Nadu etc. The paddy stem borer moth is 15 - 20 mm in length and has a wing. The female moth is bigger than male and it has black spot on each of the bright yellowish forewing. The male moth has pale whitish yellow coloured front wing without any spot.

**Life cycle:** After emergence of 3 to 4 days from pupa, the female moth fertilized and lays about 200 to 300 eggs. The eggs are laid on the underside of tender paddy leaves in cluster of 15 – 80 eggs and are covered with buff (yellow) coloured hair on the tip or upper surface of leaves. The eggs after 6 to 8 days of incubation period hatches into the tiny black headed caterpillars. The caterpillars, upon reaching the leaf sheath enter through the space between leaf blade and inner sheath and soon bore into the stem. The larval period is for 15 - 35 days, through which 6 stages of different instar larvae are forms. The full grown larva or caterpillar is 20 mm long, yellowish white and dark brown head. The larva pupates inside the attacked stem and remain for 5 - 12 day of pupal period. From pupa emerges out adult. The whole life cycle is about 38 - 55 days.

**Damage:** All instar of caterpillars are active internal feeders causing "deadhearts", white and empty ear-heads and chaffy grains formation. A paddy stem borer causes 80 - 95% loss of a crop during severe infestation.

- (i)Destruction of old stubbles.
- (ii)Ploughing of dry soil, to destroy the larvae in the stubbles.

- (iii)Removal of infested seedling from the nursery.
- (iv)Uprooting of dead-hearts.
- (v)Mass collection of adult moths by light or pheromone trap.
- (vi)Introduction of resistant variety of paddy.
- (vii)Spraying with any suitable insecticides 15 day after sowing at the interval of 3 weeks. Lindane (6% granules), carbaryl (4% granule), mixture of Lindane and carbaryl (4: 4) granules.

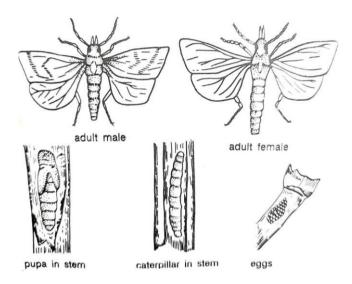


Fig4.5: Life cycle of Tryporyza incertulas

**(6)Rice Hispa** (*Dicladispa armigera*): It is a major pest of rice throughout in India. The pests become serious in hot and humid condition. The adult body is square shaped of about 0.5 mm long with bluish-black colour and spiny.

**Life cycle:** After mating fertilized female lays about 50 - 300 eggs within the internal tissues of leaf tip singly. The eggs after incubation period of 3 - 5 days hatches into larvae or grubs. The grubs mine the leaf. The larval period is 15 - 16 days, in which 6 different instar larva are forms. The larva undergoes pupation, takes place inside the larval mines within the leaf. The pupal period is for 3 - 6 days. After pupation adult hatches out. The total life cycle span is 15 to 25 days.

**Damage :** The rice Hispa attack at early growing stage of the crop. Grubsare the internal feeders of leaf and make fine galleries inside leaf miners and feed on mesophyll. Adult feed on green part of leaf. The infested leaves turn whitish and die showing white burn symptom. They causes 60 to 70 % loss of crop during severe attack.

- (i)Cutting and destroying the infected leaves.
- (ii)Clipping the leaf tips of seedlings to kill egg masses.
- (iii)Application of 0.05% methyl parathion, fenitrothion or endosulfan as sprays at early growing stage of the crop.



Fig4.6:Rice Hispa (Dicladispa armigera)

(7)Spotted green leafhopper (*Nephotettix virescens*): It is also pest of rice and others grasses. It is serious during September or October, where hot and humid conditions are occurring. The adult are small (5 mm) long, green with 2 black spots on the forewing of male jassids. The entire life of insect takes place on plants.

**Life cycle:** After mating female insert her ovipositor and lays 25 - 34 eggs in longitudinal rows in the parenchyma tissue of leaf. A single female lays nearly 100 - 300 eggs during her entire life. The eggs undergo incubation and hatches into nymph. There are 5 different nymphal instar larva are form. The nymphal period is of 13 - 21 days. The nymph change into adult. The adult life span is 1 month. The total life cycle is 47 - 57 days.

**Damage :** The nymphs and adults suck sap from green leaves due to which the leaves turn yellowish and later the entire plant is drying up losing their vigor and seedling die.

- (i)Spraying with 5% malathion or dusting with 5 10 % Benzene hexachloride.
- (ii) Mass collection and killing by light trap.
- (iii) By avoiding summer paddy cultivation.

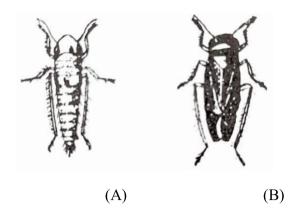


Fig4.7: Spotted green leafhopper (*Nephotettix virescens*) (A)Nymph (B) Adult

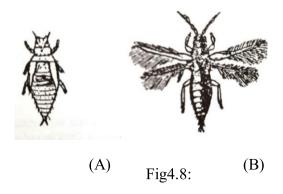
(8) Wheat thrips (Anapothrips flauicinctus): It is a pest of wheat but also attack sugarcane and other graminaceous plant. The pest is worldwide in distribution. It is a serious pest of wheat in Maharashtra and Gujarat. The low temperature favours pest incidence at early stages of the crop. The adults are minute, black, delicate 1 mm long insects with fringed wing and rasping sucking mouth parts.

**Life cycle :** After mating female lays 25 - 60 eggs in tissue of the tender leaves. The eggs take 6 - 13 days of incubation. The development occurs within the leaf sheath. From egg nymph hatches out. The nymphal instar larva is of 2 different types. The nymphal period is of 3 - 8 days. The nymphal is followed by prepupal instar. The prepupal period is 1 -3 days. The pupal period is 1 - 4 days. After the pupal period prepupal instar changes into adult.

**Damage**: The excess feeding of plant sap from the tender foliage causes curling of leaves and hamper growth. Brown patches or characteristic white streaks develop on the leaves.

# **Prevention and control:**

(i)Application of organochlorine or systemic organophosphates at interval of every 10 - 15 days after removing the leaf sheath.



Wheat thrips (Anapothrips flauicintus(A) Nymph (B) Adult

(9)Sugarcane stem Borer (*Chilo infuscatellus*): This is a serious pest of sugarcane but it also affect sorghum, maize, bajra and some other grasses. It causes serious damage during September to March, 20 - 40 percent of crop. It is commonly found in India, Burma, Afghanistan, Indonesia, and Taiwan etc. This moth is straw coloured, 30 -40mm in length and wing span of 3.5 cm in female and 2.6 cm in male. The larva and adult are nocturnal.

**Life cycle:** After mating female lays 10 - 35 scale like egg masses on lower surface of sugarcane leaves. A single moth lays nearly 300 - 400 eggs in her life span. The eggs after 4 - 5 day of incubation period hatches out into larvae called caterpillar. The caterpillar bore inside the shoot of sugarcane plant. The caterpillar feed voraciously and attain full grown of 3.8 mm long and 4 mm width. It has dull white, with brown red, longitudinal stripes on the trunk. It takes nearly 3 - 4 week for this. After caterpillar is fully grown, it under go pupation for pupate. After 5 to 7 days of pupal period, adult moth emerges from the pupae which come outside of the stem through a hole made earlier by the caterpillars. The life span of moth is about 2 - 4 days. The whole life cycle is completed in 35 - 45 days.

**Damage :**The caterpillar feeds on the leaves and later bores into the shoot from the ground level and move toward upward direction. It causes formation of dead hearts.

- (i)Removal and destruction of dead hearts.
- (ii) Collection of moths by light.
- (iii)10% BHC or heptachlor in the soil, spraying with 0.5% endosulfan, 5% malathion or 2% parathion.
- (iv)The pre-sowing treatment with lindane or chlordane causes heavy mortality of the pest.

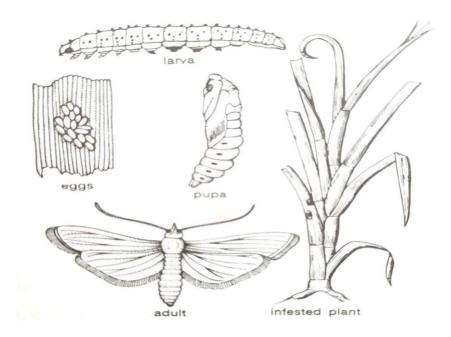


Fig4.9: Life cycle of Sugarcane stem Borer (Chilo infuscatellus)

(10)Sugarcane leaf hopper (*Pyrilla perpusilla*): The *Pyrilla* is the major pest of sugarcane but it also attacks maize, wheat, barley, bajra, oat, sorghum and grasses. It occurs in India and its neighboring countries. In India it causes a great loss in Uttar Pradesh, Madhya Pradesh and Maharashtra. *Pyrilla* adult is straw coloured, 8 - 10 mm in length. The head with a long beak like proboscis of about 20 mm long. It bear two pair of wings folded like a roof. The female bears a pair of anal tuft which help in up and downward active movement of the insect.

**Life cycle :** After mating female lays eggs. The 20 - 25 eggs are laid on the lower surface of the leaves during summer (April) and inside the leaf sheaths during winter (October &November) and the eggs are covered with cotton waxy filaments, secreted by anal tufts. Each female lays about 700 eggs. The eggs undergo incubation period of 8 - 10 days in summer but in winter it is longer. From eggs hatches out nymph. The nymphs are waxy white with a pair of anal waxy filament like processes and it starts sucking the cell sap of the leaves. The nymphal period is 45 - 60 day in summer and in winter it is prolonged. The nymph changes into adult. The adult life is 6 - 8 weeks for female and 4 - 6 weeks for the male.

**Damage :** Adults and nymphs suck the sap from the leaves of sugarcane, which become yellowish and dry. Plant growth is arrested and even the cane dry up. The infested leaves appear white in colour while the leaves below are black due to sooty mould growing on the honeydew excreted by the nymphs. The yield of canes, sugar recovery, and also quality of jaggery suffer badly. In severe attack it can damage up to 50% crops.

#### Prevention and control:

- (i)Collection and destruction of egg masses.
- (ii)Bagging of adult in nets.

perpusilla)

- (iii)Quantity of nitrogen should be maintained in soil.
- (iv)Spraying of dimecron, dimethoate, metasystox or carbaryl.
- (v)Resistant varieties of sugarcane should be taken.

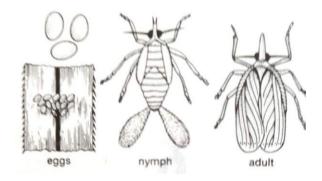


Fig4.10: Life cycle of Sugarcane leaf hopper (Pyrilla

(11)Pink bollworm (*Pectinophora gossypiella*): It is a pest of cotton but also found on maize, lady finger and other malvaceous plant. Cosmopolitan in distribution. It is nocturnal moths. The body is 1 cm long with 1.5 cm wing span. Body is dark brown with many black spots on forewings and fringed hind wings. It can survive for two years.

**Life cycle :** After 3 days of emergence female perform mating. The female lays about 100-400 pale yellow reddish colour eggs in cluster on underside of leaves, floral buds, bracts and bolls. The eggs take 4 to 6 day of incubation period sometime it extends up to 25 days. From egg 4 different types of instar larva are form. The first instar is creamy white with dark brown head but  $2^{nd}$  and  $3^{rd}$  instars are pink in colour. The full grown larvae are 1 cm long, white and with a double red band on upper part of each segment. The larval period is 8-41 days. The larva undergoes for pupation. It takes 6-20 days after that adult emerges out from cocoon.

**Damage :**Pink boll worm damage cotton by feeding inside the buds, opened flowers, young and developing bolls, mature bolls and seeds. The damaged buds and young bolls drop. The lint of the larger bolls is spoiled and the seed are destroyed. Ginning percentage, oil content and spinning qualities of the lint are impaired. Pink boll worm also initiates boll rot because the exit holes of larvae provide pathways for entry of bacteria and fungi.

#### **Prevention and control:**

- (i)Removal and destruction of fallen cotton boll, stubble, off season cotton sprouts etc.
- (ii)Uprooting of cotton stalk.
- (iii)Fumigation of cotton seed by methyl bromide or phostoxin.
- (iv)Seed heating up to 60 °C or sun heating.
- (v)Spraying with 0.2% carbaryl, 0.05% endosulfan, fenitrothion, phosalone.

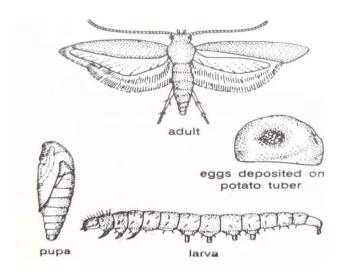


Fig4.11: Life cycle of Pink bollworm (Pectinophora

(12)Red cotton bug (*Dysdercus cingulatus*): It is also a pest of cotton but also attacks several members of malvaceae family. It is commonly occurs in India and Asia. The adult bug is 12 mm long and red in colour. The forewing with a black spot. Ventral side of abdomen with many transverse white bands.

**Life cycle :** After mating female lays 100 - 150 eggs under the soil of cotton field. The takes 4 - 7 day of incubation. From egg hatches into nymph. The nymph instar are of 6 types. The nymph takes 30 - 90 day and changes into adults. The nymphs are similar to adult but are small and wingless. The entire life cycle isof 40 - 100 days.

**Damage :**The nymphs and adults suck the plant sap from the leaves, shoots and bolls. They adversely affect the quality of ginning and oil content of the seeds.

## Prevention and control:

gossypiella)

- (i)Mass killing of the nymphs and adults by hand picking.
- (ii)Ploughing the field to destroy the eggs.

(iii)Spraying with sevin, heptachlor, methyl parathion.

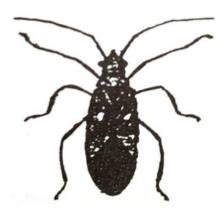


Fig4.12: Red cotton bug (*Dysdercus cingulatus*)

(13)Gram cut worm (Agrotis ypsilon): It is a serious pest of grams, peas, but it also affects potato, lentil, mustard, wheat, maize, sugarcane, groundnut, barley, cotton, brinjal and other vegetable also. It is cosmopolitan in distribution. Its body length is about 25 mm, dirty or black coloured having some grayish patches on the back and dark lines on the forewings. This moth has small prothorax, hairs on the underside of the femur and setae on the middle and hind tarsi.

**Life cycle:** The female moth after fertilization lays about 30 - 50 egg in cluster. The eggs are laid at night on the under surface of the leaves of the host plant, grasses or in the soil beneath the plant. A female lays about 1000 eggs during her entire life. The eggs take 4 - 7 days of incubation period. The eggs hatches into caterpillars. The caterpillar are dark coloured having greasy body and are nocturnal in habit and hide in soil, cracks or waste vegetation during day time. The larval period is of 4 - 6 weeks. The caterpillars are of 5 different type instars larva. The first instar caterpillars are the semi-loopers and get coiled at middle during crawling. The last instar larva undergoes pupation inside the soil cracks after preparing the earthen cocoon. The pupal period is 10 days in summer and 30 day in winter after which moth emerges out usually at night. The entire life cycle is completed in 48 - 77 days.

**Damage :** The young caterpillar cut the leaf branches or shoot either above or below the ground and destroy the crop heavily. They feed on foliage during night.

- (i)Clean cultivation
- (ii)Ploughing the soil and breaking the sods.

- (iii)Cultivation of heaps of green grass to trap the caterpillars and removing the grass regularly.
- (iv)Hand picking at large scale.
- (v)Spraying of carbaryl or endosulfan.
- (vi)Dusting with 5% heptachlor or chlordane.

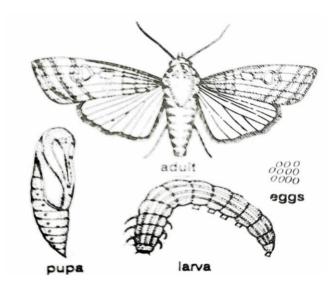


Fig4.13: Life cycle of Gram cut worm (Agrotis ypsilon)

(14)Rice weevil (*Sitophilus oryzae*): The *Sitophilus oryzae*are worldwide distribution. It is responsible for 50% damaging of stored grains. It is commonly found in stored grains such as rice, wheat, maize, jowar, barley, bajra etc. The adult feed upon whole seeds or flour, but their larvae feed only on seeds or piece of seeds or cereals products. Larvae are mainly responsible for the damage of stored grains.

**Life cycle :**The adults are reddish brown colour, 3 mm in length and bear 4 yellow spots on its back. The head is provided with well developed rostrum. Larvae are white coloured 5 mm in length and legless called grub. Female are larger than male. A female weevil bores with the help of rostrum or snout about 1mm deep hole in the seed and lays about 400 eggs. After 6 - 7 days of incubation of eggs, larvae hatches out. The larvae are legless grub and start feeding on the grains and pupate. The pupa after 6 - 14 days emerges into adult weevil. The life span of the adult weevil is 6 - 8 month to two years.

**Damage :**Generally infestation starts in grains only during storage, which may lead to heat spots in the grain. The grains are hollowed and weight is reduced. Adult which are winged are even known to fly from the godown to the fields in the vicinity where begin to infest the grain in the field.

#### Prevention and control:

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of infested grain with methyl bromide is also effective and kill all stages of the pest including eggs.

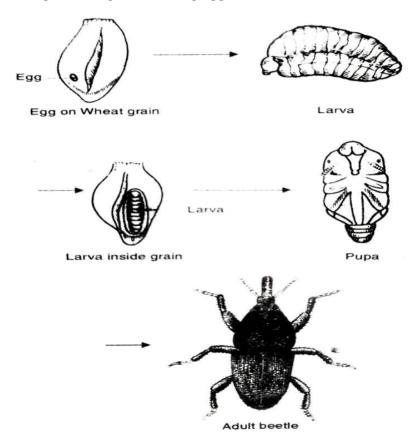


Fig4.14: Life cycle of Rice weevil (Sitophilus oryzae)

(15)Red flour beetles (*Tribolium castaneum*): *Tribolium castaneum* are cosmopolitan in distribution. These beetles are severely attack wheat flour, but flour of all starchy materials, peas, baking powder, nuts and many other food materials. Both adult and larvae are responsible for infesting and damage. The adult of *Tribolium castaneum* is reddish brown colour about 3 to 3.5 cm in length.

**Life cycle:** After fertilization female lays 1000 eggs in the flour or grains. After 4 - 7 days of incubation periods, the egg hatches into larvae which after 6 - 7 moulting in 22 to 25 days get changed into pupae and settle in the flour. The whole developmental period takes about 26 - 30 days under favourable conditions.

**Damage:** It feeds on powdered product produced by other pest after feeding the grains. Both adult and larvae are infective stages. The pests become serious in humid condition.

#### Prevention and control:

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of grains by HCN for 18 hrs in the closed godown. Other fumigants included ethylene dibromide, methyl bromide.
- (vi)Flour mills should be kept clean and dry.
- (vii)The adults or its other life stages should be removed from stores or godowns.

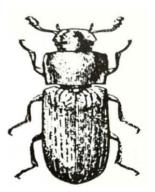


Fig4.15: Red flour beetles (*Tribolium castaneum*)

(16)Rice moth (*Corcyra cephalonica*): It is a major pest of rice but also feeds on gram, sorghum, maize, ground nut and cotton seed. It is generally found in Asia, Europe and North America. It causes serious damage of wheat.

**Life cycle:** Generally rice moth breed in warm season. The female moth lays 30 - 350 eggs. The incubation period is 2 days or 2 weeks. After that larvae hatches out from eggs. The larvae feed on the grains and attain full grown stage in about 30 - 35 days and pupate in the form of cocoon. The pupal stage is of about 4 - 35 days after which adult moth emerge. The whole life cycle takes place 5 - 6 weeks under favourable condition.

**Damage**: Damage is caused by the larvae which feed on the grains of rice and maize under silken webs. After sometime the entire stock may be converted into mere frass and useless for human consumption.

#### **Prevention and control:**

- (i)Seeds and grain should be sterilized before storage.
- (ii)Godown should be heated for 12 hrs at 135°C.
- (iii)Fumigation by carbon tetrachloride, carbon bisulphide and ethylene dibromide.
- (iv)Stores should be clean, dry and devoid of cracks.

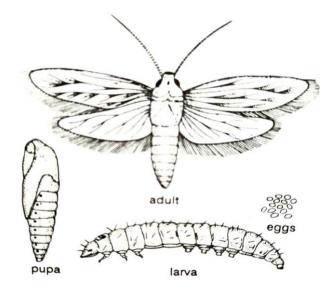


Fig4.16: Life cycle of Rice moth (*Corcyra cephalonica*)

(17) Wheat weevil or Khapra beetle (*Trogoderma granarium*): It is also a major pest of wheat in India and other countries like USA, England and Germany. It also attacks rice, maize, oat, jowar, barley, gram and pulses. The adult are dark brown coloured, 2 - 3 mm in length. The females are larger than males.

**Life cycle**: After emergence of 2 - 3 days of the adult, copulation take place and the fertilized female lays egg 13 - 85 in 1 - 7 days. The eggs undergo

incubation period of 3 - 5 day, after that larvae hatches out. The male hatches out after 20 - 30 days and female 24 - 40 days, after that they pupate. Pupation occurs within grain. After 4 - 6 days of pupation adult weevils emerge. The adult survive for a short period of 10 - 30 days. The adult cannot fly.

**Damage :** Only the larvae stage cause damage to wheat grains. The larvae feed on grains right from the superficial layer to the internal embryo and the grains become useless for germination.

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of grains by HCN for 18 hrs in the closed godown. Other fumigants included ethylene dibromide, methyl bromide.
- (vi)During severe infestation the adults and larvae can be trapped by spreading gunny bags over the grains resulting into clinging of the adults and larvae to the bags from which weevils should be collected and destroyed.

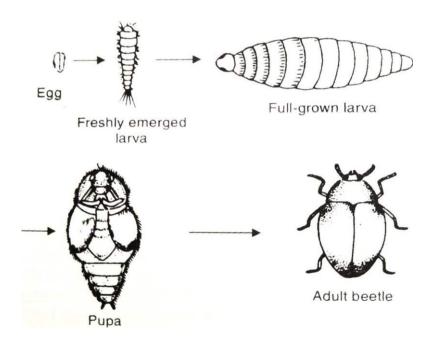


Fig4.17: Life cycle of Wheat weevil or Khapra beetle (*Trogoderma granarium*)

(18)Angoumois grain moth (*Sitotroga cerealella*): It is cosmopolitan in distribution. It is a serious pest of stored cereals (wheat), millets like maize, sorghum etc. The adult moth is grey-yellow or brown coloured, 10 to 12 mm in length with expanded wing.

**Life cycle:** The moth after 24 hours of emergence start mating and after fertilization female moth lays 150 egg and they deposit in cervices, crack and holes in the store house, on the grains. The eggs take 4 -8 days of incubation, after that larvae hatches out. The young larvae feed on seeds for about 3 weeks and get changes into pupae of reddish- brown colour which ultimately emerge into adult. The adult moth are buff coloured, small, wing are narrow and fringed hair. The whole life cycles take place in 28 - 37 days.

**Damage :** During rainy season maximum damage has been observed. Caterpillars bore the cereal grains. The infested grains are hollowed out and filled by excreta and webbing by the larvae.

#### **Prevention and control:**

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of grains by HCN for 18 hrs in the closed godown. Other fumigants included ethylene dibromide, methyl bromide.
- (vi)Spraying of chloropicrin on the closed bin gives excellent results.

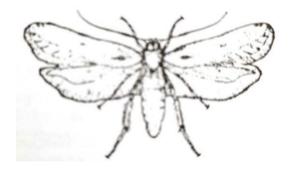


Fig4.18: Angoumois grain moth (Sitotroga cerealella)

(19)Fig Almond moth (*Cadra cautella*): It is cosmopolitan in distribution. It is commonly found in flour mills.

**Life cycle:** After mating female lays small white oval eggs are deposited in accumulated food stuff in cracks or crevices. After 4 - 6 days of incubation pinkish-white colour of larva hatches out. The larva lives inside the spinning tube for 25 - 50 days and pupate. The pupal period is 8 -14 days. After that it changes into adult. The adult life is 7 - 8 days. They do not eat grains but survive for breeding.

**Damage:** Caterpillars feed on food stuff, grains, flour. They form massive webs and clogging.

# Prevention and control:

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of grains by HCN for 18 hrs in the closed godown. Other fumigants included ethylene dibromide, methyl bromide.

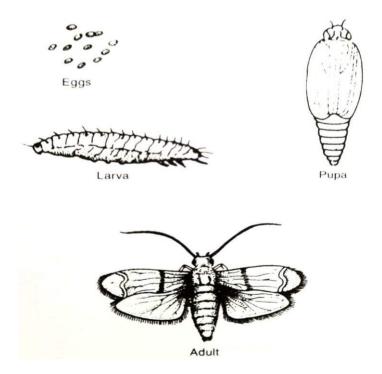


Fig4.19: Life cycle of Almond moth (*Cadra cautella*)

(20) Pulse beetle (*Callosobruchus chinensis*): It is commonly found in gram, cowpea, beans, lentil, arhar and other pulses. It is distributed in India, Burma,

China, Japan, Africa, USA. The adult beetle is reddish-brown in colour, 3 - 4 mm in length and provided with elongated serrated antennae.

**Life cycle :** After emergence male and female copulate and fertilized female lays eggs which are attached with the grains. A single female lays nearly 34 - 113 eggs. After incubation of 7 - 14 days eggs are hatched into larvae which bore into the grains and complete their development inside. The larva after 10 – 12 days changes into pupa. From pupa after 4 - 28 days emerges adult by cutting a circular hole in the seed coat. The life span of adult varies from 5 - 20 days.

**Damage:** The pest attacks leguminous pods in the field from where they are carried to storage godowns. The larvae bore into the pulses and grains and feed develop inside. The infestation in case of grains in early stages cannot be detected, since the hole through which the larva enters is very minute. The damaged grains are hollow inside, bearing small holes and are unfit for human consumption.

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of grains by HCN for 18 hrs in the closed godown.
- (vi)Two inch thick sand layer should be spread over the grains surface to check the egg laying.

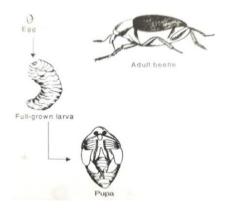


Fig4.20: life cycle of Pulse beetle (Callosobruchus chinensis)

(21)Potato tuber moth (*Gnorimoschema operculella*): Gnorimoschema operculella is a serious pest of potato and causes heavy loss. It also damage tobacco, tomato. The adult moth is dark brown coloured having a fringe of hairs at the posterior margin of the hind wing.

**Life cycle:** After emergence female moth gets fertilized and lays 80 oval eggs on the eyes of potato. The eggs hatches into caterpillars. The caterpillars feeding on the tuber get pupated after 10 - 15 days. The pupa is yellow brown 5.5 - 7 mm in length and emerges into the adult moth. The life cycle is completed in 25 - 35 days.

**Damage:** The larva of this moth voraciously feed on green tissues of tuber and thus make infection of bacterial and fungal diseases.

#### **Prevention and control:**

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of grains by HCN for 18 hrs in the closed godown.
- (vi)Potato tuber should be kept in treated with 1% DDT solution of xylene.
- (vii)Proper ventilation of godown will reduce the temperature and render it fit for storage.

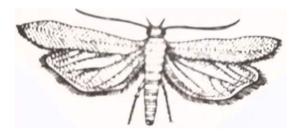


Fig4.21: Potato tuber moth (*Gnorimoschema operculella*)

**(22)Indian meal moth** (*Plodia interpunctella*): It is pest of grains, meal, seed, soybeans, dried fruits, nuts. It also damage in candy factories. Cosmopolitan in distribution. The size of adult moth is 13 - 20 mm with cone like beak.

**Life cycle:** The adult male and female copulate and fertilized female lays 30 - 350 eggs. The eggs takes 2 days to 2 weeks period of incubation. After

incubation hatches into larvae which feed on grains and other food materials. The larvae take 30 - 35 days to pupate into cocoon. The pupa after 4 - 35 days emerges into an adult moth.

**Damage :** The caterpillar of this moth causes severe damage to the grains or other food materials.

# Prevention and control:

- (i)Sun drying of the storing grains.
- (ii)Godowns should be clean, damp-proof and with heating arrangement. Before storing the grains, godowns to be heated to 150°F at least for 10 -12 hours.
- (iii)Grains can be mixed with dry neem leaves.
- (iv)Godowns should be sprayed with 0.4% BHC or DDT or 0.02% malathion before storage.
- (v)Fumigation of grains by HCN for 18 hrs in the closed godown.
- (vi)Stores should be clean, dry and free from cracks.
- (vii)Heat or cold treatment proves to be a very much effective control measure.

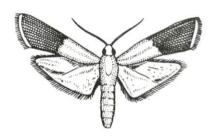


Fig4.22: Indian meal moth (Plodia interpunctella)

# Role of insecticides in their control

The insecticides are one of the pesticides specially prepared for killing the insects and their relatives with practically no harm on plants and animals. The insecticides used must have following properties.

- (i) It should be cheaper so that poor farmer can afford.
- (ii) Low dose make greater effect.
- (iii)It should not harm to human health, domestic animal and plants.
- (iv)It should be quickly degradable.
- (v) It should be easily available in the market.

(vi)It should not impart off flavour of food materials.

The insecticides can be classified into 3 types.

- (1) Contact Poison
- (2) Stomach Poison
- (3) Fumigants
- (1)Contact Poison: These are the chemicals which kill the insects by simply coming in contact with the body of insects. The contact poison kills the insects by clogging the spiracles or by penetrating into insect body. These are generally lipophilic so it readily absorbed by the liquid present in the epicuticle of exoskeleton. Nearly all the pesticides of plant origin are of contact poison. The contact poison can be classified by two ways.
- (i) Natural organic insecticides
- (ii)Synthetic organic insecticides
- **(i)***Natural organic insecticides*: These are derived from plants and animals. They are more commonly use because they have no toxic effect and are easily degradable. Some of the common natural organic insecticides are:
- (a) *Nicotine*: The nicotine ( $C_{10}$   $H_{14}$   $N_2$ ) is an alkaloid and is obtain from 2 species of tobacco *Nicotiana tobacum* and *Nicotiana rustica*. The nicotine alkaloid and nicotine sulphate is a highly toxic to many insect. It acts as nerve poison. It is absorb through body wall, tracheae or ingested by food. It is used against piercing and sucking type of insects and mites.
- **(b)** *Pyrethrum*: Its extract is derived from the flower of 3 species *Chrysanthemum cinerariaefolium*, *Chrysanthem coccineum*, *Chrysanthemum cameum*. The flowers of pyrethrum contain 4 compounds: Pyrethrins I & II and Cinerins I & II. Pyrethrum are formulated as dust, emulsions, solutions and aerosols. This chemical attacks the insect peripheral nervous system and has rapid knockdown.
- (c) Rotenone: Rotenone ( $C_{23}H_{22}O_6$ ) is found in the root of 68 species of leguminous plant. But two species *Derris* and *Lonchocarpus* are being used for the commercial production of rotenone. It is a metabolic inhibitor and is a broad spectrum contact and stomach poison that affects insect nerve and muscle cell, causing the insects to stop feeding and die after ingestion. It is effective against leaf eating caterpillars and beetles and applied as spray or dust. Due to its low mammalian toxicity, it is useful for the control of external parasites of live stock like lice's and fleas.

- (d) Azadirachtin: Azadirachtin (C<sub>35</sub>H<sub>44</sub>O<sub>6</sub>), a terpenoid, is a substance derived from neem (Azadirachta indica) plants and is highly toxic to insect pests. The terpenoid is present in all parts of the plant, in the living tissues especially in seed kernels. The azadirachtin interfere the metamorphosis of insects. As it enter into the body of larvae, the activity of moulting hormone ecdysone is suppressed and the larva fail to moult and it remain in larval stage and ultimately dies. Neem based insecticides can be used to control insect pest as cabbage loopers, Colorado potato beetle, mites, aphids, corn earworms, cut worms corn borers, flea beetles, fungus, grasshoppers, flies, leafhoppers, leaf miners, white flies etc. Azadirachtin is nontoxic to humans and animals and is biodegradable.
- **(e)** *Sabadilla*: It is derived from the seeds of lily, Sabadilla (*Schoenocaulon officinale*). It is alkaloids that affect the nerve cells of insects causing paralysis and ultimately death. It can be dusted in slow early in the morning when plant are wet with dew. If it is ingested or absorbed through the skin and mucous membrane of person, is highly toxic. It degrades rapidly in sunlight and air, leaving no harmful residue.
- **(f)** *Neristoxin*: Neristoxin is a substance derived from marine annelids, *Lumbrineris heteropoda* and *Lumbrineris brevicirra* have insecticidal properties. Neristoxin has a neurotoxic effect on insects. They are extremely expensive to produce and for this reason they are rarely used.
- (ii) Synthetic organic insecticides: These insecticides can be classified into 3 classes.
- (A)Chlorinated hydrocarbons
- (B)Organophosphate
- (D)Carbamates
- (A)Chlorinated hydrocarbons: These are the first widely used synthetic organic insecticides. They have carbon, hydrogen and chlorine as their basic constituents but some of them also contain oxygen and sulphur. These are DDT, Methoxy chlor, Lindane, Chlordane, Heptachlor, Dieldrin, Aldrin, Toxaphene, Kepone, Mirax. Many of these chemical have been banned from use because of their persistence in the environment and toxicity to non target organisms.
- (i) **DDT:** The dichloro diphenyl trichloro ethane (C<sub>14</sub>H<sub>9</sub>Cl<sub>15</sub>) is a white coloured amorphous waxy powder. It is primarily use to control lice, flies, mosquitoes, houseflies etc. It acts as contact or stomach poison to insects, affecting the sensory organs and nervous system and ultimately paralyzing and

death of insects. It has banned in agriculture all over the world because it is non biodegradable.

- (ii) Methoxy chlor: It is an analog of DDT and is white solid substance, soluble in common organic solvents and insoluble in water. It is less toxic to mammals and is not accumulated in fatty tissues or excreted in milk.
- (iii) Lindane: Lindane is odourless, volatile and was widely used as house hold furnigant. It is a nerve poison to insect.
- (iv) Chlordane: Chlordane ( $C_{10}H_6Cl_{13}$ ) is a dark amber viscous liquid. It is used against corn root worms, cutworms etc.
- (v) Heptachlor: Heptachlor ( $C_{10}H_5Cl_{17}$ ) is a derivative of chlordane. It is white crystalline solid and is more toxic to insect than chlordane.
- (vi) Aldrin: Aldrin ( $C_{12}H_8Cl_{16}$ ) is a white crystalline solid, insoluble in water and brown in colour. It is easily converted in plant and animal tissues as dieldrin and hence it shows the same toxic effects as dieldrin.
- (vii) Dieldrin: Dieldrin ( $C_{12}H_8Cl_{16}O$ ) is a epoxy of aldrin and is one of the most persistent chemicals. It is used in the situation where long lasting residual effect is advantageous.
- (viii) Toxaphene: Toxaphene ( $C_{10}H_{10}Cl_8$ ) is a chloroterpene and is used exclusively in agriculture. It is used against grasshopper, cotton insects and livestock pest. It can be formulated as wettable powder, emulsive concentrate and as a dust. It is not highly toxic to mammals and birds and they easily metabolized.
- **(B) Organophosphate:** These insecticides are derived from phosphoric acid. It mainly act as stomach or contact poison. But sometime act as poison and fumigants. It inhibits the activity of cholinesterase and hence the transmission of nerve impulse across the synapsis is affected. Due to these it leads to a death of insects. These are as follows:
- (i) Malathion: Malathion ( $C_{10}H_{19}O_6PS_2$ ) has been used for all types of agricultural insect pests and house hold insects. It has also been used for head, body and crab louse problems. It is formulated as dusts or sprays. It kills insects by contact or vapour action or stomach poison.
- (ii) Parathion: Parathion is a remarkably effective insecticide and is used in many countries to control many kinds of insects infesting various crops. It is not generally used to control insects that effect man and other animals because of extreme toxicity.

- (iii) Monocrotophos: Monocrotophos (C<sub>4</sub>H<sub>7</sub>Cl<sub>2</sub>O<sub>4</sub>P) is effectively used in vegetables.
- (iv) **Dichlorovos:** Dichlorovos (C<sub>4</sub>H<sub>7</sub>Cl<sub>2</sub>O<sub>4</sub>P) is a colourless liquid and is very volatile insecticide which gives rapid knockdown of house flies. It is also used on live stock to control flies.
- (v)Nephthalene: It is one of the older organic insecticides, which is obtained by the destructive distillation of coal. It has a fumigation action but its objectionable odour is not easily removed from the fabric.
- (vi)Methyl Parathion: It is a white crystalline compound and is less stable that parathion. It is toxic to domestic use. It uses only those crops where honey bees are not act as pollinator.
- (vii)Stirophos: It is less toxic and used for live stock parasites.
- (viii)Famphur: Famphur is used against cattle grubs but should not be used on lactating dairy cattle. These insecticides are simply poured over the animal body and are absorbed through the skin.
- (ix)Fonophos: Fonophos is used against soil insect both in field and vegetable crops.
- (x)Diazinon: Diazinon ( $C_{12}H_{21}N_2O_3PS$ ) is moderately safe and hence useful for house hold and garden sprays. It is formulated as wettable powder and emulsive concentrate.
- (xi)Chlorpyriphos: Chlorpyriphos ( $C_9H_{11}C_{13}NO_3PS$ ) is most useful insecticides. It is a stomach and contact poison. It is less toxic to animals and hence it is safely to apply. It is effective against cockroach, termites and other house hold insect pests.
- (xii)Methidathion: Methidathion use on field, forage, fruits, and nut crops against a variety of insect and mite pest.
- **(C) Carbamates:** Carbamates are derivatives of carbamic acid and dithiocarbamic acid. The carbamate esters inhibit acetylcholinesterase in insects and mammals. The carbamates tend to break down rapidly once applied, leaving no harmful residues. The carbamates are as follows:
- (i)Carbaryl: Carbaryl ( $C_{12}H_{11}NO_2$ ) has low toxicity to humans and hence therefore is a common insecticide for use against house hold pests. It is widely used on fruit trees, vegetables and cotton insects but should not be sprayed on the crops at the flowering stage as it also kills the pollinator insect.

- (ii)Carbofuran: Carbofuran ( $C_{12}H_{15}NO_3$ ) is widely used as a soil insecticide for suppression of nematodes, corn, root worms and other soil insect pest. It is highly toxic to human beings.
- (iii)Propoxur: Propoxur ( $C_{11}H_{15}NO_3$ ) is used against cockroach, sand flies, chinch bugs and adult mosquitoes.
- (iv)Aldicarb: Aldicarb ( $C_7H_{14}N_2O_3S$ ) is a systemic insecticide, nematicide and acaricide. It is highly toxic and formulated as 10% granules. Aldcarb is used to control the insect pest of potato.
- (v)Methomyl: Methomyl ( $C_5H_{10}N_2O_3S$ ) is effective against sucking insects and caterpillars such as cabbage looper and diamond back moth.
- (2) Stomach poison: These poisons are mixed with food material which on ingestion causes death of insects. The stomach poisons are commonly applied to those insects having chewing type of mouth parts. They are also applied to insect having sponging, siphoning, and lapping types of mouth parts. The food material of insects are spread with insecticide or insecticides mixed which food and an attractant, the other way is the insecticide are sprinkle on the runways of pests where poison is picked up by feet or antennae and while cleaning these parts with mouth, pests ingests the poison and die due to poisoning through the digestive system. The stomach poisons are applied by dusts, sprays, dips or baits etc.

The stomach poisons like arsenicals and boric acid are widely used for insects. The arsenicals are ideal stomach poison they leave residues upon the treated surfaces that may be fatal to humans and other animals. Arsenicals include arsenites and arsenates. The arsenites are highly toxic to insect and are used as bait e.g. sodium arsenite, Paris green. The Paris green [Cu (C<sub>2</sub>H<sub>3</sub>O<sub>2</sub>)<sub>2</sub>. 3Cu (Aso<sub>2</sub>)<sub>2</sub>] are used against Colorado potato beetle. The arsenates are less toxic than arsenites. The arsenates are used as dust or as a spray. The Acid lead arsenate (PbHAsO<sub>4</sub>) is used to protect fruit trees, ornamental plants and forest against chewing insects.

(3) Fumigants: When the insecticides are in gaseous form and it is responsible for killing the insect are called as fumigants. The poisonous gas enter into body of insect through spiracles, circulate and being absorbed by body tissues resulting into death. The fumigants are generally applied to house hold insect, soil insect & seed which are placed in a close chamber. The fumigants must have high penetrating power so that it kill all the stages of insects, low cost, safety to human being & livestock some of the common fumigants are as follow:

- (i)Carbon bisulphide: Carbon bisulphide (CS<sub>2</sub>) is a colourless liquid with disagreeable odour. It is used to control household pests in godowns, clothes, dresses and wood borers. The suitable dose is 20 ppm air.
- (ii)Carbon tetrachloride (CCl<sub>4</sub>): It is also used as fumigant for killing pest. Carbon tetra chloride is highly toxic to mammal. It is usually mixed with ethylene dichloride to avoid danger from fire. The suitable does is 25 ppm.
- (iii)Chloropicrin ( $Cl_3CNO_2$ ): It is a tear gas and use as fumigants. It is mainly used to fumigate flour mills, grain elevators etc. It is not explosive and not inflammable. The suitable dose is 1-3 lbs / 1000 cu.ft of chloropicrin is use.
- (iv)Nicotine: Nicotine ( $C_{10}H_{14}N_2$ ) is also used as fumigants. It is safe for plants and human being.
- (v)Phosphine: Phosphine (PH<sub>3</sub>) is used to fumigate flour, grain and cereals in godown. It is highly toxic to all stages of insects. It is sold in market in the form of tablets of aluminium phosphide and ammonium carbonate.
- (vi)Methyl Bromide: Methyl Bromide (CH<sub>3</sub>Br) is highly volatile fumigants. It is very effective against insects and mites. It is used in mills, granaries and warehouses.

# SAQ 1.

Complete the following sentences by inserting appropriate words in the blanks.

- (i)Pink boll worm is one of the most destructive pests of -----
- (ii)----- is a serious pest of sugar cane all over India.
- (iii) Red pumpkin beetle is a most destructive pest of -----
- (iv)Leucinodes orbonalis is the most destructive pest of -----

# 4.3 Interrelationship of mosquito with Malaria, Yellow fever, Dengue, Encephalitis and Dermatobia, their presentation and control

#### **MALARIA**

Malaria is a very important parasitic disease. It is of serious public health importance. Though it has been eradicated to some extend in certain parts of the world, it still prevails in some remote place and interior villages. It is a wide spread disease. At least 2.5 million people all over the world are affected.

Africa is the worst affected country and at least 20 million people get affected every year. Malaria disease claims importance from time immemorial. Chills, intermittent fever and shivering were symptom of this disease. In olden days Romans and Greeks could connect the prevalence of this disease to stagnant water and measures were taken to control the disease by going in for effective drainage. The name malaria was given to this disease in 18<sup>th</sup> century in Italy. Later in late 19<sup>th</sup> century, the causative agent for malaria was discovered by Lavern (1886). The three species *Plasmodium vivax*, *Plasmodium malariae* and *Plasmodium falciparum* were reported to infect man and were described between 1889 and 1890 in Italy. In 1922 *Plasmodium ovale* was identified.

The transmission of disease was established in 1897 by Ronald Ross. He studied the life cycle in detail in mosquito. This has enabled to control and eradicate the disease. The female *Anopheles* mosquito is responsible for transmission of this disease to human beings. Though male feeds on fruit, female requires blood meal and two blood meals are required to lay the eggs.

Life cycle of Malaria: Itinvolves two stages asexual life cycle (Schizogony) in humans and sexual life cycle (sporogony) in female Anopheles mosquito. Schizogony takes place in two locations, in the red blood cells (erythrocytic cycle) and in the liver cell (exo-erythrocytic cycle) which is a very important step before the parasite can invade erythrocytes. It is called pre-erythrocytic schizogony. The products of schizogony are merozoites.

The sexual phase takes place in the female Anopheles mosquito even though the sexual forms of the parasites originate in human red blood cells. Maturation and fertilization take place in the mosquito giving rise to a large number of sporozoites. So this multiplication stage is called sporogony.

So the life cycle of malaria parasite involves alternation of generations i.e. asexual and sexual cycles occur alternately. This involves alternation of two hosts i.e. asexual phase being completed in humans and sexual phase in the mosquito. Mosquito forms the definitive host and man is the intermediate host.

When female infected mosquito bites a person, it gets infected. The sporozoites which are the infective stages of the parasites are stored in the salivary glands of the mosquito. When mosquito sucks the blood these sporozoites are injected into the blood capillaries with its proboscis. The sporozoites get into the blood stream where some of them are destroyed by phagocytes but some of them reaches the liver and enter the hepatocytes cell and enter into exo-erythrocytic stage.

**Exo-erythrocytic stage:** After one hour of injection of sporozoites by the mosquito, the sporozoites reaches the liver and enter the hepatocytes cell. The sporozoites are spindle shaped elongated bodies which very soon assume a round shaped inside the liver cell. They grow in size and undergo repeated

nuclear divisions. Each daughter nucleus is surrounded by a bit of cytoplasm pre-erythrocytic schizont. With the growth of the schizont, the hepatocytes become distended and the nucleus is pushed to a side towards the periphery. There is no pigment in the liver schizont. In a fortnight, the schizont matures and bursts releasing thousands of merozoites which enter the blood stream and infect the erythrocytes by a process of invagination.

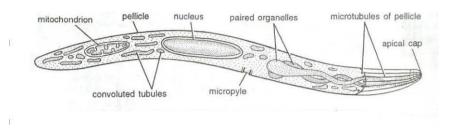


Fig4.23. Plasmodium structure of sporozoite

Erythrocytic stage: The merozoites after release by the pre-erythrocytic schizont attack the blood cells. The merozoites are bean shaped measuring  $1.5\,\mu m$  in length. The merozoites take about 30 seconds for the entry into the red blood cells. Then merozoites rounds up and loses its organelles. Now it has round shape with a vacuole in the centre, the cytoplasm being pushed to the periphery with nucleus at one pole. This gives the appearance of a ring shaped to the parasite. At this stage it is called the signet ring stage.

The parasite starts feeding on haemoglobin of the erythrocytes it leaves a residue called malarial pigment. This pigment has iron, which accumulates in the body of the parasite as dark granules or haemozoin. As the parasite grows, these granules become prominent.

The ring form grows in size, assume irregular shape and shows amoeboid movements. This is amoeboid form. When the amoeboid form has reached a certain size, its nucleus starts dividing. The parasite within the erythrocytes is now called a trophozoite. The ring form is the early trophozoite and the amoeboid form is the later trophozoite.

As the nucleus start dividing the parasite within the erythrocyte is called the schizont. The schizont ruptures releasing merozoites into circulation. These merozoites invade fresh erythrocytes where they undergo same type of development. This cycle is repeated a number of times till the host develops immune response.

The duration of erythrocytic schizogony is about 48 hrs in *P vivax*, *P.falciparum* and *P.ovale* and 72 hrs in *P malariae*. The periodicity is termed as tertian quartant.

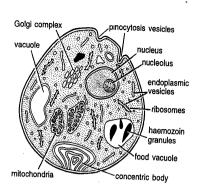


Fig4.24: Plasmodium: Ultrastructure of trophozoite in RBC under electron microscope

**Gametogony:** After a series of cycle of erythrocytic schizgony, some merozoites entering the RBC increase in size and become rounded. They are now called gametocytes. Development of gametocytes usually takes place within the internal organ like spleen or bone marrow. Mature gametocytes have a round shape. Some gametocytes are smaller in size and their nuclei are larger in size and these are known as micro-gametocytes or male gametocytes, where as other are larger in size but with smaller nuclei known as macro-gametocytes or female gametocytes. Macro-gametocytes are more in number than micro-gametocytes.

These gametocytes are incapable of causing any illness, they are important for transmission of the infection. These gametocytes do not undergo further development in the vertebrate host. They must be again introduced into the mosquito host or else they die.

**Life cycle in mosquito :** When a female Anopheles mosquito sucks the blood along with parasitized erythrocytes, asexual forms of malarial parasite are digested but the gametocytes are set free in the stomach of the mosquito. The macro-gametocytes divide into 5-8 nuclei from each of which protrudes a long actively motile whip like filament. These filaments are the male gametes or macro-gametes. They lash about for some time and then break. This is called exflagellation.

The macro-gametocytes do not divide but undergo a process of maturation to become the macrogamete. It is fertilized by one of the microgamete and this result in the formation of a zygote. This process takes place within 30 - 120 minutes after the blood meal. To start with, the zygote is non-motile round in shape, after which it elongates and within 24 hrs starts moving, assumes fusiform body fin with an apical complex anteriorly. This is called the ookiniete stage. This ookiniete penetrates the wall of the stomach and settle below the basement membrane. It assumes a round shape and measure 6 - 12  $\mu$ m in diameter. This stage is called oocyst. So the stomach of mosquito has hundreds of oocysts.

The Oocyst grow in size, and assumes a spherical shape measuring  $6-12~\mu m$  in diameter. The Oocyst matures and increases in size and the nucleus undergoes multiple divisions. This process is sporogony where within the oocyst, thousand of sporozoites are produced. Each sporozoites measures  $10-15~\mu m$  in length with centrally located nucleus and an internal apical complex. The oocyst ruptures and the sporozoites are released into the haemocoel. The sporozoites find their way into the salivary ducts. Now the mosquito is infective and when it sucks blood, the sporozoites are injected into the capillaries there by initiating human infection.

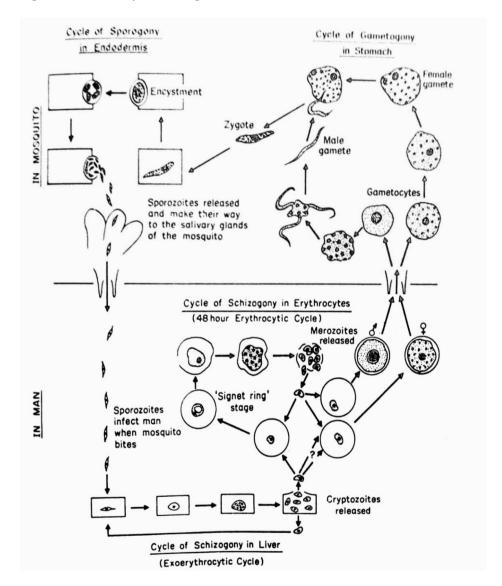


Fig4.25: Life cycle of Plasmodium vivax

**Pathogenicity**: Infection with *Plasmodium* causes intermittent fevers which are known as malaria. Each of 4 species causes a characteristic fever and the diseases are as follow:

Plasmodium vivax: Vivax malaria

Plasmodium ovale: Ovale malaria

Plasmodium malariae: Quartan malaria (Malariae malaria)

Plasmodium falciparum: Falciparum malaria (Black water fever)

## Malaria shows following symptoms:

- (i) Headache
- (ii) Shaking chillness
- (iii) Rise in body temperature as high as 106 °F at an interval of 48 hours.
- (iv) Muscular pain and ache in joints
- (v) Sweating
- (vi) Anaemia
- (vii) Constipation

#### Control of human Malaria:

Malaria can be control and prevented by applying following methods:

- (i) Chemotherapy Treatment and cure of the disease by medicine.
- (ii) Chemoprophylaxis Prevention of infection by medicine.
- (iii) Protection against adult mosquitoes
- (iv) Destruction of larvae of mosquitoes.
- (v) Removal of breeding place of mosquitoes.
- (vi) Use of natural enemies of mosquitoes

Malaria can be treated with the drugs like quinine, chloroquine, plasmoquine, camoquine, pamaquine etc.

#### YELLOW FEVER

Yellow fever was came into the existence in 17<sup>th</sup> century as "Yellow Jack" in pirates. It was initially found in Africa and was transported to Europe and America through trade. The most serious epidemics occurred in the western hemisphere i.e. Central America and the Caribbean. Since early in this century yellow fever has been largely confined to certain area of Africa and South & Central America. In the 19<sup>th</sup> century, yellow fever was claimed one of the most dangerous infectious disease.

Yellow fever is caused by RNA containing arbovirus is an acute haemorrhagic disease transmitted by the infected female "Aedesaegypti" mosquitoes. It was the Carolos Finlay of Cuba in 1881 was suggested that yellow fever was spread by "Aedes aegypti".

In 1900, the US Army, yellow fever commission, under Walfer Reed, confirmed this observation and demonstrated that *Aedes* mosquitoes were infected by feeding on human patients during the early viremic phase of the disease and become infective after an extrinsic incubation period of 12 days. In 1932 outbreaks of yellow fever occurred in Brazil in area devoid of *Aedes aegypti*. It was than recognized that the virus survives in another cycle i.e. the forest or sylvatic cycle, involving forest animals and mosquitoes.

The yellow fever virus was isolated in 1927 by inoculating rhesus monkeys with the blood of an African patient named Asibi.

**Symptoms:** Yellow fever begins after an incubation period of 3 to 6 days. In majority of cases a mild infection with loss of appetite, nausea, vomiting, headache, back pain, fever and chills are observed and infection lasts only 3 to 4 days. But in few cases (15%) infections enter in a second toxic phase with recurring fever which is accompanied by liver damage due to jaundice along with severe abdominal pain. Bleeding in the mouth, eyes and gastrointestinal tract cause vomiting of blood which is known as black vomit.

**Life cycle:** The epidemiology of yellow fever was clarified only after the recognition that the disease occurs in two distinct patterns.

In the urban cycle, the human beings serve both as the natural reservoir and as the definitive case, the virus being transmitted by the domestic *Aedes aegypti* mosquito. In the forest or sylvatic cycle, wild monkeys act as reservoirs and forest mosquitoes (*Haemagogus spegazzinii* in South America and *Aedes Africanus* and *Simpsoni* in Africa) as the vectors. Human cases occur only when human beings pass into the forest or when the monkeys raid villager near the forest.

The yellow fever virus is mainly transmitted through the bite of *Aedes aegypti*. The yellow fever virus is taken up by a female mosquito which sucks the blood of an infected person. Virus reaches the stomach of mosquito and infect epithelial cells and replicate there and further reaches haemocoel and then to salivary glands. When the female mosquito sucks the blood meal next in time, it discharges its saliva into the wound made by proboscis and thus the yellow virus reaches the bitten subjects.

**Prevention and control:** The control of urban yellow fever can be achieved by eradicating the vector mosquito as was shown in Cuba and Panama early in this century by Gorgas but this is obviously impracticable with the sylvatic disease.

Two very effective vaccines have been developed by human, use the French neurotropic vaccine (Darkar) produced from infected mouse brain was thermostable and administered by scarification and hence convenient for use under field conditions in the tropical areas. However the vaccine carries a high risk if producing encephalitis in the vaccine, especially in children. A safe and equally effective vaccine the 17D vaccine was developed by Theiler in 1937. For this work he was awarded Nobel Prize. Besides vaccination, a symptomatic treatment includes rehydration and pain relief with drugs like paracetamol. Some other things are also done to prevent are as follows:

- Destruction of mosquito and its larva
- Spraying insecticide like DDT around buildings.
- Constructing mosquito proof houses.
- Using mosquito net and applying mosquito to repellents (creams)
- Rearing biological enemies of mosquito and its larvae like larvivorous fishes *viz* sticklebacks, gambusia, trouts, minnow's, ducks etc.
- Sterilization of mosquito.

#### **DENGUE**

Dengue fever is an acute tropical frequently epidemic viral disease of human being which is caused by RNA containing dengue virus. It is transmitted by the biting of female tiger mosquito *Aedes aegypti* during day time. Dengue fever is also known as break bone fever. Dengue fever occurs intermittently in large epidemic is clinically similar to fever caused by chickengunya. There are four types of the dengue virus exist. Type 1 isolated from Hawaii in 1944. Type 2 from New Guinea in 1944 and Type 3 & 4 from the Philippines in 1956. Dengue has become a global problem since second war.

**Symptoms:** Typical symptoms include muscle joint pain, headache, Petehial rashes etc. but as it progresses to life threatening complications like dengue haemorrhagic fever and dengue shock syndrome, which cause organ dysfunction due to very low blood pressure. The course of infections is divided into 3 phases febrite, critical and recovery. The febrite phase involves high fever frequently over 40°C (104°F) and associate with generalized pain and a headache which usually lasts for 2 to 7 days. The critical phase it occurs follows the resolution of high fever and typically lasts for 1 to 2 days. During which significant fluid accumulation in the thoracic and abdominal cavity due to increased capillary permeability & leakage. Which leads to the depletion of fluid from circulation and decreased blood supply to vital organs as a result organ dysfunction and heavy bleeding especially from gastrointestinal passage may occur. The recovery phase occurs next with the resorption of leaked fluid

into the blood stream which occurs within 3 days and improvement in condition is clearly visualized but there may be acute itching and Bradycardia.

Dengue may occasionally affect several other systems of the body in which neurological disorders are significant.

**Life cycle:** The dengue fever is transmitted from person to person by the *Aedes aegypti* mosquitoes. No vertebrates hosts other than human being identified. There is however, some evidence that as in yellow fever dengue also may have a sylvatic cycle involving monkeys, squirrels and other forest animals.

Dengue is a commonly along the east coast of India and has frequently caused wide spread epidemic, sometimes along with the chickengunya virus. All four type of dengue virus has been isolated in this country. Occasionally, more than one type of the dengue virus has been isolated from the same patient.

A single mosquito bite may cause infection as a mosquito which takes a blood meal from an individual infected with the virus and about in 8 to 10 days the virus spreads to other tissues including salivary glands of mosquito and thereby released into its saliva.

**Prevention and control:** There in no specific treatment of dengue fever and treatment depends on symptoms as advice to have plenty of fluids such as oral rehydration solution or intravenous fluids. Acetaminophen is used for fever. There is no vaccine available for dengue.

#### **ENCEPHALITIS**

Encephalitis is a mosquito borne viral disease in human. There are five types of virus has been found causes encephalitis. They are named according to their geographic region found.

- **1.** *ILheus virus*: This virus occurs in South and Central America. It is maintained in forest by a cycle involving mosquitoes, wild birds and monkeys. Human infection is largely tends to febrile illness. This is rarely found.
- **2.** Saint Louis encephalitis viruses: This virus is found in North and Central America and is the most important mosquito borne disease in USA. It has caused several large epidemics in recent years. The range from mild febrile illness frank encephalitis and its causes fatality range is from 2 20%. The wild birds are act as the reservoir and *Culex tarsalis* is the vector.
- **3.** West Nile viruses: For the first time this virus was isolated in 1937 from the west Nile province of Uganda. Later it has also been reported from many other countries like African countries, Israel, Cyprus, France and India. It causes a dengue like illness in human being and encephalitis in horse. It is endemic in

Egypt, affecting mainly children. In Israel it causes epidemics, the virus is maintained in nature in wild birds by culex mosquitoes.

During 1980-81 in Karnataka encephalitis virus has been isolated from the brain of children suffering from encephalitis. It has also been isolated from culex mosquito. The West Nile virus may perhaps be contributing to sporadic and epidemic encephalitis in India.

**4.** *Japanese encephalitis virus*: This virus is found in Korea and Japan in the North to India and Malaysia in the south. This disease has been recognized in Japan since 1871 and was named Japanese-B encephalitis to distinguish it from encephalitis 'A' which was then prevalent.

The virus was first isolated in Japan during an epidemic in 1935. The *Culex tritaeniorhynchus*, a rural mosquito that breeds in rice field, is the principal vector.

**5.** Murray Valleys encephalitis virus: This virus is found in Australia and New Guinea. The virus was isolated during an epidemic of encephalitis in Murray River valley in 1951. The virus is believed to occur normally in as enzootic cycle involving wild birds and mosquitoes. The vector is *culex annulirostris*.

**Symptoms:** Among different encephalitis virus, the Japanese encephalitis virus causes the most serious disease. The disease has typically an abrupt onset with fever, headache and vomiting. After 1-6 days signs of encephalitis set in with rigidity, convulsions, altered sensorium and coma.

The fever is high and continuous. The neutrophils leucocytosis in the peripheral blood and pleocytosis with normal or raised sugar and a slightly raised protein in the cerebrospinal fluid. The mortality rate in some epidemic has been up to 50 %.

In India 1955, the Japanese encephalitis was first time recognized. The virus was isolated from mosquitoes of the *Culex vishnui* from vellore district during an outbreak of encephalitis in Tamil nadu and Andhra Pradesh is subsequent year also. This virus causes illness mainly in children, indicating the endemic nature of the virus. Most of the cases occur between October and November. Japanese encephalitis remained confined to the south eastern part of India till 1973, when it causes a large outbreak of encephalitis in West Bengal cases occurred mainly during June-October.

It is also found in Dibrugarh (Assam) in the east, Gorakhpur (U.P) in the North and Goa in the west. In the South, out breaks have occurred in Kolar in Karnataka, various areas in Andhra Pradesh and South Arcot in Tamil Nadu and Pondicherry.

**Life cycle:** The natural cycle of the virus has been worked out in detail in Japan. Herons act as reservoir hosts and pigs as amplifier hosts. Human infection is a tangential "dead end" event and occurs when the infected mosquitoes reach high density. The natural cycle in India also may be similar. Natural infection has been demonstrated in Ardeid birds (herons & eqrets) as well as birds to bird transmission through *Culex tritaeniorhynchus*, other bird such as ducks, pigeons and sparrow may also be involved vertebrate hosts may include cattle and buffaloes, besides pigs. The major *Culex tritaeniorhychus* has a predilection for cattle and bites them in preference to human begins or pigs. The high cattle pig ratio in the country has been suggested as a factor limiting human infection.

**Prevention and control**: Preventive measures include mosquitoes control and locating piggeries away from human dwellings. A formalin inactivated mouse brain vaccine being the Nakayama strain has been employed successfully for human immunization in Japan and in a small scale in India also. Two doses at two weeks, interval followed by a booster 6-12 months later constitute a full course. Immunity produced by the vaccine is short lived, vaccination of pigs has been proposed in view of their importance as amplifier hosts.

#### **DERMATOBIA**

Dermatobia or human bot fly or tropical warble fly is a parasite of humans, cattle's, cats, dogs, horses, sheep and other mammals. The larvae of dermatobia feed under the skin, causing often episodically painful, swollen, draining cutaneous lesion with a typical air pore. The fly is not known to transmit disease causing pathogens but the larvae of dermatobia will infest the skin of mammals and live out the larval stage in the subcutaneous layer causing painful pustules that secrete fluids. The infestation of any fly larvae inside the body is known as Myiasis. Dermatobia are endemic to the highlands of Central and South America. Their range extends from Southern Mexico to Northern Argentina. They are found typically in coffee growing highlands like highly moist and cool secondary forest.

The Adult of dermatobia are 12 - 18 mm in length are bluish in colour and resemble bumble bees. They have three ocelli and a pair of large compound eyes. The females are normally larger in size than males and bear a pseudovipostor at their posterior. The larvae or maggots are identified by the pyriform shape, the transverse rows of spines on their tegument, sclerotized mouth parts and the pair of projecting spiracles at the posterior end. They may reach 25 mm in length and 7 mm in diameter.

#### Life cycle

It reaches sexual maturity soon after emergence from the puparium and viable eggs may be laid as of the second day of adulthood. The eggs are transported

by over 40 species of mosquitoes, muscoid flies as well as one species of tick to the vertebrate host. The female capture the mosquitoes and glues her eggs on to one side of its abdomen using a water-in - soluble glue after which the mosquito is released without harmed. Being sensitive to a sudden rise in temperature. The eggs instantly hatch upon contact with the warm blooded body of a definitive host as the mosquitoes land on to it, usually to feed on blood. Either the egg hatch while the mosquito is feeding and the larvae use the mosquito bite area as they entry point or the eggs simply drop off the muscoid fly when it lands on the skin. The larvae develop inside the subcutaneous layer of skin. The eggs take 5-9 days to develop after which it requires an additional 27 – 128 days to pass through the three larval stages inside the definitive host. Normally about 12, 18 and 12 days are required for a larva to pass through the first, second and third instar respectively. At the end of the larval period, the third larval instar exits the definitive hosts body and drops on the soil after which it burrows deeply into the soil or other available debris and pupates within a period of 2-3 days. At the end of the pupation period which takes somewhere between 27 – 28 days depending on seasonal variation in soil temperature, the adult emerges and becomes a sexually active within two hours.

#### Clinical features

Myiasis is a diseases caused by the parasitic infestation of human body with dermatobia larvae. The larvae burrowing into the skin and maturing there, leading to an expansive nodules. The affected persons complain of a cyst or bump that is associated with a moving sensation. The lesion may grow over weeks or months but eventually to complete the life cycle, matured larva must exit the skin to become mature insects. Because the organism must have to respire, so the nodule is seen to have a central punctum or breathing hole.

#### **Diagnosis**

The diagnosis of myiasis is usually established by a travel history of outdoor exposure at the destination of interest and a clinical situation of a nodule or dermal abscess, often with a central punctum.

#### **Symptoms and Treatment**

Dermatobia larvae cause a raised lesion in the skin that becomes hard and sometimes painful. In some cases the patients can feel the larvae moving when they shower or cover the wound. The host reacts with elevated white cell counts and high amount of macrophages can be found around the wound. For this reason, the lesion often secretes pus.

There are several methods of treatment the most conventional way of removing the larvae is with a simple surgical procedure that includes local anesthesia. Using a scalpel to cut a slit to enlarge the wound, the larvae can be taken out.

Dermatobia survives in its host by breathing through spiracles that are flush with the skin. So if lesion skin can be covered with bacon, petroleum jelly, bee wax or any other thick substance that prevents the larvae from breathing. The larvae will come out of the lesion to breathing allowing it to be removed with forceps.

In some cases the larvae may be popped out by applying pressure around the wound.

The use of lidocaine injection underneath the cyst. This creates pressure that pushes the larvae out. After any of these procedures, antibiotics are given to prevent infection the wound should heal in one to two weeks with little or no scarring.

#### Prevention

Prevention of bot fly myiasis includes avoiding biting insects in an outdoor environment and the use of bed netting when sleeping outdoors. Prevention of tumbu fly myiasis includes ironing, clothing and sheets hung outdoors.

#### SAQ 2.

Complete the following sentences by inserting appropriate words in the blanks.

- (i)Malaria disease is caused by -----.
- (ii) Malaria disease is transmitted by -----
- (iii) Dengue fever is transmitted by ------
- (iv)Murray Valleys encephalitis virus is found in ------

# 4.4 Biological control of insect pests

It has been observed that huge amount of money is lost for controlling the population of insect by using different kinds of pesticides or insecticides. These inorganic & organic chemical not only have adverse effect to the environment but they also have adverse effect to the living organism including plants and animals also. So to solve the problem, biological control method play a very important role. In biological control insect pest can be controlled. By using biological organism like predatory insects, predatory vertebrates, parasites, and insect disease.

(i) Predatory insects: The predatory insects like Chilocorus nigritus attack on scale insects which attack coconut, tapioca. The lady bird beetle are very effective in controlling plant lice, white flies etc. which causes serious damage to crops. The coccinellid beetle Menochilus sexmaculatus are predatory of

aphids. There are some other predator insects like certain ants, robber flies, hover flies, lace wings play an effective role for controlling insects population.

(ii) Predatory vertebrates: The predatory vertebrate like fishes, insectivorous birds, frogs and reptiles play a significant role in managing the population of insects pests. The larval stages of mosquito and certain other harmful aquatic insects can be killed by introducing certain larvivorous fishes like Gambusia and birds like ducks in pond. Such animals will feed on them and thus help in eliminating the insects in the larval conditions. Amphibians like frog and toad, reptiles like lizards, harmless snake, and other insect eating mammals may be allowed to flourish round about as they feed on insects.

(iii) Parasite: There are many insects which are parasite on insect pests for example the Aphelinus mali is a parasite of Eriosoma lanigera, which is serious pest of apple. The Sponggossia bezziana is a parasite of Nephantisserinopa caterpillar, which is found in coconut garden. The parasite Spoggosia brings down the population of Nephantis caterpillar. The Nephantis serinopa is also a serious pest of coconut palm. The parasite Perisierola nephantidits is responsible to control the caterpillar population of Nephantis. The parasite Trichogramma is responsible for control of Pectinophora gossypiella pink boll worm. The Trichogramma australicum parasite on Chilo infuscatellus a sugarcane borer.

(iv) *Insect disease*: This is also one of the best methods for biological control. In this insect pests are attack by micro-organism like bacteria, virus, fungi, protozoa etc. which enter into the pest body or present on the surface of pest and causes a disease which result in death of pest.

The bacteria *Bacillus thuringiensiskurstaki* is responsible for control of many caterpillar pests like cabbage worm, horn worm, European corn borer, cut worms, diamond back moth, bagworms, gypsy moth caterpillar etc. The bacterial *Bacillus thuringiensis tenebrionis* are use against larvae of Colorado potato beetle and elm leaf beetle adult and larva. The *Bacillusthuringiensis aizawai* is used to control wax moth larvae in bee hives and various caterpillars.

The nuclear polyhedrosis viruses (NPV) and granulosis viruses (GV) are useful for control of *Helicoverpaarmigera* on pulses like chick pea and pigeon pea. The NPV is also available against *Spodoptera litura*, *Spilosoma oblique*, *Achaea janata* and *Amsacta albistriga*. The granulosis viruses (GV) are generally used against Lepidoptera pest.

The fungi are also responsible for control of pest. The fungi infect the insects by direct penetration of their body wall. The fungi *Trichodermaviridae*, *Trichoderma harizianum* and *Gliocladium* are very commonly used to control insect. The *Aschersonia goldiana* and *Aschersonia alevrodis* fungi live on the

body of white flies which attack citrus plant. The Verticillium lecanii fungi
found in green house aphids. The Entomorphthora grylli fungi live on
grasshoppers. The Beauveria bassiana live on castor semilooper and white grubs.

#### SAQ 3.

Complete the following sentences by inserting appropriate words in the blanks.

- (i) The lady bird beetle are very effective in controlling-----, ------
- (ii) Aphelinus mali is a parasite of -----
- (iii) Sponggossia bezziana is a parasite of -----
- (iv) The granulosis viruses (GV) are generally used against-----

# 4.5 Summary

In this unit we have discussed about life cycle, damage and prevention and control of various insect which damage plants and stored grain. We have also discussed about the role of various insecticides used to control the pest.

In other segments of this unit we have discussed about malaria, yellow fever, dengue, encephalitis and dermatobia their prevention and control in very detailed manner.

In last segment of this unit we have discussed about the biological control of insect pests in very detailed manner.

# 4.6 Terminal Question Q1. Explain the life cycle of Rice weevil.

Q2. Explain the life cycle of dengue fever.

Q3. E	Exp	lain the Preda	atory insect	s.	 	
4.7	A	nswers				
SAQ	1	(i) Cotton (ii) Pyrilla				

- **SAQ 2** (i) Plasmodium

(iv)Brinjal

(ii) female *Anopheles* mosquito

(iii) Curcurbit vegetables

- (iii) Aedes aegypti mosquitoes
- (iv) Australia and New Guinea
- **SAQ 3** (i) Plant lice, white flies
  - (i) Eriosoma lanigera
  - (ii) Nephantisserinopa caterpillar
  - (iv) Lepidoptera pest.

Ans 1. The adults are reddish brown colour, 3 mm in length and bear 4 yellow spots on its back. The head is provided with well developed rostrum. Larvae are white coloured 5 mm in length and legless called grub. Female are larger than male. A female weevil bores with the help of rostrum or snout about 1mm deep hole in the seed and lays about 400 eggs. After 6 - 7 days of incubation of eggs, larvae hatches out. The larvae are legless grub and start feeding on the grains and pupate. The pupa after 6 - 14 days emerges into adult weevil. The life span of the adult weevil is 6 - 8 month to two years.

Ans 2. The dengue fever is transmitted from person to person by the Aedes aegypti mosquitoes. No vertebrates hosts other than human being identified. There is however, some evidence that as in yellow fever dengue also may have a sylvatic cycle involving monkeys, squirrels and other forest animals.

Dengue is a commonly along the east coast of India and has frequently caused wide spread epidemic, sometimes along with the chickengunya virus. All four type of dengue virus has been isolated in this country. Occasionally, more than one type of the dengue virus has been isolated from the same patient.

A single mosquito bite may cause infection as a mosquito which takes a blood meal from an individual infected with the virus and about in 8 to 10 days the virus spreads to other tissues including salivary glands of mosquito and thereby released into its saliva.

Ans 3. The predatory insects like *Chilocorus nigritus* attack on scale insects which attack coconut, tapioca. The lady bird beetle are very effective in controlling plant lice, white flies etc. which causes serious damage to crops. The coccinellid beetle *Menochilus sexmaculatus* are predatory of aphids. There are some other predator insects like certain ants, robber flies, hover flies, lace wings play an effective role for controlling insects population.

# **Unit-5 Aquaculture**

#### Structure

- 5.1 Introduction Objectives
- 5.2 Basic concept of Aquaculture
  - Fish Culture
  - Prawn Fishery
  - Pearl Culture
- 5.3 Management and Economics of Aquaculture
- 5.4 Summary
- 5.5 Terminal Questions
- 5.6 Answers

### 5.1 Introduction

Aquaculture is the process of rearing, breeding and harvesting of aquatic species both animals and plants. It controlled aquatic environments, like the oceans, lakes, rivers, ponds and streams.

Particular kinds of aquaculture include fish forming, oyster farming. Pearl is of animal origin and obtain from pearl oyster belonging to phylum mollusca. Pearl is a white highly shining globular concretion, found within the shell of an oyster (a king of shell fish). It is also called as "moti" or Muktaphal. Pearl is of animal origin and is obtained from Pearl oyster, belonging to phylum mollusca. The old ancient Hindu believe, which still persists in common Indians is that the rain drops of "swati nakshatra" when fall inside the open mouth of pearl oyster become converted into pearl. But the actual nature and mode of formation of pearl inside the oyster has now been explained scientifically. Pearl culture which is not a very old venture, is restricted to certain parts of the world only. It includes the culture of oyster in restricted areas and after attaining a particular size and treated specially with the help of scientific equipments and appliances to produce pearl.

Fisheries and Aquaculture economics management covers all aspects on the economics of fisheries and aquaculture. It provides the prospect on current state of the global fishery and aquaculture and points out certain key feature of these production activities. It discuss key issues such as how to finance and plan new Particlular kinds of aquaculture include fish forming, oyster farming. Pearl is of animal origin and obtain from pearl oyster belonging to phylum mollusca mollusca. aquaculture business, how to monitor and evaluate economic performance, and how to manage labor and business risk.

# **Objectives**

	After studying this unit you will be able to known:
	☐ About it basic concept of aquaculture
	☐ Explain fish culture and pearl culture
	☐ Explain management and economics of aquaculture
<b>5.2</b>	Basic concept of Aquaculture

#### Fish Culture:

#### **Indian Food Fishes**

Some food fishes, especially the carps, are cultured in ponds or tanks or in special breeding grounds near the river banks. Fish farms are prepared for large scale fish farming. The fish farms are built of a chain of ponds or tanks fed by running water. It includes four types of tanks: hatchery, nursery, rearing tank and stocking tank.

- 1. Hatchery- It is a shallow pond  $10 \times 5$  to 8 ft and about 2 ft deep. The spawn (i.e. egg) and newly hatched larvae collected from puddles and potholes or rivers are kept here for about 18 to 24 hours.
- 2. Nursery tank- It is 50 ×30 ft deep and rectangular in shape which gets submerged during rainy season because of overflowing of river.
- 3. Rearing tank- It is  $50 \times 50 \times 10$  ft. The fish fry about an inch long is transferred to this tank and is kept for 4-6 months.
- **4. Stocking tank-** It is the main tank where young fish are stocked till ready for marketing. It is very large, covering about half and acre and 6' to 10' deep.

# Fish Breeding

<b>Breeding</b>	Pond:	First	step	in	the	fish	culture	is	the	breeding	of
fishes, there	fore for	prope	bree	din	g sp	ecial	types of	f pc	onds	are prepar	red
called as bre	eeding po	onds.									

**Types of breeding:** According to mode of breeding there are two categories (1) Natural breeding (Bundh breeding) (2) Induced breeding

**Natural:** The bundh are special type of perennial or seasonal ponds. Perennial ponds are often called as wet bundh, where as seasonal ones are called "dry bundh".

1. **Preparations of Tanks-** Tanks are drained and cleaned every year about 30 days before commencement of breeding season to remove unwanted weeds at aquatic animals. The tanks are then filled with clean water. Organic manure such as cowdung or dilute sewage water is added to this water to provide nutrients needed for the growth of plankton. The planktons are eaten by the fish.

Another alternative is to raise the rice crop and leave the straw of the plants in the ground. When steeped in water, the straw decomposes, aquatic vegetation springs up and algae growth occurs in abundance leading to the appearance protozoans, crustaceans, worms and snails.

2. Collection of spawn- The collection of eggs from breeding ground and allowing them to hatch in hatching pits, the hatching and fries may directly be collected from breeding ground by means of specially made frynets. In West Bangal and neighbouring areas a standard sized frynet called "Benchi Jal" is used.

The major carps, *Labeo, Catla, Cirrhina* etc. do not breed in confined water. These lay their eggs in shallow water of submerged lands adjoining the river sides.

The eggs and newly hatched larvae are collected every year from the natural breeding grounds along the river bank. These are stored in eathenware pots within 12 to 14 hours after the mother fish was spawned and marketed for sale. These are kept in hatchery for about 18-24 hours. After this the young larvae are transferred to the nursery tank, where these are kept for a short period. This is simply to look after the young and delicate larvae and protect them from larger fishes. In about a week the fry is transferred from here to the rearing tank, when it is about an inch long.

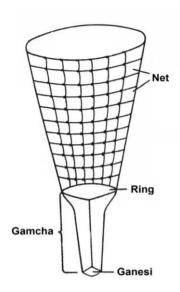


Fig 5.1. Benchi jal

In the rearing tank the fish fry is caught in a special small meshed net daily and is released. The main purpose of this practice is simply to condition the fry to overcome the shock of capture and transfer. In the rearing tank the fish fry is kept for 4-6 months. By that time it attains the size of one foot and becomes sturdy.

In the stocking tank the young fish are kept till these are ready for marketing. This pond is rich in food and allows a quick growth and a rapid increase in size.

# Maintenance of Stocking Tank

The stock ponds should be cleaned of weeds and predatory fishes. Sufficient food is essential for good growth of fishes in these ponds. Thus proper manuring is needed to increase the production of zooplankton. Cowdung is the best for proper organic manuring. It is used at the rate of 20,000 to 25,000kg/hectare/year. The inorganic fertilizers like superphosphate, ammonium nitrate and ammonium sulphate may be added at the rate of 1,000 to 15,000kg/hectare/year.

Groundnut, mustard, coconut, oil cakes, paddy and powered rice are commonly used as artificial food for the fishes. The artificial food should be cheap and easily digestible. The food quality should not be changed abruptly. The quantity of fertilizers used should depend on the fertility of soil, number of fishes and types of fishes present in the stocking ponds. The fishes should be harvested when they attain maximum length and weight.

# **Induced Breeding in Fishes**

Fish seeds are generally collected from natural breeding grounds in rivers. But such a collection is a mixture of economic, uneconomic and predatory fishes.

Keeping this in view, several techniques have been evolved to obtain fish seed by artificial methods. These include artificial fertilization and induced breeding.

In induced breeding, sexually mature fishes are induced to lay eggs in captitivity (in sepeial ponds or bunds) by hypophysation or by regulating external factors.

# **Methods of Induced Breeding in Fishes**

Based on the breeding habits, cultivated species of fishes are divided into two groups-

- (i) Pond breeding fish species.
- (ii) Fish species that do not breed in ponds.
- 1. Methods of induced breeding in pond breeding fishes— The pond breeding fishes are well adapted for laying eggs in maintained ponds. But to avoid wild and excessive spawning, the pond breeding species are segregated sex-wise and are induced to lay eggs by one of the following methods-
  - (i) A few selected brood fishes are introduced in specially maintained breeding ponds.
  - (ii) The ponds are introduced with fresh and well oxygenated water.
  - (iii) Pond water may be replaced with fresh rain water to induced spawning.
  - (iv) By providing suitable material for clinging the eggs.
  - (v) By regulation of physical factors (like temperature, light and population density etc.)
  - (vi) By injecting pituitary hormone.

**Induced pond breeding in India-** In India common carp, *Cyprinus carpio;* is induced to breed several times in a year in ponds, while its European counterpart breeds only once a year. Separate ponds are constructed for brood fishes for spawning and for hatching

Breeders are carefully selected, segregated sex-wise and fed with artificial food. These are introduced in the spawning ponds. Spawning ponds are hard bottomed. These are dried and then filled with oxygen-rich water. Freshly introduced oxygen rich water induces spawning. *Hydrilla* and *Naja* are also introduced in the ponds. Fishes breed within 10-12 hours after introduction and egg are transferred to hatching ponds.

Fishes like *Clarias batrachus*, *Heteropneustis fossil* and *Anabas testudineus* are also induced to breed in ponds.

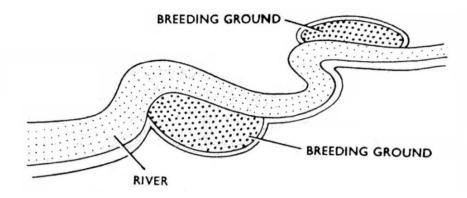


Fig 5.2. Spawning grounds and breeding grounds of carps in river.

- 2. Methods of induced breeding in fishes which do not breed in ponds- The most important cultivated species of edible fishes like Indian carps (*Labeo*, *Catla*, *cirrhina*), Chinese carps and a few commercial catfishes and brackish water fishes like mullets, milkfish etc. do not prefer to breed in ponds. Two methods are evolved for induced breeding in these forms-
  - 1. Breeding in bundhs.
  - 2. Breeding by hormones.
- (1) **Bundh breeding-** Bundhs are specilized types of ponds, where riverine conditions are provided for the breeding fishes. These are constructed in the middle of low lying area with proper embankments and where large quantities of rain water accumulates after heavy shower. Indian carps prefer to breed in running water of rivers during floods. Bundhs provide conditions similar to river after continuous heavy rains. Spawning is stimulated by heavy rains, water currents, temperature between 24 to 32°C and cloudy condition. Bundh breeding is being practiced in India in West Bengal, Bihar, U.P. and Madhya Pradesh.
- (2) Induced breeding by Hypophysation- The gonadotropic hormones FSH and LH secreted by anterior pituitary influence maturation of gonads and spawning. Induced breeding by hypophysation is being practised in Brazil, America, Russia and China. In India spawning was induced in *Cirrhina mrigala* by Khan (1938), in *Esomus danricus by* Chaudhari (1955) and in *Heteropneustis fossilis* and *Clarias bartachus* by Ramaswany and Sundararaj (1956). Now induced breeding is being practised in several carp species.

# **Process of Hypophysation**

Pituitary gland is taken out from healthy, fully mature and freshly killed fishes and preserved in absolute alcohol in sealed tubes in a desicator at room temperature or in acetone in sealed phails in refrigerator. The donor fish of the same species are most preferred for this purpose.

Just before injection, previously weighed glands are homogenized in distilled water or 0.3% saline. The suspension is centrifuged and supernatant is collected. It is injected intramuscularly on the back or base of the caudal fin or in the peritoneum at the base of pectoral fins.

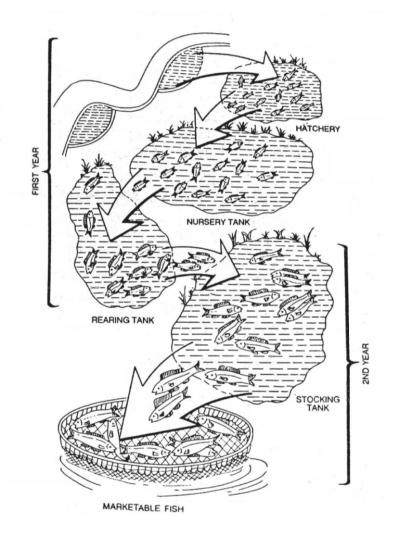


Fig 5.3. Plan of a fish form

# **Economic Importance of Fishes**

Fishes constitute an economically important group of vertebrates. These have influenced human life in various ways. These have constituted as an important source of wholesome food for man and his cattle from time immemorial. To date, this has developed into a flourishing fish industry and a means of earning

foreign exchange by exporting fish and fish products. In addition to serving as an important item of food, fishes provide several by products.

#### **Uses of Fishes**

- 1. **As food-** The fish are being used as food from the time of Palaeolithic man. These are consumed in almost all the countries of the world. The fish is eaten fresh, salted, smoked, prickled or canned. The fish diet provides proteins, fats and vitamins A and D.
- 2. Fish meal and fish cake- The scrap from canneries and the small fishes not relished as food by man, are dried and ground into fish meal. The fish meal is used as food for poultry, pigs and cattle. The fish are cooked in large pots containing water. The cooked fish are pressed to remove water and dried in the sun. The dried, sterilized product can be stored for a long time. These are called fish cakes. The fish meal contains about 60% protein and high percentage of calcium and phosphorous.
- **3. Fish manure-** Fish manure is prepared from those fishes which are not relished by man or when these are caught in a proportion more than can be consumed or if these are landed in spoiled condition. Such fish are sun-dried and then ground. The fish flour is used as manure that provides nitrogen, calcium and phosphorous.
- **4. Fish guano-** It is prepared from material left after extracting oil from fish body. It contains 8-9% nitrogen and phosphorous and is used as manure.
- **5. Fish oil-** A few groups of fishes yield fish oil. It can be body oil extracted from fish body or liver oil obtained form fish liver. Liver oil is rich in vitamin A and D, while body oil contains them in traces. The fish liver oil had medicinal use and is administered as source of vitamin A and D. Liver oil is prepared from the liver of sharks and rays, cods, halibuts and tunas. The liver is cut into small pieces and boiled in sufficient quantity of water. The oil contains 5-10% protein and vitamin A and D. This oil is used in poultry farming also.
  - The fish body oils are used in painting, varnishing, soap, candles and in leather and steel industries. For preparing body oils, the fish are boiled in water and oil is washed in boiling salt water. It is prepared from sardine, herring and salmon.
- **6. Fish flour-** This is actually fish manure but is comparatively fine and of better quality. It is used in preparing bread, biscuits, cakes and sweets by mixing with wheat or maize flour.
- 7. **Fish protein-** The fish protein is prepared by removing fats from fish flour. It is sold in the market as a white powder without any fishy smell.

- It contains 80-90% soluble proteins. This is used in the preparation of certain medicines and also for increasing the protein content of bread, ice-cream and cake.
- **8. Glue-** Liquid glue is prepared from the connective tissue of fish skin, fins and bones. The glue is used as an adhesive in book-binding, sticking labels, wood, leather, and glass and in the manufacturing of furniture.
- 9. **Isinglass-** The air bladder of certain fishes is used in the preparation of collagen of fine quality. It is in the form of shining white powder, used for cleaning wine, beer and making edible jelly. The air bladder is removed from fish, washed in cold water and is flattened by beating it on a piece of wood. It is dried and used in the preparation of isinglass.
- **10. Fish leather-** The thick skin of certain fishes like sharks and rays is utilized in the preparation of fish leather. This leather is used in the manufacture of purses, bags, ladies shoes, etc. Because of the presence of placoid scales, the skin of sharks and rays is rough and looks more beautiful.
- **11.Shagreen-** The rough skin of sharks is used in rubbing and polishing the furniture, is called shagreen.
- **12.Fish finse-** The fins of sharks are exported to China where these are greatly appreciated for preparing soups.
- 13. For manufacturing of artificial pearls— The materials obtained by scrapping the silvery coating of the scales of certain fishes is called guanine. It is used for polishing the hollow glass beads. These beads are then filled with wax and marketed as artificial pearls used in jewellery.
- **14. For sport and games-** Fishing forms an important outdoor game for millions of people, who catch various species of trouts, salmon carps and other species of fishes.
- **15. For decoration-** Several species of beautiful coloured fishes are kept in aquaria, ponds and lakes, and used for ornamentation. They are maintained by stockists who offer numerous varieties for this purpose, and earn their livelihood from this trade.
- **16. Biological control-** Several species of fishes are larvivorous in habit and feed upon insect larvae e.g. *Chela, Puntius, Berilius, Danio, Coliso, Rasbora, Esomas, Ambassis, etc.* Several diseases are spread by mosquitoes, hence the larvivorous fishes are introduced in the waters of the area. They feed upon larvae and help in reducing the population of mosquitoes.
- **17. Evolutionary significance-** The Choanichthyses or crossopterygian fishes are very important as these provide evidence for the evolution of tetrapods, the land vertebrates.

# **Fishing Industry**

One of the first things learnt by ancient people was the fish and fish eggs as food. Fish is eaten fresh, salted, smoked, pricked or canned. It constitutes a valuable and easily accessible source of food both for rich and poor. In addition their being a valuable source of food, a few groups of fishes yield oils rich in vitamins A and D. Fishes are also used in the production of glue, isinglass, fish-meals, fish-manure and other commercial products. The catching and rearing of fish in great quantities for sale and commercially important fishes are described as **commercial fishes**.

# **Prawn Fishery:**

Some aquatic crustaceans are among the fisheries of economics importance and constitute food for persons from various parts of the world. Prawns form highly nutritive diet and tasty food for human beings.

# **Prawn Species**

A number of species of prawn are found distributed in water resources and of different sizes. But only those prawns are of commercial value which are of good size and good taste; are available in plenty and are easily culturable.

The following species of Prawns are important from culture point of view-

- (i) Penaeus indicus and P. monodon.
- (ii) Metapenaeus affinis, M. dobsoni, M. monoceros.
- (iii) Parapenaeopsis sculptilis and P. stylifera.
- (iv) Palaemon fluminicola, P. styliferus, P. tenuipes.
- (v) Macrobrachium carcinus, M. idac, M. malcolmsoni, M. mirabilis.

# **Preservation and Processing of Prawns**

Prawns after fishing are taken to the market for local consumption as soon as possible by keeping them in ice layers. For the supply, prawns are frozen in different forms as given below for the purpose of export. The preservation of prawns is of following types-

- 1. Peeling and deveining
- 2. Cooking and peeling
- 3. Peeling, deveining or cooking
- 4. Headless (shellon).

#### 1. Peeling and deveining

The fresh water prawns are beheaded, peeled, deveined and washed thoroughly with water. After removal of shell parts and other tissues, the pulp is placed in freezing trays or in a waxed cardboard lined outside with polythene sheets. Now ice-water is added in the box containing prawns, kept in freezer at 30 to 40°F for about 3 to 4 hours. If prawns are frozen in trays the sticky hard matter obtained is dipped in ice water for glazing because glazing protects the frozen material from dehydration, oxidation etc. and is performed at 10 to 15°F. The slabs after glazing are wrapped in polythene sheets and packed into a waxed cardboard and stored in a frozent storage room at 10°F till shipped.

# 2. Cooking and peeling

In this method fished prawns are cooked in 7 to 10% boiling brine for about 2 to 3 minutes, then cooled in ice-cold water containing 3 to 5% salt. After cooling prawns are peeled and washed in 20ppm chlorinated water. The washed material is then placed in cardboard or trays, frozen and glazed with 50ppm chlorinated water.

# 3. Peeling, deveining or cooking

First of all the prawns are peeled, deveind and washed with water and cooked in 3% to 5% brine for about 3 to 5 minutes. After cooking they are cooled and placed in trays and processed for freezing as mentioned above.

# 4. Headless (shellon).

In this method of prawn preservation only the head of the prawns are removed and the rest of the body, covered with its shell is preserved. Now headless prawn is processed for freezing as in the case of peeled and deveined prawn.

At the time of prawn freezing only fresh prawns are taken and sufficient amount of ice is used under strict hygienic conditions.

# SAQ-1

- 1. Name to species of prawn....., ......
- 2. The fish farms are built of a chain of ponds or tanks fed by running water. It includes types of tanks: ....., ...... and stocking tank.

#### **Pearl Culture:**

# **Pearl producing Molluses**

The pearl oyster belongs to genus *Pinctada*, family pteriidae, class bivalvia and phylum mollusca. The important species producing good quality of pearl are *Pinctada vulgaris* (schumacher), *Pinctada margaritifera*, *Pinctada chemnitzi*,

Pinctada anamiodes (Reeve) and Pinctada atropurpurea (Dunker). All these species are marine and it is the marine forms which produce the pearl of fine quality P. Vulagris is a common oyster distributed in the gulf of Kutch, gulf of Mannar. Certain fresh- water forms of mussels belonging to the genera Unio and Anodonta also produce pearls but they are of inferior quality and hardly of any use.

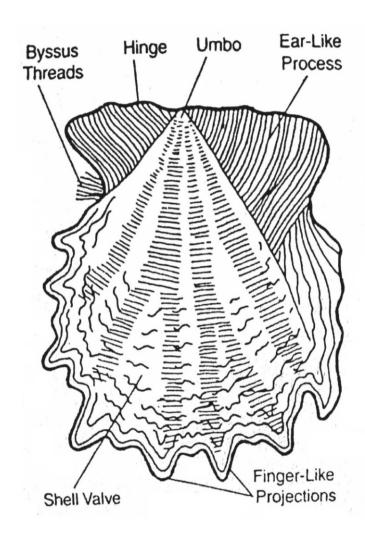


Fig 5.4. External features of Paerl oyster.

**Formation of Pearl.** Pearl is secreted by the mantle of the pearl oyster as a protection against foreign objects which may be sand particles, minute larval forms or other such things. The mode of formation of pearl it is essential to know the structure of the shell and mantle. Shell of pearl oyster is composed of three distinct layers. They are as follows:-

**Periostracum.** It is the outermost, greenish-brown, thin, translucent layer made up of an organic substance "Conchiolin". It is secreted by mantle. It

serves to protect the underlying layers from harmful effects of weak carbonic acid in water.

**Prismatic Layer.** It is the middle layer secreted by mantle. This layer is made up of minute crystals of calcium caerbonate, separated by thin layers of conchiolin. These crystals are arranged perpendicular to the shell surface. It gives strength and rigidity to the shell.

**Nacreous Layer.** It is inner most layer of the shell and is better known as "mother of pearl", because this layer is responsible for the formation of pearl. It consists of alternate layers of calcium carbonate and conchiolin, which lie parallel to the surface of the shell.

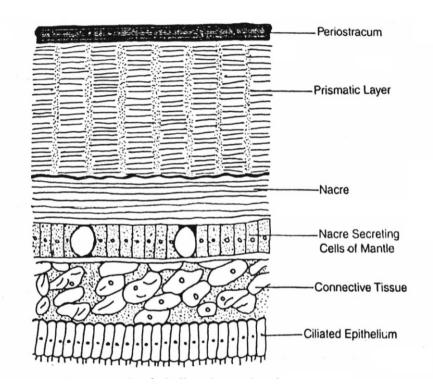


Fig 5.5. T.S. of shell and mantel of pearl oyster.

This layer is also secreted by mantle and its function is to protect the delicate surface from harmful effects of the foreign particles.

Mantle is also made up of three layers, which are as follow:-

- (1) Columnar epithelium. They contain numerous nacre secreting unicellular glands.
- (2) Connective tissue layer. The middle, fibrous layer is mainly composed of connective tissues.
- (3) Ciliated epithelium. Inner most layer containing mucous secreting cells.

A pearl bears a central nucleus around which several layers of organic and inorganic matters are laid. A beautiful and a fine quality pearl is that in which the layers are accurately and symmetrically laid. It is also free from any sort of adhesion. Such a pearl is, however, rare and if it occurs, it fetches a good market. The chemical analysis of a pearl shows that it contains about 90% calcium carbonate, 5% organic substances and 5% water and other residues.

Introducing the Artificial Production of Pearl: Pearl formation can be induced by nucleus as foreign particle in between the shell and mantle and pearl oysters. This is called **artificial production of pearl.** The whole process involves following steps-

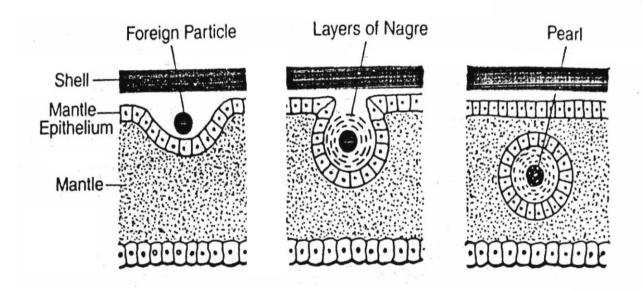


Fig 5.6. stages of pearl formation

# 1. Collection of Oysters

(i) Pearl oysters are collected from the sea bottom by professional divers. In Japan, these divers are called 'AMA.' The oysters are collected by small hand net and are stocked in the wooden bucket, attached to the diver's left wrist.

Collection of oysters is done during summer months when water is cleaner and sea is calm, and the best time is form early morning to midday.

The collected oysters are sorted out according to age-

- (a) Two years old oysters are stored in shallow water to be utilized later.
- (b) Three years old oysters are sent to pearl farms and are used for pearl formation.

- (ii) Now-a-days even eggs of oysters are incubated for obtaining oysters.
- (iii) Oysters are also caught in special types of cages (84×54×20cm). These are suspended in sea water at a depth of 6 meters from July to November. The oysters in these cages are transferred to rearing cages.

# 2. Rearing of Oysters

Collected oysters are reared in special types of rearing cages. These are formed of a heavy wire frame with 2cm wire mesh and are of the size of 84×54×20cm. These are covered with metal mesh and netting of cotton. These cages are further divided into 4 to 6 smaller chambers.

The cages are nicely protected from enemies of oyster (*octopus* or devil fish and eel).

#### 3. Insertion of Nucleus

In this method a piece of mantle of one oyster (graft) is cut off an inserted with a nucleus in other oyster. Insertion of foreign particle (nucleus) involves following types:

(i) Fitness of oyster for operation- Healthy oysters are taken for this operation, so that these are able to overcome the shock of handling and operation. These are dipped in cold and hot warm current of water alternately so that the eggs and sperm are ejected. Released of gametes makes oysters more resistant to shocks.

Before operation oysters are kept under stress of suffocation so that their shell valves start opening. A piece of bamboo (peg) is then inserted between the gap of shell valves.

- between shell and mantle is called **graft.** A strip of about 7×0.75cm is cut from the edge of mantle of healthy oyster by sharp knife. The piece is smoothed, cleaned and washed. Its margin is removed by sharp scalpel and the remaining piece of graft is cut into 2-3 long narrow strips and may be cut further into squarish 48 pieces according to the size of nucleus. These graft pieces are kept in sea water at 22°C where these can survive for about 48 hours.
- (iii) **Preparation of nucleus-** The best nucleus is prepared from molluscan shell formed of CaCO<sub>3</sub>.
- (iv) Insertion of nucleus- The oysters are fixed in a desk clamp with right valve facing upward. Mantle folds are touched to exposed foot and body mass. An incision is made in the epithelium of foot and a channel in the visceral mass. A graft piece is placed into the channel and the nucleus is placed over the graft. The bamboo peg is then removed closing the shell.

A second insertion can be made on the other side (left side) in the gonadial tissue.

(v) Postoperational care- The nucleated oysters are placed in the cages which are then suspended in the sea to a depth of 2-3 meters for about 6-7 days. These remain attached to floating rafts. This helps the oysters in recovering out of the shock. This is called **recovery period.** 

Afterwards dead oyster are removed from cages. 3000-6000 nucleated oysters are kept in different cages. These are again suspended in sea water for 3 to 6 years at a depth of 2 to 3 meters.

#### 4. Harvesting of Pearls

Pearls are harvested in the months of December to February, 3 years after the insertion of nucleus and pearls are taken out from the shell.

#### 5. Cleaning of Pearls

The Pearls are washed and cleaned in soap solution.

#### 6. Quality of Pearls

The pearls obtained are of various shapes and sizes. These may be pink, cream, red or pink-red or white. Spherical pearls with rainbow colour are the best rare. The best quality of pearls are called 'Lingha pearls' and are obtained from marine oysters.

# **Precaution for Pearl Industry**

- 1. Oysters shall be protected from enemies like devil fish, eel, etc.
- 2. Lethal cold water, low salinity, turbidity and high range of temperature variation have unfavourable effect on pearl industry.
- **3.** During breeding season, oysters should not be disturbed to ensure new generations of oysters.
- **4.** Controlled fishing of oysters is essential to avoid the exhaustion of oyster-stock

# SAQ-2

1.	The pearl oyster belongs to genus, class
	bivalvia and phylum mollusca.
2.	It is the outermost, greenish-brown, thin,
	translucent layer made up of an organic substance "Conchiolin". It is
	secreted by mantle.
3.	Mantle is also made up of three layers,, Connective
	tissue and

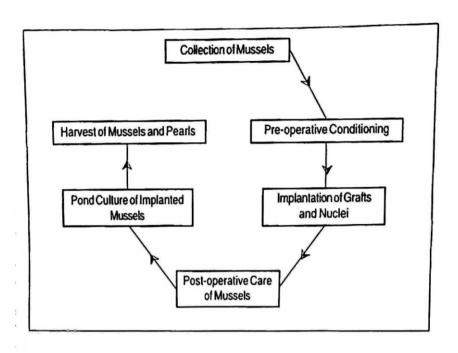


Fig 5.7. Steps in freshwater pearl culture.

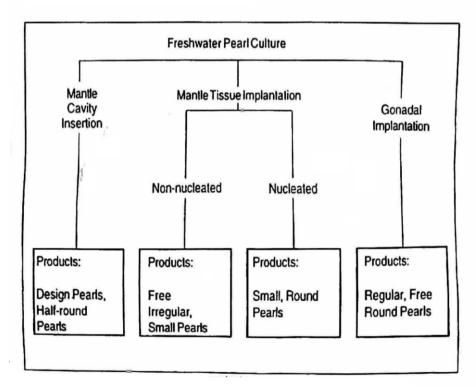


Fig 5.8. Implantation methods and products.

# 5.3 Management and Economics of Aquaculture

Economics plays an important role in the survival and development of aquaculture husbandry. Aquaculture economics can be considered from several different perspectives. It can be considered from the point of view of an individual aquaculture business, from the perspective of the whole industry of from a national stand point.

In western countries in particular, profitability is likely to be the major economic concern in an individual business, whereas overall net national benefit should be the main focus from the national viewpoint.

The global fish production industry is highly varied with respect to species, production technology geographical location and various other aspects. Fish farming is basically subject to the same economic laws as traditional farming, capture fisheries deal with certain quite specific and deep rooted economic problems. The most fundamental of these problems are the inherent dynamic complexities of wild fish stocks and the traditional common property arrangement of most capture fisheries. The capture fisheries of Asia and the Pacific region are dominated by pelagic species.

Economies of scope or of diversification seem to be very important at the hatchery/nursery stage from an economic viewpoint. Casual observation indicates that a large number of hatcheries/nurseries supply a range of aquaculture species or varieties of these, even though the mixture may be restricted to closely related species.

Possibilities for economies of scale, scope and specialisation are limited by the available techniques of production and those adopted. The appropriate choice of a technique from those available is partly an economic matter.

It should be observed that the location of an aquaculture business is likely to have a significant influence on its cost of production and profitability. The location of an aquaculture business' facilities will affect its cost of access to markets, its availability of inputs and their costs. A good location ecologically may be an uneconomic one if it is distant from markets and lacks ready availability of supporting human-related resources or services.

Aquaculture can be a risky undertaking both due to uncertainty about economic variables, such as future prices, and production uncertainties which can arise from environmental changes, disease, etc. Most aquaculture businesses need to adapt to such uncertainties in order to survive or minimise possible losses. Some methods of adaptation include:

- 1. product diversification;
- 2. diversification in techniques used for production;
- 3. incorporation of flexibility or adaptability into the capital equipment or facilities used, so as to keep options open;

Aquaculture production has remained relatively stable, with rising global incomes, demand for fish products will almost certainly continue to grow. A corresponding increases in supply can not come from capture fisheries, which are already close to

the maximum sustainable production. It can only come from fish forming which is not subject to the same binding constraints.

Fisheries are concerned with fish or shell fish. They mainly deal with catching processing and selling fish. On the other hand aquaculture is related to the cultivation of both aquatic animals and aquatic plants. Aquaculture is also called fish farming and it involves the natural or controlled cultivation of shell fish, fish and seaweed in fresh water and marine environments.

Aquaculture is science that involves all aspects of marine life. Aquaculture is a business that involves the production and marketing of shrimps, oysters and other animals of aquaculture is the production of aquatic organisms including fish, mollusks, crustaceans, and aquatic plants and the cultivation of fresh water and marine plants and animals.

#### **Benefits of Aquaculture**

Productive use of poor agricultural lands. Ponds built on the best agricultural land have the highest natural productivity. High production from aquaculture is also possible in ponds built on land, which is unsuitable for other forms of agriculture. Hilly land which is difficult to farm or is easily eroded can be utilized for fish pond. Swampy areas or soils with high salt or heavy clay content can also be utilized for aquaculture.

#### **Natural Resource conservation:**

Aquaculture and water harvesting can contribute substantially to the conservation of natural resources, especially water and soil. In many developing countries, surface water is often allowed to drain away instead of being harvested and stored for beneficial use. The requirement by aquaculture for abundant water provides justification and opportunity to build ponds for harvesting and storing water, This also makes water available for supplemental irrigation, stock watering and domestic needs.

# High economic value of aquacultural products

Aquaculture may produce a cash crop in subsistence level economy. Farmers frequently receive higher net returns for fish relative to other traditional crops. Even small ponds can contribute substaintially to form income production costs for fish, poultry beef and pork have been compared in numerous studies, Initial construction costs for fish forming are high, but once ponds are buit fish are usually the most profitable to produce. The use of waste material from integrated livestock and crop enterprises may also reduce input costs, while raising fish production.

Integrated aquaculture is a highly sustainable form of agriculture. Aquaculture is sustainable because it makes use of locally available resources. Integration of aquaculture with other forms of agriculture diversifies farm productivity. Fish culture integrated with garden irrigation, livestock, watering and various domestic uses are all possible. It serves different purposes, including fish culture, food production restoration of threatened etc. Aquaculure also known as aquafarmig, is the farming of fish, crustaceans, molluscs, aquatic plants, algae and other organisms.

## Types of aquaculture

There are different type of aquaculture

- 1) Depending on hydorbiological feature
- 2) Depending on the motive of farming
- 3) Depending on special operational techniques.

#### Level of management input

#### (1) Extensive culture system

When food base of a pond is exclusively dependent on nature without supplementation (either by feeds or fertilizer) the culture system is an extensive one. Extensive culture attracts less cost, but are often less productive and less profitable.

# (2) Semi-intensive culture system

In this system there is occasional supplementary feed additional and natural food supply is augmented with manure. This attracts more cost but better productivity and profit are assured compared with the extensive culture system.

# (3) Intensive culture system

This system demands the highest level of management input. Protein rich feeds and fertilizers are intensively applied following appropriate recommended rates.

Suitable materials like agricultural lime are also applied to stimulate
productivity.
The ponds are occasionally disinfected against parasite and diseases.
Fish grow very fast when intensively managed and grow least in
extensive management

## **Marketing**

In fish farming market has key role to play in the management decisions taken an nay aspect of fish farming. Management decisions taken on any aspect of fish farming management decisions which affect customers are part of marketing and must be considered from marketing point of view. Marketing strategies for fish farmer involves the following steps.

- Identify changing demands of market places
- Match production to market need.
- Select ideal candidate, fish species for culture i.e. fast growers
- Evaluate market acceptance of fish species to be grown
- Attempt satisfying buying pattern of consumers.
- Match production and consumers need to available resources
- Apply the marketing mix concept
- a) Product- planning and development
- b) Place for transfer of product to consumer i.e. ideal selling location.
- c) Promotion of product sales by advertisement and other sales promotion.
- d) Price determination and pricing policy.
- e) Economic costs are based on opportunity costs, that is, the economic benefit forgone by not choosing the best alternative to the choice actually made. For example, if family labour is supplied to an aquaculture business free of charge, this would not be included in the accounting cost of the business. However, if that family labour could earn an income if employed elsewhere, the highest income which it can earn elsewhere is its opportunity cost. In order to calculate economic cost, this opportunity cost would be imputed to the family labour employed.
- f) The **internal rate of return (IRR)** is equal to the rate of interest which will just make the present discounted benefits from a project (or for a business) equal to its present discounted costs or outlays. IRR is an excellent measure of the profitability of a project or business. If the IRR of a business exceeds the going rate of interest, the business is profitable. It is more profitable the higher is the internal rate of return in relation to the rate of interest.
- g) The profitability of culturing the different species varies considerably. The most profitable in decreasing order are:
- h) Pacific oysters on a good site;
- i) barramundi farming initially involving a nursery phase and then a freeranging phase;
- j) redclaw freshwater crayfish farming on a 15 hectare farm;
- k) prawns stocked at medium density in North Queensland.

Variations in the range of possible returns between species are considerable.

## Input records

There are two kinds of input, variable and fixed, variable inputs often have variable costs. Fixed inputs are those that do not change with the level of farming activity, included in this category such as rent or land, tax, interests, insurance premium and staff salaries.

# **Output records**

harvest	llowing are important items that should be included in output record. Date of t, species harvested and the disposition of product. These records are important ious reasons as started below.
	Records help the farmer to establish a number of facts or efficiency standard which form the basic tools of diagnosis and planning.
	Record can provide the farmer with information on production situation in the farm.
	A good record provides on effective mechanism for monitoring and evaluating farm.
	Records give data that may be used to formulate plans and construct estimater.
	Record add credibility to the claim of many business organization.
Fixed	cost items
	Land (purchase) taxes and rents
	Pumps/tanks and accessories and other farm equipment
	Farm structure (buildings, pond structure etc.)
	Staff salaries
	Interest payment on loans
	Depreciation on assets
<u>Varia</u>	ble cost items
	Fish
	Fertilizers/ manure/ lime
	Casual labour/ maintenance
	Transportation on maintenance (fuel etc.)
	Other consumables.
5.4	Summary
	The pearl oyster belongs to genus <i>Pinctada</i> , family pteriidae, class bivalvia and phylum mollusca.

☐ Pearl is a white highly shining globular concretion found within the shell of an oyser (a king of shell fish). It is also called as "moti" or Muktaphal.

	Some aquatic crustaceans are among the fisheries of economics importance and constitute food for persons from various parts of the world.
	Prawns form highly nutritive diet and tasty food for human beings.
	Aquaculture is science that involves all aspects of marine life.
П	Aquaculture is a business that involves the production and marketing.
	Aquaculture is the production of aquatic organisms including fish, mollusks,
	crustaceans, and aquatic plants and the cultivation of fresh water and marine
	plants and animals.
	plants and animals.
5.5	Terminal Questions
1.	Give an account of Pisciculture in India mention zoological
	and common names of important Indian food fishes.
	and common names of important matan rood nones.
2	Describe aquaculture of fish and its maintenance in a pond.
2.	Describe aquaestrate of fish and its maintenance in a pond.
•	Waite an array of the array is immented as a College
3.	write an essay on the economic importance of fishes.
3.	Write an essay on the economic importance of fishes.
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3.	write an essay on the economic importance of fishes.
3.	write an essay on the economic importance of fishes.
3.	write an essay on the economic importance of fishes.
	Write an essay on the economic importance of fishes.  Write an essay on Prawn fishery.

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5.	Write an essay on Pearl culture.
6.	Write a short note on peeling and deveining of Prawn.

# 5.6 Answers

# SAQ-1

- 1. Penaeus indicus and P. monodon
- 2. hatchery, rearing tank
- 3. Labeo, Catla

# SAQ-2

- 1. Pinctada, family pteriidae
- 2. Periostracum
- 3. Columnar epithelium, Ciliated epithelium



# SBSZY-03

# **Bachelor of Science**

# **Block**

2

# **Environmental Biology**

Unit - 6	AIR POLLUTION	157
Unit - 7	WATER POLLUTION & SOIL POLLUTION	178
Unit - 8	ENVIRONMENTAL HEALTH	196

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SBSZY – 03: Economic Zoology and Environmental Biology

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#### **Block-II: ENVIRONMENTAL BIOLOGY**

In the previous block you have studied about the Economic Zoology. In this and the following block, we will deal with the environmental biology. We have discussed the Air pollution, Water pollution, Soil pollution and Environmental health. Urbanization stress, behavior patterns of health and diseases.

This block consists of 3 units (unit 6 to 8)

Unit-6 This unit deals with the air pollution. Air pollution is the contamination of air, due to presence of substances in the atmosphere that are harmful to the health of human and other living beings.

Unit-7 This unit deals with the water pollution. The later part of the unit describes the soil pollution. Water pollution is the contamination of water, which makes the water unusable for drinking, cooking and other activities.

Soil pollution is defined as the presence of toxic chemicals(pollutants) in the soil.

Unit-8 This unit deals with the environmental health. It is the branch of public health that focuses on the relationship between people and the environment.

After studying this block, you will be able to

- discuss the nature of pollutants, air pollution, water pollution and soil pollution
- explain the animal in relation to human health.
- explain the water in relation to human health.
- discuss the Urbanization stress and behavior patterns of health and disease.

# **UNIT 6. AIR POLLUTION**

# Structure (A)Air pollution

- 6.1 Introduction
  Objectives
- 6.2 Nature of Pollutants
- 6.3 Their Sources and effects on Humans, Plants and animals and their control
- 6.4 Summary
- 6.5 Terminal Question
- 6.6 Answers

# 6.1 Introduction

After the 18<sup>th</sup> century, the beginning of industrial revolution brings tremendous change in human life. But it marked the start of man's increasing interference with nature. Populations increased villages multiplied and become towns, cities and nations. The demand of food for every increasing population has increased. Man cleared forests and introduce many chemicals into the environment to set up agricultural productions. These hazardous chemicals used for the control of crop pests have created environmental problems. Rapid industrialization and urbanization has also created several problems in the environment. Every year big industrial projects are set up which create serious problem of environmental pollution. The emission of dust and toxic gases, discharge of effluents has polluted our atmosphere and aquatic environment as well as soil. Man is continuously exploiting the natural recourses instead of conserving them for future generations. Serious degradation and depletion have been caused through over use, misuse and mismanagement of resources to meet the human needs and to satisfy the increasing greed. Pollution is a major problem of the environment in which human activities have played a prominent role. Unlimited exploitations of nature by man disturbed the delicate ecological balance between living and nonliving components of the biosphere.

The first world conference on human environment was held in Stockholm, Sweden from June 5 - 14 in 1972 in which 114 countries participated. It was the first time when the world had come together and thinks about man made climate changes. At this conference our late Prime Minister Smt Indira Gandhi

in her speech had stressed the need of linking environment with development at a global level. She had also identified poverty as the most important polluter of our environment.

The earth summit conference held at Rio de Janeiro, Brazil (3 – 14June 1992). It was the largest gathering of world leaders with 117 heads of states and representative of 178 nations called upon all nations to take appropriates measure for conservation of biodiversity and sustainable utilization of its benefits.

Pollution may be defined as "an undesirable change in the physical, chemical or biological characteristic of our air, water and soil harmful affect human life or create a potential health hazard of any living organism". Pollution is thus direct or indirect change in a component of the biosphere i.e. harmful to living components and in particular undesirable for man affect adversely the industrial progress, cultural and natural assets or general environment. Thus pollution is a necessary evil of all development. Not only in India, but in developed western world also pollution is a scare word. Pollution is a man made problem, mainly of affluents countries. The heavily industrialized countries dump lot of hazardous materials in their environment which become polluted.

The Indian life is very much connected with nature i.e. ecofriendly. There is a strong oppose to environmental destruction. They are traditionally lovers and protectors of nature. Some common examples are like Bishnoi movement in Rajasthan. After independence people become more aware and educated for environmental protection therefore many movements are being, Chipko movement is the unique movement in the world and it accelerate afterword in the form of Western Ghat Bachav movement, Tribal people of central India, where forest is their life line and also fighting against forest cutting. In Singbhum and Bastar districts the movement is very notable as they are fighting for the protection of biodiversity.

#### Air Pollution

Air is precious and life cannot be sustained on the earth without it. The air is present in the atmosphere and is composed of nitrogen (78.09%), oxygen (20.95%), argon (0.93%), carbon dioxide (0.03%), ozone (0.0001%), hydrogen, neon, helium, methane and water vapour. Thus atmosphere is an envelope of gases divided into different layers and forms an insulating blanket around the earth. Any alteration in the composition of atmospheric air leads air pollution. There are varieties of contaminants or pollutants are continuously added in the atmosphere, which interact with the environment and causes toxicity, diseases, aesthetic distress, deterioration of property, damage to plants and animals, physiological effects or environmental decay are called pollutants. The pollutants are natural as well as artificial or man made. The natural pollutants, such as hydrocarbons and sulphur oxides in atmosphere and

radiations causes air pollution but the severity is less where as the artificial pollutants produced by human actions are more significant because their adverse effects of pollution are most severe. Thus the primary cause of pollution is an action of people and as population increase, the pollution problem also increases proportionately.

Air pollution problem was not acute in past because there was no human encroachment on nature. But as the science and technology increases, there is heavy industrialization and ever expanding world population which are responsible for the world wide problem of air pollution. The definition of air pollution are describe in many ways many peoples

"Air pollution may be defined as any atmospheric condition in which certain substances are present in such concentrations that they can produce undesirable effects on man and his environment. These substances include gases (sulphur oxides, nitrogen oxides, carbon monoxides, hydrocarbon), particulate matter (smoke, dust, fumes, aerosols), radioactive materials and many others."

#### C.S.Rao

"Air pollution is the excessive concentration of foreign matter in the air which adversely affects the well beings of the individual or causes damages top property."

#### **American medical Association**

"Air pollution is nothing but the excessive concentration of foreign matter in the ambient atmosphere generally resulting from the activity of man, present for sufficient time and under circumstance which interfere significantly with the comfort, health or welfare of persons or with full use or enjoyment of properties."

#### **Objectives**

After studying this unit you will be able to-

Discuss the developmental process, population growth and exploitation
of natural resources.
Discuss the different types of air pollutants and their sources and how
they effect on human, animal and plants.

#### **6.2** Nature of Pollutants

The varieties of pollutants are continuously emitted into the atmosphere by natural and anthropogenic or man made source is so diverse that it is difficult

to classify air pollutants clearly. But some authors classify air pollutant in this way

- (i)Natural pollutants: Example natural fog, pollen grains, bacteria and products of volcanic eruption.
- (ii) Aerosols or Particulate matter: Example Dust, smoke, mists, fog and fumes.
- (iii) Gases and vapour: Example Sulphur, Nitrogen, Oxygen and Halogen compounds, Organic and Radio active compounds.

No	Group	Example
1	Sulphur compounds	SO <sub>2</sub> , SO <sub>3</sub> ,H <sub>2</sub> S,Mercaptans
2.	Nitrogen Compounds	NO, NO <sub>2</sub> ,NH <sub>3</sub>
3.	Oxygen compounds	$O_3$ , $CO$ , $CO_2$
4.	Halogen compounds	HF, HCl
5.	Organic compounds	Aldehydes, Hydrocarbons
6.	Radio active compounds	Radioactive gases

There are also some other pollutants which are formed from the above pollutants, undergo chemical reactions and enter the atmosphere. As a result the end products formed are more harmful and toxic than the original or parents pollutants. For example the smog is formed by reaction of unsaturated hydrocarbons with nitrogen dioxide in sun light. This is also called photochemical smog which is secondary pollutant. The pollutants are divided into two categories

- (1)Primary pollutants
- (2) Secondary Pollutants
- (1)Primary pollutants: The primary pollutants are those which emitted directly from the sources. There are several types of primary pollutants are describes as follows
- (a) Particulate matter: Ash, smoke, dust, fumes mist and spray.
- (b) Inorganic gases: Sulphur dioxide (SO<sub>2</sub>), Hydrogen sulphide (H<sub>2</sub>S), Nitric oxide (NO), Ammonia (NH<sub>3</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), hydrogen fluoride (HF), olefinic and aromatic hydrocarbons and radio active compounds.

There are five major types of primary pollutants are particulate matters, sulphur oxides, oxides of nitrogen, carbon monoxide and hydrocarbons which are responsible for causing the air pollution and serious hazards to animal and plant life. Carbon dioxide is generally not considered an air pollutants but

because of its increased global back ground concentration, it influence on global climatic patterns is of great concern. The global warming is serious consequence of the ever increasing concentration of CO<sub>2</sub> in the atmosphere.

(2)Secondary Pollutants: The secondary pollutants are formed in the atmosphere by chemical interactions with primary pollutants and normal atmospheric constituents. In this category pollutants such as sulphur trioxide (SO<sub>3</sub>), Nitrogen dioxide (NO<sub>2</sub>), Peroxyacetyl nitrate (PAN), Ozone, Aldehydes, Ketones and various Sulphate and Nitrate salts are included. The secondary pollutants are more dangerous than the primary pollutants. The formation of secondary pollutants is acomplex process in which several reaction mechanism and various steps are involved. The process is influenced by many factors such as concentration of reactants amounts of moisture present in atmosphere, degree of photo activation, meteorological forces and local topology.

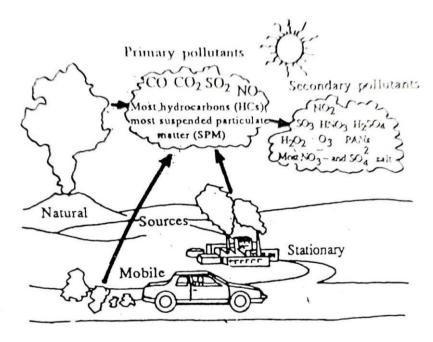


Fig6.1: Primary and secondary air pollutants

#### Particulate matter:

The solid and liquid aerosols suspended in atmosphere are called particulate matter. An aerosol can be defined as a colloidal system in which the dispersion medium is a gas and the dispersal phase is solid or liquid such as dust, smoke or mist. The term aerosol is used when it is suspended in the air. If it is settled either by virtue of its weight, by agglomeration or by impact on a solid or liquid surface, the word aerosol does not applies. Thus particulate matter is an air pollutant only when it is an aerosol. They may arise either condensation processes or from dispersion processes for example erosion, grinding and spraying. The following are various aerosols

- (1)Dust: The dust is made up of solid particles of the size ranging from 1 to  $100\mu$ . These particles are larger than those found in colloids and capable of temporary suspension in air or other gases. These are formed by natural disintegration of rock and soil or by the mechanical process of grinding and spraying of organic and inorganic materials. The fine dust particles act as centre of catalysis for many of the chemical reactions taking place in the atmosphere. The particles are generally more than  $20\mu$  in diameter. The thermal power station chimney discharge fly ash particles, their size varies between 80 to  $3\mu$ . The size of fly ash particle from cement factory is 150 to 10  $\mu$ .
- (2)Smoke: The smoke are produced by incomplete combustion. The size of smoke particles ranges between 0.01  $\mu$  to  $1\mu$ . The fine smoke particle can be liquid or solid. The smoke particles consist predominantly carbon particles and other combustible materials. The size of coal smoke particle is 0.2 to 0.01 $\mu$ , the oil smoke particle size is from 1.0 to 0.03 $\mu$ .
- (3)Fumes: Fumes are solid particles of the size ranging from 0.1 to  $1\mu$ . Fumes are formed by condensation from gaseous state, generally after volatilization from melted substances and often accompanied by a chemical reaction like oxidation. Fumes are normally released from chemical or metallurgical processes.
- (4)Mist: Mist is made up of liquid droplets generally smaller than  $10\mu$  which are formed by condensation in the atmosphere or are released from industrial operations. According to meteorology it means a light dispersion of minute water droplets suspended in the atmosphere. Natural mist particles formed from water vapour in the atmosphere are ranging from  $500\mu$  to  $40\mu$  in size.
- (5)Fog: Fog is a visible aerosols in which the dispersed phase is liquid. It is usually formed by condensation. In meteorology fog refers to dispersion of water ice in the atmosphere near the earth's surface reducing visibility to less than 500 meters. In natural fog the size of particles ranges from  $40\mu$  to  $1\mu$ .

#### **Chemical composition of Particulate matter**

The chemical composition of the particulate matter dependents on the origin of the particulate matter. Particles coming from soils and minerals it contain calcium, aluminum and silicon compounds. If smoke coming from combustion of coal, oil, wood and solid waste contains mainly organic compounds in particulate matter. Insecticides dusts and certain fumes released from chemical plants also contain organic and inorganic compounds. Hydrocarbon themselves can coalesce into aerosol droplets that form one kind of particulate matter. The most harmful components of incomplete combustion are grouped as particulate polycyclic organic matter (PPOM). These materials are derivative of benzo  $\alpha$ -pyrene, potent carcinogen. In the atmosphere all type of particulate matter also

contain in trace elements such as lead, cadmium, nickel and mercury may constitute the greatest health hazard. They are highly toxic and occur in combined forms, such as oxides, hydroxides, sulphates and nitrates.

#### Effect of particulate matter

The particulate matters discharged in the atmosphere create variety of problems in the environment and also for the plants and animals. These are as follows

- (i)The particulate matter can scatter and absorb the sun light and thus reduce visibility.
- (ii)The particulate matter in the atmosphere have the effect of cooling the earth. So it may affect the global climate.
- (iii)Dust on snow and ice reduces reflection, increase absorption and can promote melting.
- (iv)The particulate matter has many effects on materials such as corrosion of metal.
- (v)A new problem produced by particulate matter is its corrosion and damage of electronic equipment, especially through chemical or mechanical action on electrical contacts. This problem is due to particles which settled out of the air.
- (vi)The particulate matter can cause toxic effects on animal and humans and they are of 3 types.
- (a)Intrinsic toxicity due to chemical or physical properties.
- (b)Interference with clearance mechanisms in respiratory tract.
- (c)Toxicity due to adsorbed toxic substance.

The fine particles are more harmful because they reach the lung more easily and remain in the lung. There are several diseases related to particulate matter are as

- (1) Chronic bronchitis: In this diseases of bronchial tubes are permanently damaged leading to the failure of cilia, over production of mucus and consequently a chronic cough to remove the mucus.
- (2) Bronchial Asthma: The foreign matter leads to an allergic reaction of the bronchial membranes, which swell and causes wheezing and shortness of breath.
- (3) Emphysema: The bronchioles (smaller branches of the bronchial tubes), constrict causing the lung air sacs (alveoli) to over inflate and burst, this result

in fewer blood capillaries which means less oxygen transfer into the blood and chronic shortness of breath results.

**(4)***Lung cancer*: Large number of toxic particle have been found in polluted urban atmospheres including metal dusts, asbestos and aromatic hydrocarbons such as the carcinogen 3,4-benzopyrene. Their concentration is very small but they may play a role in the higher cancer rates that occur in urban areas as compared to rural areas.

#### Gases and Vapours:

The following are the gases which are air pollutants

- (1)Sulphur dioxide or oxides of sulphur
- (2)Hydrogen sulphide
- (3) Hydrogen Fluorides
- (4) Chlorine and hydrogen chloride
- (5)Oxides of nitrogen
- (4)Carbon monoxide
- (5) Carbon dioxide
- (6)Ozone
- (8)Hydrocarbons
- (9) Photochemical smog

#### Sulphur dioxide (SO<sub>2</sub>)

The major source of So<sub>2</sub> emission are burning of fossil fuels (coal) in thermal power plants, smelting industries (smelting sulphur containing metal ores)and other processes as manufactures of sulphuric acid and fertilizers. These account for about 75% of the total SO<sub>2</sub> emission. Remaining 25% emission is from petroleum refineries, fuel gases and automobiles.

In the polluted atmosphere,  $SO_2$  reacts photochemically or catalytically with other pollutants or normal atmospheric constituents to form sulphur trioxide ( $SO_3$ ), sulphuric acid ( $H_2SO_4$ ) and salts of sulphuric acid. These all are dangerous to health.

#### Effect of SO<sub>2</sub>

(i)The SO<sub>2</sub> and H<sub>2</sub>SO<sub>4</sub> are both capable of irritating the respiratory system of animals and humans. The pathological lung damage or mortality are caused in

higher concentrations, but lower concentrations also produce adverse health effects. It is absorbed in the moist passage of upper respiratory tract, leading to swelling and stimulated mucus secretion. Exposure to 1ppm level of SO<sub>2</sub> causes a constriction of air passage and causes significant broncho-constriction in asthmatics at even low concentration.

- (ii)SO<sub>2</sub> causes intense irritation of eyes.
- (iii)SO<sub>2</sub> is oxides to SO<sub>3</sub> and in presence of water vapour or water forms sulphurous and sulphuric acid respectively. SO<sub>3</sub> is very strong irritant much stronger than SO<sub>2</sub> causing severe bronchospams at relatively low levels of concentration.  $H_2SO_4$  is strong irritant than SO<sub>2</sub>.
- (iv)SO<sub>2</sub> has been also affect vegetation adversely. Plants are relatively more sensitive to SO<sub>2</sub> than are animals and man. High concentrations over short periods can produce acute leaf injury such as narcotic (tissue destroying), blotching of broad leaved plants and grasses or brownish discolouration in the tips of pine needles. Lower concentrations over longer periods (days or weeks) lead to chronic leaf injury such as a gradual yellowing (chlorosis) because chlorophyll production is impeded. There is bleaching of leaf pigments due to conversion of chlorophyll—a to phaeophytin-a. Thus SO<sub>2</sub> in air reduce the pH of leaf tissue of some trees, increasing the total sulphur content of leaves and tree bark.
- (v)SO<sub>2</sub> affects stomatal pores, stomatal frequency and trichomes as well as chloroplast structure.
- (vi)SO<sub>2</sub>, SO<sub>3</sub> can damage materials and property through their conversion into the highly reactive H<sub>2</sub>SO<sub>4</sub>. Discolouration and physical deterioration are produced in building materials. H<sub>2</sub>SO<sub>4</sub> mist in the atmosphere causes deterioration of structural materials such as marble, lime stone, roofing slate and motar.

#### Hydrogen sulphide (H<sub>2</sub>S)

The chief source of H<sub>2</sub>S are decaying vegetation and animal matter, especially in aquatic habitats. Naturally, it is emitted due to anaerobic decay processes on land, marshes and the oceans. Volcanoes and natural water springs emit H<sub>2</sub>S to some extent. Coal pits, sulphur springs and sewers also give this gas. One of the major sources of hydrogen sulphide is the kraft pulp industry, which uses a sulphide process for manufacturing paper. The other industrial sources of hydrogen sulphide are petroleum refineries, coke oven plants, viscose rayon plants and some chemical operations.

The other sulphur compounds in air pollution are methyl mercaptan (CH<sub>3</sub>SH), dimethyl disulphide (CH<sub>3</sub>SSCH<sub>3</sub>) and their higher molecular homologs. The

main sources of mercaptans are pulp mills, petroleum refineries and chemical manufacturing plants

#### Effects of Hydrogen sulphide (H<sub>2</sub>S)

- (i)It is fauling gas. Its unpleasant odour may destroy the appetite at 5 ppm level in some people.
- (ii)At a low concentration, H<sub>2</sub>S causes headache, nausea, collapse, coma and finally death.
- (iii)Conjunctivitis and irritation of mucus membrane and are caused at a concentration of 150 ppm.
- (iv)It can easily pass through the alveolar membrane of lung and penetrates the blood stream. Death occurs due to respiratory failures.

#### **Hydrogen Fluorides**

If the fluorocarbon are in minute quantities are beneficial helping prevention of tooth decay in man. But if it is in higher level is toxic. This causes the problems of fluorosis in our country as well as in many other countries like France, USA, Italy, Germany etc.

The major sources of fluorides are the manufacture of phosphate fertilizers. The aluminum industry, brick plants, pottery and ceramics, ferroenamals works, fluorinated plastic, uranium and other metals. The pollutant is in gaseous or particulate state. Small amounts are also emitted from other metallurgical operations such as zinc foundries and open hearth steel furnaces. Burning coal also contributes about 0.01% fluorine. In air hydrogen fluorides is an important contaminant even in extremely low concentrations of 0.001 – 0.10 ppm by volume. These levels of hydrogen fluorides cause injuries to vegetation and animals. Fluorides enter plant leaves through stomata. In plants, it causes tip burn due to accumulation in leaves of conifers. Fluoride pollution in man and animals is mainly through water. In India fluoride related problem occur in many states like Gujarat, Rajasthan, Punjab, Haryana, Uttar Pradesh., Andhra Pradesh and Tamil Nadu.

#### Chlorine and Hydrogen Chloride

In the polluted atmosphere chlorine is found as the elements itself (Chlorine), as hydrogen chloride, as chlorine containing organic compounds such as perchloroethylene as an inorganic chlorides. Some compounds are in gaseous form while some are found in particular form.

The chief source of the chlorine in the atmosphere is where it is manufactured or used as a material to produce other chemicals. Chlorine is used for

purification of water in water purification plants, in sewage plants and in swimming pools. Sometimes, equipment failure or damage of chlorine container leads to leakage of chlorine into the atmosphere. Hydrogen chloride is used in numerous industrial chemical processes. It is easy to recover, so very little amount reaches the atmosphere.

Chlorine and its compounds are respiratory irritants, highly corrosive and causes damage to the vegetation

#### **Oxides of Nitrogen**

There are total seven oxides of nitrogen (N<sub>2</sub>O, NO, NO<sub>2</sub>, NO<sub>3</sub>, N<sub>2</sub>O<sub>3</sub>, N<sub>2</sub>O<sub>4</sub>, N<sub>2</sub>O<sub>5</sub>) but only nitric oxide (NO) and Nitrogen dioxide (NO<sub>2</sub>) arises from human activities and are considered as harmful pollutants. By the combustion of fossil fuel about 95% of nitrogen oxide is emitted as NO and remaining 5% as NO<sub>2</sub>. In urban areas about 6% of oxides of nitrogen in atmosphere come from autovehicles and 25% from electric generation and the rest from other sources. The nitric oxide (NO) and Nitrogen dioxide (NO<sub>2</sub>) both play an important role in the production of photochemical smog.

(1)Nitric oxide (NO): It is largely produced by fuel combustion. The chief sources of this gas are the industries manufacturing nitric acid and other chemicals and automobile exhausts. NO is oxidized to NO<sub>2</sub> in the polluted atmosphere through series of photochemical reactions. Thus it is responsible for the formation of several pollutants like peroxyacetyl nitrate (PAN), ozone and carbonyl compounds in the presence of the other compounds. Its role in health hazard is less.

(2) Nitrogen dioxide ( $NO_2$ ):  $NO_2$  gas is the chief constituent of photochemical smog. Its importance in photochemical reactions is due to its strong absorption of ultraviolet radiation.  $NO_2$  is probably produced by the oxidation of NO by ozone.  $NO_2$  is of major concern as a pollutant. It is emitted by fuel combustion and nitric plant.

If concentration of  $NO_2$  is 100 ppm or more, it will be lethal to human and animals. If exposure of  $NO_2$  of 5 ppm for few minutes it lead to adverse effects on the respiratory system. If exposure to 50 ppm for 2 hours, it damage lungs, heart, liver and kidney and produce pulmonary changes lead to emphysema followed by oedema and finally death.

#### Carbon monoxide (CO)

Carbon monoxide is originated from the incomplete combustion of carbonaceous material and it has strong affinity toward the haemoglobin of the blood stream. The chief source of CO in atmosphere is automobile exhausts. The other sources are like electric and blast furnaces, petroleum refining

operations, gas manufacturing plants and coal mines are potential contributor of CO in atmosphere.

#### Effect of CO

The toxic effects of CO on human beings and animals are that it reacts with haemoglobin to form carboxyhaemoglobin.

$$HbO_2 + CO2 \longrightarrow HbCO + O_2$$

Haemoglobin has greater affinity for CO than O<sub>2</sub>. This reduces the oxygen carrying capacity of the blood so that less oxygen is available to the body cells and person will suffer from anoxia (oxygen starvation). If CO gas is inhaled for few hours at low concentration of 20 ppm, it causes headache and reduced mental acuity. Above 300 ppm it causes throbbing headache followed by vomiting and collapse. More than 500 ppm man reaches into coma and at 1000 ppm death can occur.

If there is increased level of carboxyhaemoglobin level from 1-2% to 3-4% causes cerebral anoxia resulting into impairing of vision and psychomotor activity. Generally plants are not affected by CO gas, but at higher levels i.e. 100 to 10,000 ppm, it affects leaf drop, leaf curling, reduction in leaf size, premature aging. It inhibits cellular respiration in plants.

#### Carbon dioxide

Carbon dioxide is not a pollutant. The amount of  $CO_2$  is formed due to animal respiration is utilized by the plants in the process of photosynthesis. But due to heavy industrialization and heavy consumption of fossil fuels vast amount of  $CO_2$  is released in the atmosphere which may probably bring about drastic changes in the world climate. It is estimated that global consumption of fossil fuel like coal, petroleum, natural gas etc. release about 9 x  $10^9$  tonnes per year. The primary source of  $CO_2$  is the burning of fossil fuels. The secondary source is the oxidation of carbon compounds in marshes and forest by natural degradation.

The atmospheric  $CO_2$  in natural carbon cycle is normally removed by two major sinks called plants and oceans. Plants absorb  $CO_2$  during the process of photosynthesis and some of the  $CO_2$  dissolves in oceanic water. But now this balance is disturbed as the product of  $CO_2$  is more than the absorption of  $CO_2$  by these two important sinks. Therefore the  $CO_2$  level in atmosphere is increasing day by day and it has become the threat to world climate.

The increased level of  $CO_2$  in the atmosphere has an influence on the earth climate is called "green house effect". The  $CO_2$  layer above the earth acts like the glass in a green house. Under normal conditions the temperature at the surface is maintained by the energy balance of the sun rays that strike the earth

surface and heat that is radiated back into space. The layer of CO<sub>2</sub> gas prevents the heat from being re-radiated out. This CO<sub>2</sub> layer thus function like the glass panels of a green house allowing the sunlight to filter through but preventing the heat from being re-radiated in outer space. This results into heating of earth. Recent studies have predicted arise about 1.9°C in surface temperature from a doubling of CO<sub>2</sub> concentration. Such an increase would have great effects on the earth climate. If there will be continuous rise in earth temperature all the glaciers will recede and the ice caps in Antarctica and Arctic will begin to melt. Consequently, the sea level will be rise by a few meters and most of the cities on the sea shore may be submerged.

The situation in India is alarming. There was dense forest in Gangetic plains, the Deccan and the Central plateau and Rajasthan in past. At 36% of the Indian continent was covered by the forest but today is reduced to 20% thus deforestation, heavy consumption of fossil fuel responsible for increases deviation in the climate with decreasing rains.

#### Ozone (O<sub>3</sub>)

The ozone layer is present in the stratosphere (above 16 km upto 50 km) which protects us from harmful UV radiation from Sun. So ozone layer acts as a protective shield for the living organisms on the earth. The ozone is formed through chemical reactions involving certain pollutants (SO<sub>2</sub>, NO<sub>2</sub>, aldehydes). Since last few years there is adepletion of this O<sub>3</sub> layer by human activities which may have serious implication on the life. The atmospheric ozone is now regarded as potential danger to human health and crop growth. Thus ozone plays dual role of destroyer as well as protector.

In the atmosphere (8 to 16 km from earth surface), temperature decreases with increasing altitude, while in stratosphere (above 16 km upto 50 km), it increases with increasing altitude. This rise in temperature in stratosphere is caused by the ozone layer. The ozone layer has two important and interrelated effects. The first is it absorbs UV light and thus protects all life on earth from harmful effects of radiations and secondly by absorbing the UV radiation the ozone layer heats the stratosphere, causing temperature inversion. The effect of temperature inversion causes limits the vertical mixing of pollutants and thereby causing the dispersal of pollutants over large areas and near the earth's surface. That is why a dense cloud of pollutants usually hangs over the atmosphere in highly industrialized areas causing several unpleasant effects. The pollutants spread horizontally relatively fast (than slow mixing vertically) reaching all longitudes of the world in a about a week and all latitudes within months. Therefore any country cannot protect itself from ozone layer above it. Thus ozone problem is the global problem. Inspite of slow vertical mixing, some of the pollutants like chloroflurocarbon (CFCs) enter the stratosphere and these (CFCs) pollutants unfortunately react with ozone and deplete it. The O<sub>3</sub>

near earth's surface in troposphere create pollution problems. Ozone and other oxidants such as peroxyacetyl nitrate (PAN) and hydrogen peroxide are formed by photochemical reactions between hydrocarbons and NO<sub>2</sub>. The ozone may also be formed by NO<sub>2</sub> under UV radiation effect. These pollutants are responsible for the formation of photochemical smog. The increased concentration of ozone near earth surface reduces crop yield significantly.

In plants ozone enter through stomata and produces visible damage to leaves and thus a decrease in yield and quality of plant products. At 0.02 ppm ozone damages tomato, tobacco, bean and pine and other plants. It also causes tip burns in pine seedlings. Ozone also causes destruction of fibres like cotton, nylon and polyster and dyes. The higher concentrations of ozone are hazardous to human health.

Ozone also play a vital role of protection from the harmful UV radiation from sun, so it acts as protective shield. It filters out all radiation below 3000Å. Any change or depletion in ozone layer will have catastrophic effects on the life on earth. The depletion in ozone layer is due to several reasons.

- (i)Some pollutants enter the stratosphere and they react with  $O_3$  converting it into other pollutants. Thus they deplete  $O_3$ .
- (ii)Chloroflurocarbon (CFCs), nitrogen oxides and hydrocarbons are the major pollutants responsible for O<sub>3</sub> depletion. The CFCs is used as coolants in air conditioners and refrigerators, clearing solvents, aerosol propellants.
- (iii)Motor Vehicles, jet engines, nitrogen fertilizers and other industrial activities are responsible for emission of CFCs, oxides of nitrogen.

#### Effects of O<sub>3</sub> depletion

- (i)The depletion of O<sub>3</sub> would lead to serious temperature changes on the earth and consequent change to life support systems.
- (ii)The O<sub>3</sub> depletion would lead to temperature changes and rainfall failure on earth.
- (iii)Due to reduction of O<sub>3</sub>, UV radiation increases and it causes skin cancer to man.
- (iv)It has also have harmful effect such as cataracts, destruction of aquatic life, vegetation and loss of immunity.

#### Hydrocarbon

The chief hydrocarbon air pollutants are benzene, benzpyrene and methane. The main source of these hydrocarbon are motor vehicles, emitted by evaporation of gasoline through carburetors, crankcase. The two and three

wheelers are the main contributor of hydrocarbon in environment. They have carcinogenic effects on lung. They combine with oxides of nitrogen under UV component of light to form other pollutants like PAN and O<sub>3</sub> (photochemical smog) which causes irritation of eye, nose and throat and respiratory distress. Benzene is a liquid pollutant is emitted from gasoline and responsible for causing lung cancer.Benzpyrene is present in small amount in smoke, tobacco, charcoal boiled stakes and gasoline exhaust and is most potent cancer inducing hydrocarbon. Methane (Marsh gas) is a gaseous pollutant and produce by decay of garbage, aquatic vegetation. It is also produce by burning of natural gas. At high level of methane, in absence of oxygen is narcotic on man.

#### Photochemical smog

The photochemical smog is secondary pollutant which is produced in air by interaction among two or more primary pollutants or by reaction with normal atmospheric constituents with or without photo activation.

Photochemical smog is restricted to highly motorised areas. This kind of pollution occurs where inversion conditions prevail in the atmosphere. It is due to the action of sunlight on two pollutants hydrocarbons and nitrogen oxides. The major sources of these two pollutants are the exhaust gases from the automobiles. The main constituents of photochemical smog are Peroxyacetyl nitrate (PAN), nitrogen oxides, hydrocarbon, CO and O<sub>3</sub>. It reduces visibility, causes eye irritation, damage to vegetation and cracking of rubber.

The coal induced smog is called fog and it is formed by the burning of coal. This fog covers the urban areas at night or on cold days when the temperature is below 10°C and when very calm meteorological conditions exist. The main constituents of the fog are smoke, sulphur compounds and fly ash. The constant prolong exposure to smog results in a high mortality rate, especially among the aged and those suffer from chronic bronchii, asthma, broncho-pneumonia and other lung or heart diseases.

# 6.3 Their Sources and effects on Humans, Plants and animals and their control

**Sources :**Describe in the above segment 1.2

#### **Effects of Air Pollution**

Air pollution leads various diseases and health hazards. The air pollution effects on human health, animals, plants and climate.

#### Effects on human health

The polluted air is dangerous and affects human health. There are several factors which are responsible for affecting human health are as

- (i)Nature of pollutants
- (ii)Concentration of pollutants in air
- (iii)Duration of human exposure
- (iv)Age group of the individual
- (v)State of health of the individual

Infants, children and aged individuals are generally more susceptible to pollutants. Those who are suffering from chronic diseases like heart or lung are thought to be at a great risk. Seasonal changes also causes great effect on human health.

Air pollutants come in contact with the exposed membranes and skin and causes damage. The toxic gases, vapours, fumes, mist and dust may be absorbed by the exposed membranes of eyes, nose, throat, larynx, trachea, bronchii and lungs. The air pollutants causes following important health effect in human

(1)The high concentrations of SO<sub>2</sub>, NO<sub>2</sub>, particulate matter and photochemical smog are responsible for chronic pulmonary diseases like Asthma & Bronchitis. The increase concentration of SO<sub>2</sub>& NO<sub>2</sub> reacts with atmospheric water and form H<sub>2</sub>SO<sub>4</sub> & HNO<sub>3</sub> i.e. Acid rain. It is dangerous hazard to forest, aquatic life and human bodies as well as to soil biological process which lower production of soils.

World famous historical monuments and buildings, precious stones and marbles get damaged. e.g. A fate of marble Taj Mahal at Agra is gloomy by emission of sulphur dioxide from Mathura oil refinery. Similarly it is also happening in western countries also. So to save them they are kept in museums or industrial units have been shifted.

- (2)Carbon monoxide in human body combines with haemoglobin of blood faster than oxygen, which causes suffocation and respiratory problem.
- (3)Fluorosis, a disease of bone is caused due to hydrogen fluoride. It also causes mottling of teeth.
- (4)The carcinogenic agents like polycyclic aromatic hydrocarbons, nitrosomine, nickel, pesticides are responsible for cancer.
- (5)The increase concentration of CO<sub>2</sub> in atmosphere may create green house effect, which is going to be doubled in the mid of twenty first century. The warming of environment i.e. global warming would causes melting of ice caps, continental glaciers and this would bring the rise in sea level and low lying coastal land will be submerged.
- (6) The leakage of poisonous gases from gas plants and chemical plant pollute the air to such extent that within no time it brings the death of thousands. It

also effects on micro-organisms, human being and decomposers. The leakage of Methyl Isocynate (MIC) from Union carbide factory at Bhopal gas tragedy disaster take place on Dec 3<sup>rd</sup> 1984 by human negligence results into a loss of thousands of animals and more than 3500 lives. It has its long term adverse effect particular on pregnant women and foetus.

The Chernobyl disaster was a nuclear accident that occurred on 26<sup>th</sup> April 1986, in the North of Ukrainian SSR (USSR) and consider as worst nuclear disaster in history both in term of cost and casualties.

- (7)Emission of CFC from refrigerators, air conditioners, aerosol and foam plastic cosmetic increase the concentration of chloroflurocarbon in atmosphere which do not degrade for longer time. CFC gets broken down by ultra-violet and stratospheric O<sub>3</sub> get destroy and protective cover of all biotic get damaged in biosphere. So increase in concentration of CFC is most dangerous form of air pollution.
- (8)The heavy metals like lead, cadmium, nickel mercury are harmful to the human health. Lead is neurotoxic and it affects blood system and causes behavioral disorders and death. Cadmium is responsible for cardiovascular diseases and hypertension and kidney damage. Nickel causes respiratory disorders and lung cancer. Mercury causes nerve, brain and kidney damage.
- (9)Dust particles causes respiratory diseases, silicosis, asbestosis are the diseases caused by silica and asbestos dust.
- (10)The radioactive substance causes somatic or genetic damage. The radioactive fall out from testing of nuclear weapons causes cancer, shortening of life span and genetic effects of mutation.

#### Effects of pollutants on plants

It has also been known that air pollutants have adverse effects on plants. The gaseous pollutants particulate matter, pesticides, heavy metals, number of industrial chemicals are responsible for the destruction of vegetation.

The most common damage caused by air pollutants to vegetation occurs in the leaf structure. The leaf surface is covered by waxy coat called cuticle. Epidermis lies beneath cuticle. Its chief functions are the protection of the inner tissue from excessive moisture loss and the admission of CO<sub>2</sub> and O<sub>2</sub> to these internal tissues. The surface of leaf contain large no of stomata, through these stomata toxic gases enter and damage the inner tissue.

There are several disease are caused by air pollutants in plants are as follows

**Necrosis:** It is dead areas on a leaf structure.

**Chlorosis:** It is a loss or reduction of chlorophyll and leads to the yellowing of the leaf. Chlorosis generally indicates a deficiency of some nutrient required by the plant.

**Epinasty:** In leaf epinasty is a downward curvature of the leaf due to higher rate of growth on the upper surface.

**Abscission**: It is dropping of leaves.

In plant injury may be acute or chronic. In acute injury plants are exposed to relatively high concentrations of pollutants where as in chronic injury, the plants are exposed to low levels of pollutants for longer periods.

#### **Control of Air Pollution**

Air pollution can be controlled and minimized effectively by two methods

- (A)Preventive methods
- (B)Control methods

#### (A)Preventive methods: Are as follows

- (1) Selection of site for plant (industry) by atmospheric consideration e.g. meteorology of industry.
- (2) Siting of industry must consider the environmental Impact Assessment first.
- (3) Setting of industries should be remote from residential areas.
- (4) Selection of suitable fuel and its efficient and wise utilization.
- (5)Install tall chimneys (human volcanoes)
- (6)Use low sulphur content coal in industries sothat the level of pollutant emission will be reduce.
- (7)Use modern technology in industries and industrial processes so that emission level will become low.
- (8) Remove sulphur from coal either by washing or by bacteria.
- (9) Eradicate extreme hazardous forms from its use.
- (10)Use alternative less harmful products like solar cooker, solar heater, solar powered vehicles.
- (11)Be aware and motivate people in society, Govt. bodies and officials to make best use of environmental resources.
- **(B)Control methods**: The common methods of reducing the pollutants includes
- (1)Collect the pollutants by some instrumental devices.
- (2)Destroy the pollutants by thermal or catalystic combustion.
- (3) Change the form of pollutants to be less toxic.
- (4)Arresters should use separate particular matter from contaminated air either by cyclonic separators or by trajectory separators.

- (5)Use filters for collecting extreme fine particulate.
- (6)For removing of particulate electrostatic precipitator is the best device generally used in thermal power plants.
- (7)Gaseous pollutants in combustion techniques burns completely at high temperature.
- (8)Unburnt hydrocarbons in auto emission can be reduced at multy point fuel engine.
- (9)Use good quality fuel for reducing toxic contaminants in exhaust, at a drastic rate.
- (10)Lead free petrol minimizes pollution.
- (11)Preference shall be given to CNG which significantly minimizes the toxic contaminants in exhaust.
- (12)Use mass transport on non-conventional energy resources.
- (13) Use biofilters and bioscrubbers.
- (14) Replace old vehicles and select new with modern technology vehicles.
- (15)Plant more trees and keep more open spaces.

#### SAQ 1.

Complete the following sentences by inserting appropriate words in the blanks.

- (i)Which Gas leaked from industrial accident, worst tragedy in Bhopal was ------
  - (ii) "Acid rain" is a result of increased concentration of gas -----
  - (iii) The ultraviolet rays in atmosphere are absorbed by -----
  - (iv)Fluoride pollution mainly affects -----

# 6.4 Summary

Developmental process, population growth and exploitation of natural resources have made destructive impact on our ecological balance and it damages the biodiversity due to pollution. In this unit you will learn about what is pollution, Air pollution. Different types of air pollutants like SO<sub>2</sub>, oxide of nitrogen, carbon monoxide, carbon dioxide, hydrogen fluoride, photochemical smog, ozone, etc. their sources and how they effect on human, animals and plants

# 6.5 Terminal Question Q1. Explain the secondary pollutant. Q2. Explain the effects of pollutants on plants. Q3. Explain the Preventive methods of air pollution control. 6.6 Answers SAQ 1 (i) Methyl Isocynate (ii)SO<sub>2</sub> & NO<sub>2</sub>

- (iii)Ozone
- (iv)Teeth

Ans. 1: The secondary pollutants are formed in the atmosphere by chemical interactions with primary pollutants and normal atmospheric constituents. In this category pollutants such as sulphur trioxide (SO<sub>3</sub>), Nitrogen dioxide (NO<sub>2</sub>), Peroxyacetyl nitrate (PAN), Ozone, Aldehydes, Ketones and various Sulphate and Nitrate salts are included. The secondary pollutants are more dangerous than the primary pollutants. The formation of secondary pollutants is a complex process in which several reaction mechanism and various steps are involved. The process is influenced by many factors such as concentration of reactants amounts of moisture present in atmosphere, degree of photo activation, meteorological forces and local topology.

Ans. 2: It has also been known that air pollutants have adverse effects on plants. The gaseous pollutants particulate matter, pesticides, heavy metals, number of industrial chemicals are responsible for the destruction of vegetation.

The most common damage caused by air pollutants to vegetation occurs in the leaf structure. The leaf surface is covered by waxy coat called cuticle. Epidermis lies beneath cuticle. Its chief functions are the protection of the inner tissue from excessive moisture loss and the admission of  $CO_2$  and  $O_2$  to these internal tissues. The surface of leaf contain large no of stomata, through these stomata toxic gases enter and damage the inner tissue.

There are several disease are caused by air pollutants in plants are as follows

Necrosis: It is dead areas on a leaf structure.

Chlorosis: It is a loss or reduction of chlorophyll and leads to the yellowing of the leaf. Chlorosis generally indicates a deficiency of some nutrient required by the plant.

Epinasty: In leaf epinasty is a downward curvature of the leaf due to higher rate of growth on the upper surface.

**Ans. 3:** (1)Selection of site for plant (industry) by atmospheric consideration e.g. meteorology of industry.

- (2) Siting of industry must consider the environmental Impact Assessment first.
- (3) Setting of industries should be remote from residential areas.
- (4) Selection of suitable fuel and its efficient and wise utilization.
- (5)Install tall chimneys (human volcanoes)
- (6)Use low sulphur content coal in industries so that the level of pollutant emission will be reduce.
- (7)Use modern technology in industries and industrial processes so that emission level will become low.
- (8)Remove sulphur from coal either by washing or by bacteria.
- (9) Eradicate extreme hazardous forms from its use.
- (10)Use alternative less harmful products like solar cooker, solar heater, solar powered vehicles.

#### UNIT 7. WATER POLLUTION& SOIL POLLUTION

#### Structure (A) Water Pollution

7.1 Introduction

Objectives

7.2 Sources, Consequence and control

## **Structure (B) Soil Pollution**

- 7.3 Introduction (Soil Pollution)
- 7.4 Sources, Nature and harmful effects
- 7.5 Summary
- 7.6 Terminal Question
- 7.7 Answers

#### 7.1 Introduction

Water is one of the most important natural resources which is essential for variety of purpose to human beings as well as plants and animals. Water has many uses like drinking and other domestic uses, industrial cooling, power generation, agriculture or irrigation, transportation and waste disposal. Water is a sources of life for living organisms hence it cannot be replaced. It helps in circulation, movement and cycling of nutrients which is found in various phases and storages such as

(i)Liquid phase: Oceans, Seas, Lakes and Rivers.

(ii) Solid phase: Glaciers, Ice caps, Ice sheets

Water pollution is one of the most serious environmental problems. Water become polluted when water is contaminated by such substances as human and animals wastes, toxic industrial chemicals, agriculture residues, oil and heat. Most of our water bodies such as ponds, lakes, streams, rivers, seas, oceans, underground water resources like tube well, bore well have become polluted due to urbanization, industrial growth and other man made problems.

The problem of water pollution is due to discharge of domestic and industrial wastes into aquatic systems like rivers, ponds, lakes, seas, oceans and estuaries has become as serious problem in our country. Most of our rivers and fresh water streams which pass near the major cities, townships or other human

dwellings are polluted by industrial wastes or effluents. Our all major rivers are polluted either by industrial effluents or by sewage or domestic waste water. Most of our holy rivers such as Ganga, Godawari, Yamuna and many others have been turned into an open sewer. The sewage, industrial effluents containing toxic chemicals and heavy metals are responsible for various diseases like enteric disorders, typhoid, cholera, dysentery, dysfunction of kidney, liver, reduction in haemoglobin, mental retardation. Fluoride causes knock- knee syndrome i.e. pain in the bones and joint and outward bending of legs from knees, mottling. Methyl mercury causes Minimata disease.

Water gets polluted naturally as well as artificially or man-made causes. For example fluoride a strong pollutant, which causes knock- knee disease, occurs naturally in water bodies but it also results from industrial activities such as ceramic industries, phosphate fertilizer plants and aluminum factories.

In India nearly 84% of water is used in agricultural sectors, 12% in industrial sector and 4% in domestic sector. Even after 50 years of independence Indian are not fortunate to obtain pure and safe drinking water. Water problem is one of the most important crises on global as well as national level. More than 60% of Indian population do not have clean safe and pure water to drink.

Water pollution is defined as "The addition of any substance to water, changing physical and chemical characteristic of water in any way which interferes with its use for legitimate purpose".

The water pollution also refers to deterioration in chemical, physical and biological properties of water brought by human activities which may cause harmful effects on human and aquatic life.

Normally water is never pure in a chemical sense. It always contains impurities of various kinds, dissolved as well as suspended. These include dissolved gases like CO<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub> and N<sub>2</sub>, dissolved minerals Ca, Mg and Na salts, suspended matter clay, silt, sand and even microbes. The natural impurities in water are in very low concentrations which are derived from atmosphere and soil. These impurities do not pollute water and the water is potable.

The polluted waters are turbid, unpleasant bad smelling, unfit for bath and washing or other purposes. They are harmful and are sources of number of diseases such as cholera, dysentery, typhoid etc. Polluted water may look clean or dirty but contains germs, chemicals and other harmful toxic materials that can causes inconvenience, illness or death.

Water pollution can be categories into fresh water pollution and marine water pollution. The fresh water pollution may be of surface water pollution or ground water pollution. If pollutant enters in a lake, pond or river is known as surface water pollution and if pollutants find its way into aquifer, along with water of percolation can deteriorate ground water pollution. The fresh water bodies have very low salt content alwaysless than 5 ppt(parts per thousand).

The marine water salt content is between 35 ppt or above. The Estuaries and brackish water having salt content between 5 to 35 ppt. Thus, the pollution of oceans, seas, estuaries, salt marshes are known as marine pollution or ocean pollution.

## **Objectives**

After studying this unit you will be able to-	-
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Discuss the different sources of water pollutions.
Explain the different sources of soils pollution.
Discus the important sources for soil pollutants like industrial wastes,
fertilizers, pesticides etc.

## 7.2 Sources, Consequence and control

The chief sources of water pollutions are

- (1)Domestic waste water and sewage
- (2)Industrial wastes (effluents)
- (3) Agricultural wastes
- (4) Physical pollutants (Thermal and radioactive)
- (1)Domestic waste water and sewage: It includes water-borne wastes derived from house hold activities such as bathing, laundering, food processing and washing of utensils. Domestic waste contains garbage, soaps, detergents, waste food, paper cloth, use cosmetics, toiletries and human excreta. This waste water which is known as sewage is the largest primary source of water pollution. Most of our natural water bodies like river, pond, lakeand stream are heavily polluted by sewage. There is uncontrolled dumping of wastes of rural areas, towns and cities into our ponds, lake, streams, rivers and oceans. Most of our cities, towns and villages are located on the bank of rivers and they directly discharge their domestic waste water into the river. Therefore, there is accumulation of sewage and other wastes in these bodies on a very large scale, they are not able to recycle them. Because of heavy load of sewage the natural water bodies have lost their self regulatory capability.

Domestic waste water and sewage are mainly carbonaceous organic material that can be oxidized by microorganisms to CO<sub>2</sub> and water. The decomposition of these wastes by aerobic microbes decreases due to higher levels of pollution. The self purifying ability of the water is lost and such water becomes unfit for drinking and other domestic purpose. The decomposition of sewage and other oxygen demanding wastes is largely an aerobic process. When these wastes are accumulated in large scale in water the aerobic process increases its oxygen requirements. This is called "Biological oxygen demand" (BOD).

#### Biological oxygen demand

Biological oxygen demand is the amount of oxygen required for biological oxidation by microbes in any unit volume of water. BOD is the standard test to measure the oxygen demand of waste. The BOD values generally approximate the amount of oxidisable organic matter and is therefore used as a measure of degree of water pollution and waste level. Thus mostly BOD value is proportional to the amount of organic waste present in water.

If the amount of sewage discharged is low, a river will not become badly polluted because biological degradation will soon removed most of the wastes. But if strong sewage or heavy polluted wastes from industry or agriculture can lead to the depletion of the dissolved oxygen in the water. Normally the dissolved oxygen (DO) be at least 5 ml/l.

Under aerobic condition, when sufficient O<sub>2</sub> is present for degradation of organic materials, carbon becomes CO<sub>2</sub>, sulphur becomes sulphate, phosphorous becomes phosphate and nitrogen becomes ammonia and nitrate. But if dissolved oxygen (DO) is insufficient then carbon become methane, nitrogen compound can become amines (whose odours typically make one think of rotten fish decaying in a stinking esspool), sulphur compounds can become hydrogen sulphide (rotten egg odour) and phosphorous compounds have wormy odour.

The sewage and other oxygen demanding wastes are classified as water pollutants because their degradation leads to oxygen depletion which affects (and even kills) fish and other aquatic life, because they produce annoying odours, because they impair domestic and lives stock water supplies by affecting taste, odour and colours and because they may lead to scum and solid that render water unfit for recreational use. They may also contain infectious agents.

Infectious agents: Waste water from municipalities, sanitoriums, tanning and slaughtering plants and boats may be the source of bacteria or other microorganisms capable of producing diseases in men and animals, including livestock. Disease causing micro-organisms are always present in sewage. There are several types of human infections but some of them such as cholera typhoid are transmissible through water. These diseases are water borne. There are many animal infections that are of public health importance because they are transmissible to humans either through water or by direct contact. Tetanus, cholera, fever, bacillary dysentery, infectious hepatitis from water and food through ingestion.

Domestic waste contains soaps and detergents. Phosphates are the main ingredients of major detergents. Plant nutrients such as nitrogen and phosphorous can stimulate the growth of aquatic plants, which interfere with water uses and which later decay to produce disagreeable odours and add to the

BOD of the water. Phosphates and nitrates favour the luxuriant growth of algae which form algal blooms. The excessive algal growth also consumes most of the available  $O_2$  from water body. This leads into decrease in  $O_2$  level which becomes detrimental to the growth of other organisms as it produce foul smell after decay.

The sewage and domestic waste contains organic waste contains nutrients chiefly nitrates and phosphates. Due to high amount of nitrate and phosphates the water body becomes highly productive or eutrophic and the phenomenon is called Eutrophication. In eutrophic lake or river many pathogens like bacteria, viruses and protozoa are present. These may result into spread of fatal water borne diseases. Some of which may assume an epidemic state. These are viral hepatitis, polio, cholera, typhoid, diarrhoea, amoebiasis etc.

(2)Industrial wastes (effluents): Most of the rivers and fresh water streams which pass near the major cities, townships or other human dwelling are polluted by industrial wastes called effluents. There are wide variety of both inorganic and organic pollutants are present in the effluents of common industries such as paper and pulp industry, textile, sugar mills, distilleries, breweries, tanneries, steel industries and mining operation, thermal power plants. There are various kinds of effluent generated by industries. The paint and varnish industries produce aromatic long chained hydrocarbons, textile industries put out various dye stuffs and metal salts which are used as mordant. The other industrial effluents contains a most of pollutants such as oils, grease, plastics, plasticizers, metallic wastes, phenols, acids, salts, dyes, cyanides, DDT etc. The metallic wastes such as copper, zinc, arsenic, cadmium, lead, mercury, chromium aredischarged from industries. Some of the river and the major source of their pollution are describe as follows

Name of the river	Sources of Pollution
Cauvery (Tamil Nadu)	Tanneries, distilleries, paper and rayon mills.
Bhadra (Karnataka)	Paper and steel industries
Godawari (Andhra Pradesh)	Paper mills
Chambal (Madhya Pradesh)	Rayon mills, caustic soda mills
Damodar	Fertilizers, steel plants, coal washeries and power stations.
Ganga (at Kanpur)	Chemical, metal and surgical instruments industries, tanneries, textile mills.
Gomati (near Lucknow)	Paper and pulp mills
Hooghly	Jute, paper pulp, chemical, paint, varnishes, metal, steel, vegetable, oils, rayon and soap, polythene

	industries.
Yamuna(near Delhi)	DDT, factory, power station, Mathura refineries.
Kali (at Meerut)	Sugar mills, distilleries, paint, soap, rayon, silk, yarn, tin, glycerine industries.
Narmada (Madhya Pradesh)	Paper mills
Siwan (Bihar)	Paper, cement, sulphur and sugar mills
Sone (Madhya Pradesh)	Paper mills

The holy river Yamuna has been turned into an open sewer. The various industries located in Delhi dump the toxic effluents in river. The belt of about 48 km is highly polluted and Yamuna water near Delhi is not fit even for irrigation and there is no question of using as drinking, bathing swimming etc. There are thousands of kilolitres of effluents are discharged in the river by large and medium industries units. The effluents from these industries contains sodium, salts, acids, phenols, cyanides, metals, DDT and dyes. The same condition is exhibited by the holy river Ganga. It worst stretchis in Kanpur and Varanasi. The effluents containvariety of toxic organic and inorganic pollutants and they are capable of killing living organisms in the water bodies.

The toxic properties of heavy metals are numerous. These substances produce physiological poisoning by accumulation in the body tissue. There are several metals are present in industrial wastes water are like mercury, lead, cadmium, chromium and silver.

#### **Mercury Pollution**

Mercury is the important water pollutant found in various industrial effluents such as those from manufacture of paint and paper, chlorine and caustic soda, fertilizers and pesticides. It is a potent hazardous substance andit is present in both inorganic and organic forms which are highly toxic. Inorganic mercury undergoes rapid methylation in aquatic environment by the anaerobic bacteria in bottom muds forming methyl mercury (CH<sub>3</sub>Hg<sup>+</sup>) which is concentrated in living organisms and can lead to mercury poisoning. Mercury pollution affects the rate of photosynthesis of phytoplanktons. The vapour of methyl mercury was responsible for Minamata epidemic disease that causes several deaths in Japan and Sweden. The cause of death was that people eaten fishes which are contaminated by mercury in the Minamata bay of Kyushu in Japan during 1953 – 1961. The water of the bay was contaminated by effluents of the industry containing mercury. In Sweden also river have become polluted by mercury from paper and pulp industries and those manufacturing pesticides. Methyl mercury accumulates in fatty tissue. Fish may accumulate the methyl 3000 times more mercury in fish than in water. In Minimata bay mercury was discharge in bay from single chloride producing plant, using Hgcl<sub>2</sub> as a catalyst. The effluent of many industries making switches, batteries, thermometers, fluorescent light tubes and high intensity street light lamps also contain mercury.

The symptoms of methyl mercury are malaise, numbness, visual disturbance, dysphasia, ataxia, mental deterioration, convulsions and final death. Methyl mercury and inorganic mercury are potent teratogenic causing deformities in the developing embryos of frog and fish. They affect the nervous system. The children suffer from mental retardation.

Mercury is also responsible for bringing about genetic defects causing chromosomal defects, interference with cell division, resulting in polyploidy or abnormal distribution of chromosomes.

Methyl mercury poisoning in humans leads to severe damage to nervous system, characterized by loss of sensation at the extremities of limbs and area near mouth, by loss of co-ordination in gait by slurred speech, by diminution of vision, and by loss of hearing.

#### **Lead Pollution**

Lead pollution arises from various industrial and mining effluents. It is also the constituents of effluents arising from battery manufacturing, printing, painting and dyeing. Lead is a natural constituent of air, water and the biosphere and human beings ingest a certain amount in food, water and air.

In some plastic pipes lead is used as stabiliser, so water becomes contaminated in these pipes. From rocks also it reaches to water. Once it reaches in water, lead enters the food chain.

#### Effects of Lead

- (1)Lead is highly toxic to plants and animals including man.
- (2)It affects children more severely than adults.
- (3)Lead poisoning causes variety of symptoms such as liver and kidney damage, reduction in haemoglobin formation, mental retardation and abnormality, infertility and pregnancy.
- (4)It causes in industrial worker gastrointestinal troubles, neuromuscular effects (lead palsy), central nervous system syndrome that may result into coma and death.
- (5)Lead poisoning causes constipation and abdominal pain.
- (6)Lead is potent enzyme inhibitor because it is easily incorporated into enzyme structures especially with sulphidryl (-SH) groups. It also inhibits the synthesis of heme and utilization of iron in the body.
- (7)Lead poisoning causes brain damage and symptoms are clumsiness, subtle changes in mental attitude, sluggishness, poor memory, loss of concentration, restlessness and hyperirritability.
- (8)Lead compounds are also teratogenic and carcinogenic.
- (9)Lead is deposited in the bones.

#### Cadmium (Cd) Pollution

Cadmium is also recognized as an environmental pollution. It is a soft silvery white metal used in nickel-cadmium rechargeable batteries in alloys, in electroplating and as a plasticizer for polyvinyl plastics.

Cadmium is generated in waste streams from pigment works, textiles, electroplating, chemical plants, metal alloy and by dissolution from galvanized iron objects. It can get into food from mental cans and plated utensils. The permissible level for cadmium in drinking water supplies is 0.01 mg/l.

#### **Effects of Cadmium**

- (1) Cadmium accumulates in the body of aquatic animals like shell fish, aquatic plants which is lethal to both oysters and aquatic plants. It can retard growth of aquatic plants.
- (2)It can combine synergistically with other metals like copper and zinc which increases it toxicity.
- (3)Cadmium lead to very rapid sterilization of animals because of its toxicity to testis and sperms cells.
- (4)Cadmium and its compounds produce malignant tumours in rats but it is not certain that they are carcinogenic to humans.
- (5)It leads to heart disease in humans.
- (6)It also damages the kidneys and liver and prevents the proper functioning of enzymes.
- (7)Cadmium is responsible for itai-itai disease or ouch-ouch disease. The symptoms of this disease was the pain from pressure on the bones especially the femur, backbone and ribs. It led to bone deformation which produced a wadding gait. After several years victims would be unable to walk and their bones could be easily fractured.

#### Chromium

Chromium metal is found in two forms in effluents, hexavalent and trivalent. The hexavalent chromium is present in the effluents of plating operations, aluminum anodizing, paint and dye operations and other industries. Trivalent chromium occurs in waste waters from textile dyeing, ceramic and glass industry and photography. The permissible limit in drinking water is 0.05mg/l.

#### **Effects of Chromium**

- (i)It is toxic to aquatic plants and animals including humans.
- (ii)It produces lung tumours and potent sensitize of skin.
- (3)Agricultural wastes: The chief agriculture chemical wastes are pesticides and fertilizer which are important water pollutants. Their discharges reach into water bodies. Along with this animal waste also contributes water pollution. These pollutants have harmful effects on aquatic life including human being.

**Pesticides:** The various pesticides like insecticides, fungicides, acaricides, nematicides, herbicides, rodenticides and molluscicides are most effective dependable and economical tool in pest management on crops. These chemicals have been effective in controlling diseases and pests that affects crops, livestock and even humans.

The crops yields have been greatly increased and many millions of lives threatened by insect borne diseases are saved by the increased use of these chemicals. At present more than 1000 pesticides are in common uses all over

the world and more than a quarter of a million tonnes of insecticides alone are sold annually to the farmer in India. The widely used pesticides are classified into three groups

- (i)Organophosphate pesticides e.g. Sumithion, Malathion
- (ii)Organochlorine pesticides e.g. BHC, DDT, Aldrin, Endrin etc.
- (iii)Carbamate pesticides e.g. Furadan

The pesticides enter the aquatic environment by various ways and pollute the water. They reach water either by direct application or indirect and unintentionally. The indirect sources includes run off agricultural field, spray drifts, rain water, sewage and effluents from industries manufacturing pesticides or using them in their processes.

The pesticides present in water get concentrated in the tissues of plants and animals. The chlorinated organic pesticides like DDT, dieldrin and aldrin are hazardous mainly due to their concentration in the food chain. They have high stability, low vapour pressure and very low solubility in water but solubility in oils and fats. It tends to become more concentrated from one tropic level to another due to the process of biological magnification.

#### Effects of pesticides

- (i)Pesticides are mutagenic causing mutation in genes and chromosomes.
- (ii)Pesticides are also teratogenic causing congenital malformations.
- (iii)Pesticides like DDT, Aldrin, Heptachlor and Mirex are capable of producing tumours.
- (iv)It also causes harmful effects on wildlife because they are often concentrated in food chains. The high levels of pesticides in birds and fish damage their health or reproductive abilities causing decline in their population.
- (v)Fish also exhibit acute responses to pesticides. The major fish kill occurred due to pesticides spraying. Fish show haemorrhaging and death. The sublethal effects of pesticides on fish are behavioural changes, bone degeneration and vertebral damage.
- (vi)Pesticides are also responsible for bringing about histopathological alterations in vital organs, such as gills, skin, liver, digestive tracts, kidney and reproductive organs in aquatic animals. Pesticides also show the depression in oxygen consumption in fish and prawns.

Artificial fertilizers: Artificial fertilizers or plant nutrients are another important water pollutants. Nitrogen, phosphorous and potassium are essential elements which are required by the plants and animals for maintaining their growth and metabolism. The small amounts of these nutrients are sufficient to maintain a balanced biological growth. Modern agriculture rely heavily on artificial or chemical fertilizers. Problem can arise from over use of the fertilizers, because the fertilizers can be transported into ground water by leading or into water ways by natural drainage and storm runoff. Nitrates are of special concern. They enter our wells and ponds. These waters are very rich in nitrates. It not only makes water unfit for drinking but also causes disease.

Such water when consumed by person, the nitrates are converted to nitrites by the microflora of intestine. These nitrites then combine with haemoglobin of blood to form methaemoglobin which interfere with the  $O_2$  carrying capacity of the blood. This disease produced is called methaemoglobinaemia in infants (or blue born disease). This leads to various ailments as damage to respiratory and vascular system, blue colouration of skin and even cancer. The same process occurs in the stomach of ruminants, so livestock can also be affected by nitrate poisoning. The nitrate can be further converted to amines and nitrosoamines in the human body leading to a possible cause of gastric cancer.

# **Ground water pollution**

It is largest sources of water for biotic life. Due to releasing of raw sewage in shallow soak pits has caused pollution of ground water in many cities. Pollutants contained in seepage pits, refuse pits, septic tanks and barnyards may percolate through layers of earth and find their way into ground water. Some industrial products and process wastes may also cause pollution of ground water.

Modernization of agriculture has led to excessive use of nitrogenous fertilizers. The nitrates pollutes under ground water because of seepage of irrigation water into ground water recesses. If such underground water is used as drinking water cause serious health hazards and disease like methaemoglobinameia. The nitrates are soluble in water trickle down through layers of soil into deeper layers of earth and ultimately are added to the underground stores of water. So therefore removal of these soluble nitrates is important. It can be done by various methods such as chemical coagulation and filtration, carbon absorption, chemical oxidation, ion-exchange, electro-dialysis and reverse osmosis.

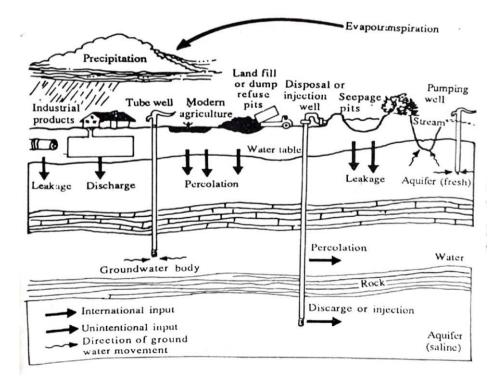


Fig7.1: Sources of ground water contamination

#### Marine pollution

Ocean is the major sources of available water on earth. Any human intervention, addition of pollutants, exploitation of ocean resources such as pollutants from oil spoilage and nuclear testing are likely to bring about drastic imbalance in the global water cycle and this may change the pattern of the climate. Estuaries and coral reefs are the habitats of richest biological rivers ultimately pour into seas. On their way to sea, river receive huge amount of sewage, garbage, agricultural discharge, biocides including heavy metals. All the pollutants are added into sea. Beside these discharges of oils and petroleum products and dumping of radio-nuclides waste into sea also cause marine pollution. Huge quantity of plastic is also being added to sea & ocean. Large amounts of sewage and domestic waste are directly dumped in the sea.

Apart from the above sources oil spills, industrial effluents and discharge of hot waters and mining of polymetallic nodules cause marine pollution. A spill in oil or petroleum product due to accidents or a deliberate discharge of oil polluted waste brings about pollution.

Petrochemical refineries and waste from auto crank oil pollution. In 1991 conflict between Iraq and Allied coalition forces, in whichmillions of gallonsof crude oil was pumped into Gulf. It badly affects flora and fauna of oceans. Many sea birds are killed by oil pollution. The oil is soaked in feathers, displacing the air and thus interferes with buoyancy and maintenance of body temperature. Detergents used to clean up the spill are also harmful to marine life. Marine pollution affects the life of fish, clams and oysters by choking of gills by oil. Photosynthetic activity is inhibited by cutting off light. Inhibition of reproduction and genetic damage top endangered species of flora and fauna occur due to oil pollution.

**(4)Physical pollutants (Thermal and radioactive)** :It include thermal pollution and radioactive pollution.

**Thermal Pollution:** The power plants and industry use large quantities of water for cooling purposes. The used coolant water is usually discharged directly into water bodies. This could result in increase in temperature of water bodies and it deleterious effects on aquatic organism. This defined as "Presences of large amount of waste heat in receiving water which causes harmful effects in natural environment". The increase in water temperature decreases the O<sub>2</sub> saturation percentage and lower dissolved oxygen levels. This is because the hot water tends to form a separate layer above the cool water due to density differences between hot and cool water layer. The upper hot layer which itself hold less O<sub>2</sub> than the cooler layer below, prevents the replacements of oxygen in the cooler layer as it denied contact with the atmosphere. The dissolved oxygen level falls rapidly due to normal biological functions in the lower layer and may lead to anaerobic conditions. The thermal pollution adversely affects aquatic life. It increases in temperature lead metabolism and respiration increase in biotic. Some time death due to failure of nervous system takes place. The reproductive mechanism also get affected and diurnal, seasonal behaviour of organism get changed. The high temperature also increases the toxicity of some chemical pollutants.

**Radioactive Pollution:** The radioactive wastes are generated when nuclear energy is produced. The nuclear energy is produced by splitting of nuclei in the atom to generate electricity. This radioactive waste is hazardous and causes death to man and other biotic community when not properly disposed. Any leakage or accidents taking place in nuclear power plants might be due to technical or manmade fault causes nuclear hazards.

Chernobyl nuclear disaster is the worst nuclear disaster in the history of human civilization, which take place on 26<sup>th</sup>April 1986 at Chernobyl in Ukraine. The accident occurred at the reactor power plants designed for the production of electrical energy 1000 MW. Due to problem in shutting down the plant, an explosion took place in the reactor. It was so intensive and severe that a very heavy concrete lid of the reactor blown off. The reactor caught fire due to graphite rod combustion. The reactor temperature goes high up more than 2000°C. The radioactive substances make harmful effects on plant, animal, environment including human in many ways. In human it increases in cancer cases, reproductive failure, eye diseases, blood abnormalities, cataract are health hazards due to this disaster.

The radioactive substance damage to aquatic environment from wastes of uranium and thorium mining and refining from nuclear power plants and from industrial use of radioactive materials. The radioactive substances can enter humans with food and water and get accumulated in blood and causes harmful effects like bone, liver, thyroid, cancer and mutagenic changes. At present radioactive wastes are sealed in containers and dumped into the ocean. If there is any damage or leakage from the containers, the nuclear wastes escape and enter the marine system.

# Control of water pollution

- (i)Water pollution at point sources can be reduced by legislation and to prevent water pollution from non-point source is difficult due to absence of proper policies and strategies.
- (ii)Sewage treatment is must before it released into water by physical methodsedimentation and filtration for removing large and suspended particles. Then by secondary treatment to promote bacterial treatment which leads biological oxidation carried out in oxidation pond and biosolid get formed. The tertiary treatment to pathogens, metals are removed by strong oxidizing agents like chlorine gas, ozone gas and then waste water is discharged into natural water or used for irrigation.
- (iii)Industrial hot water should be cooled when released from power plants or from industrial plants.
- (iv) Washing clothes and taking baths in tanks or wells from where supply of drinking water is made, it should be strictly prohibited.
- (v)Acids and Alkalies can be neutralized before releasing into water i.e. acids by lime stone and Alkalies by CO<sub>2</sub>, Sulphuric acid.
- (vi)Metallic salts can be precipitated before releasing.

- (vii)Oil spills in water, enemy of aquatic can be cleaned with Bregoli resembles saw dust.
- (viii) Avoid chemical fertilizers and use biofertilizers.
- (ix)Use of pesticides should be minimized or at least agrochemicals should be used judiciously and avoids the use along sloped area.
- (x)Integral pest management need of sustainable yield.
- (xi)Use nitrogen fixing plants as supplements to the fertilizers.
- (xii)Separate drainage channels for sewage and rain water should be provided.
- (xiii) Nutrient rich water should not be used as fertilizer in field.
- (xiv)Water pollution can be controlled and minimized by ecosystem stability.
- (xv)Activated carbon absorbents reduce the level of pollutants when waste water passes through and technique is used to remove pesticides/insecticides such as DDT

#### SAQ 1.

Complete the following sentences by inserting appropriate words in the blanks.

- (i)Dysentery causes due to -----.
- (ii) Fish inhabiting mercury contaminated water used as food causes ------
- (iii)Chernobyl nuclear disaster takes place at -----
- (iv)Eutrophication occur due to enrichment of -----

#### **Structure (B) Soil Pollution**

#### 7.3 Introduction (Soil Pollution)

The man is exploiting the environment and threatened by his reckless activities. The exponential growth of population with limited soil and water resources have created grave concern throughout the world today. The problem of land degradation as a result of human activities is alarming and seriously affecting the quality of human society. The improved technology, fertilizers, pesticides are important andessential for increase in yield but eventually they threaten to create environmental imbalance. To meet the ever increasing demand from ever increasing population requires intensive cultivation.

Soil pollution can be defined as "the addition of substance adversely affect physical, chemical and biological properties of soil and reduces its productivity". There are many natural and synthetic materials adversely affect soil and seriously affect its productivity. Once the soil becomes infertile it is very difficult to convert into fertile or productive soil. Soil erosion is another form of soil pollution where fertile soils are lost.

# 7.4 Sources, Nature and harmful effects

Soil pollution is an extremely complicated process. It may be the direct effect of dumping and disposal of wastes, application of agrochemicals or the indirect result of secondary air pollutant such as acid rain. The following are the important soil pollutants.

- (1)Industrial wastes & urban sources
- (2) Manure or farm animal wastes
- (3)Radionuclides
- (4)Pesticides
- (5)Fertilizers
- (6)Solid wastes and garbage
- (7)Acid rain
- (8) Salination of soil
- (9)Dead animals
- (1)Industrial wastes & urban sources: The urban sewage, garbage when used as source of irrigation alter the soil properties as chemical substances through industrial effluents and urban sewage enter into soil, changes the chemical properties of soil and pollute it.

The content and proportion of industrial discharges depend on the nature of the industry and processing of waste water. When such wastes are directly released on the soil, it pollutes the soil and make unproductive. The mining wasteindustry contains chlorides, heavy metals, sulphuric acids and H<sub>2</sub>S. The iron and steel industry release sulphides, oxides of copper & chromium. The food processing industry release organic matter, paper and pulp industry release organic acids, wood sugar cellulose etc. Sugar industries collect their spent wash and effluents in the lagoons which make soil acidic and it creates the problem of odour. Thermal power station releases fly ash, which ultimately settles on the soil. The fly ash contains heavy metals like cadmium, mercury, lead etc. which mixes with soil and bring about characteristic changes in soil. It becomes contaminated and loses its fertility, which causes decrease in the crop yields.

(2)Manure or farm animal wastes: The farm animal wastes have regarded as an important soil fertilizer. Fields fertilized with manure generally show higher yields than those without manure and even when the manure treatment is ended, the favourable influence persists for years and it is observed that due to such manure yields are decreases 50% in 10 year.

The excretory products of people and livestock and digested sewage sludge used as manure pollute the soil. In developing countries the unhygienic practices of people and faulty sanitation aggravate soil pollution. There is practice in some places where sewage water is directly supplied to the fields growing vegetable crops. But the innumerable pathogens contained in these wastes contaminate the soils and vegetable crops and cause serious health

hazards for man and domesticated animals. Therefore, vegetable field should not be irrigated with such waste water.

- (3)Radionuclides: The radioactive element from nuclear explosion results into release of radioactive particles like strontium 90, Cesium 137, Iodine 131, Uranium 235 in the atmosphere. These particles settle down to cause water and soil pollution. The radio activity is transferred to the soil particles. From soil these particle enter into food chain affecting different forms of life. They causes somatic and genetic damage in the body.
- (4) Pesticides: The pesticides are essential in agriculture and public health. Due to increased use of pesticides, food production has been increased in many folds and many insect borne diseases are successfully control in human beings and live stock. Due to indiscriminate use of pesticides has created serious problem of air, water and soil pollution. The pesticides like DDT, dieldrin and aldrin are hazardous, due to their concentration in the food chain. By the long lastinguses of these pesticides goes on increasing in soil and nitrogen fixing bacteria, algae and earthworms. Thus they affect the soil fertility and such polluted soil become unproductive. These chemical biomagnifications from one trophic level to another and ultimately these toxic chemicals finally reaches into human body, where they are deposited into fat tissues. On break down of fat, the pesticides are released into blood stream and producing toxic effects. Many biocides like BHC, 2,4-Dichlorophenoxy acetic acid, 2,4,5-Trichloro-phenoxy acetic acid are also polluted the soil.
- (5) Fertilizers: Fertilizers or plant nutrients, both natural and artificial are essential for maintaining the growth of the plants. They should be given in proper proportion. But to get more and more yield farmers use artificial or chemical fertilizers in large scales, which create adverse effects. Artificial fertilizers crowd out useful minerals naturally present in the top soil. The soil microbes such as bacteria, fungi and worms etc. present in top soil enrich the humus and help to produce nutrients to be taken up by the plant and later by animals. But fertilizer enriched soil cannot support microbial life and hence there is less humus and less nutrients and soil can become poor and eroded by wind and rain. Thus the over use of chemical fertilizers make soil infertile.

Many crops today lack potassium due to excessive use of nitrogenous fertilizers. Nitrates, phosphates, potash also affect the quality of food. Nitrate fertilizers increase the total crop yield but at the coat of protein. The excessive plant nutrients are harmful to soil organisms. Due to percolation these chemicals find their way into well and underground water. They make the water unfit for drinking but cause diseases.

(6)Solid wastes and garbage: The solid waste includes glass, glass containers as bottles, crockeries, plastic containers, polythene, paper and other packing materials that are used and then thrown away as garbage. The garbage contains discarded food, vegetable matter, kitchen refuse etc. The garbage piles up at public places and causes obstruction in daily life. The wastes from building material (during construction and demolition) sludge, dead animal skeletons etc. also contribute to solid waste. Many times city garbage and solid waste are deposited on the land away from city called garbage depot. Due to pathogen, soil gets polluted and it becomes useless for cultivation. Many times this garbage is mixed with soil which pollute the soil.

- (7)Acid rain: Acid rain is the secondary pollutant but very hazardous air pollutant. The oxides of sulphur and nitrogen are important gaseous pollutants of air. They are mainly produced by combustion of fossil fuels, smelters, power plants, automobile exhausts and domestic fires etc. They are released in the atmosphere and are oxidized into acid. Sulphuric acids and nitric acids are the two main acids which are formed when these gases mix with water vapour and precipitated on the soil. Acid rain creates complex problems and their impacts are far reaching. They increase the soil acidity, thus affecting the flora and fauna of the soil. Many bacteria and blue green algae are killed due to acidification, thus disturbing ecological balance. Acid rain kills forest cover of the land. Acid rain causes acidification of lakes and streams thus affecting aquatic life, affects crops productivity and human health.
- **(8) Salination of soil :** The increase in the concentration of soluble salts adversely affect the soil productivity and degrades the quality of land. Salt dissolved in irrigation water accumulate on the soil surface. This is aggravated by inadequate drainage especially in flood ravaged and well irrigated areas. Additional salt from the lower layers moves up by capillary action during summer season and are deposited as white crusts on the surface.

Intensive farming with poor drainage is causingserious salination damage in large areas of India. Total amount of saline land in our country is estimated at six million hectares. In Punjab alone annually 6000 to 8000 hectares of farm land are becoming unfit for agriculture. Nearly one-sixth of the arid and semi-arid lands of the world have high salinity.

Irrigation water can also percolate down to underground water supplies and make them increasingly salty. Salinity is a worldwide concern and has been a problem for many millennia.

**(9)Dead animals :** The disposal of dead animals is another problem. The dead bodies show decomposition and produce objectionable odours. Such dead bodies also pollute the soil.

#### **Control of soil pollution**

- (i)Animal and agriculture waste can be used for biogas production.
- (ii)Biodegradable waste should be separated and be use to generate biogas.
- (iii)Use filters in industries to collect flyash and other suspended matter.
- (iv)Low lying areas (ditches preferably used as dumping grounds for industrial waste.
- (v)Recover waste from waste so that it will produce some useful product.
- (vi)Use of incinerator to produce energy which will safeguard soils.
- (vii)Cattle dung can be used in biogas.
- (viii)Stress on biofertilizers rather than chemical fertilizers.
- (ix)Reduce the use of pesticides by using substitute like biological pest control method.
- (x)Avoid the use of DDT like for pesticide, residues of which remain years together in soil or in food chain.

- (xi)Adopting organic farming.
- (xii)Plants being the pollution indicator- plantation are must, in industrial areas and in plant (source areas).
- (xiii)Plants (vegetation) holds moisture and protects soil from erosion.
- (xiv)Better soil management strategies may be involved to get maximum result from soils without damaging them.

#### SAQ 1.

Complete the following sentences by inserting appropriate words in the blanks.

(i)Solid waste are -----

7.6 Terminal Questions

- (ii)Chemical fertilizer make the soil -----
- (iii)Pollution indicator plant must be planted near -----
- (iv)Use of filter in industries to collect -----

# 7.5 Summary

In first unit you will learn about water pollution. The different sources of water pollutions likedomestic waste water and sewage, Industrial wastes (effluents), Agricultural wastes and Physical pollutants (Thermal and radioactive). The different type of disease caused by water pollution and how to control water pollution.

In second unit you will learn about soil pollution. The important sources for soil pollutants are like industrial wastes, fertilizers, pesticides, heavy metals, ashes, salts, manure, broken glass, dead animals etc. You will also study about how to control soil pollution in this unit

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Q1. Explain about Artificial fertilizers.	
Q2. Explain about radioactive pollution.	
Q3. Explain how fertilizer causes soil pollution.	

# 7.7 Answers

- **SAQ 1** (i) Water pollution
  - (ii)Minimata disease
  - (iii)Ukraine (USSR)
  - (iv)Nitrates & phosphates
- SAQ 2 (i) Soil pollution
  - (ii)Infertile
  - (iii)Industrial areas
  - (iv)Fly ash

#### Ans 1.

Artificial fertilizers or plant nutrients are another important water pollutants. Nitrogen, phosphorous and potassium are essential elements which are required by the plants and animals for maintaining their growth and metabolism. The small amounts of these nutrients are sufficient to maintain a balanced biological growth. Modern agriculture rely heavily on artificial or chemical fertilizers. Problem can arise from over use of the fertilizers, because the fertilizers can be transported into ground water by leading or into water ways by natural drainage and storm runoff. Nitrates are of special concern. They enter our wells and ponds. These waters are very rich in nitrates. It not only makes water unfit for drinking but also causes disease. Such water when consumed by person, the nitrates are converted to nitrites by the microflora of intestine.

#### Ans 2.

The radioactive wastes are generated when nuclear energy is produced. The nuclear energy is produced by splitting of nuclei in the atom to generate electricity. This radioactive waste is hazardous and causes death to man and other biotic community when not properly disposed. Any leakage or accidents taking place in nuclear power plants might be due to technical or manmade fault causes nuclear hazards.

The radioactive substance damage to aquatic environment from wastes of uranium and thorium mining and refining from nuclear power plants and from industrial use of radioactive materials. The radioactive substances can enter humans with food and water and get accumulated in blood and causes harmful effects like bone, liver, thyroid, cancer and mutagenic changes. At present radioactive wastes are sealed in containers and dumped into the ocean. If there is any damage or leakage from the containers, the nuclear wastes escape and enter the marine system.

#### Ans 3.

Fertilizers or plant nutrients, both natural and artificial are essential for maintaining the growth of the plants. They should be given in proper proportion. But to get more and more yield farmers use artificial or chemical fertilizers in large scales, which create adverse effects. Artificial fertilizers crowd out useful minerals naturally present in the top soil. The soil microbes such as bacteria, fungi and worms etc. present in top soil enrich the humus and help to produce nutrients to be taken up by the plant and later by animals. But fertilizer enriched soil cannot support microbial life and hence there is less humus and less nutrients and soil can become poor and eroded by wind and rain. Thus the over use of chemical fertilizers make soil infertile.

# **Unit-8 Environmental Health**

#### Structure

- 8.1 Introduction
  - **Objectives**
- 8.2 Animals in Relation to Human Health
- 8.3 Water in Relation to Human Diseases
- 8.4 Urbanisation Stress and Health
- 8.5 Behaviour Patterns of Health and Diseases
- 8.6 Summary
- 8.7 Terminal Questions
- 8.8 Answers

#### 8.1 Introduction

The environment plays a crucial role in people's physical, mental and social well-being. The degradation of the environment, through air pollution, noise, chemicals, poor quality water and loss of natural areas, combined with lifestyle changes, may be contributing to substantial increases in rates of obesity, diabetes diseases of cardiovascular and nervous systems all of which are major public health problems.

Transmission patterns of communicable diseases are also influenced by ecological, social and economic factors, such as changing land- use patterns, declining biological diversity, alterations in human mobility and outdoor activity, as well as access to health care and population immunity. The Covid-19 pandemic probably began with a single transmission of virus from an animal to a human.

Water has a profund influence on human health. At a very basic level, a minimum amount of water is required for consumption on a daily basis for survival and therefore access to some form of water is essential for life. The microbiological quality of drinking water has been implicated in the spread of important infections and parasitic diseases such as cholera, typhoid, dysentery, hepatitis, giardiasis, guinea worm and schistosomiasis.

Urban health is the study of urban characteristics including features of the social and physical environment and features of the urban resource. The study of urban health requires a multidisciplinary, perspective that can consider

different types of studies, including inter and intra urban studies and public health, urban planners as well as social behavioral and environmental health.

# **Objectives:**

After studying this ur	nit you will be able to known:
☐ About animal	s with relation to human health
☐ Relation of w	ater to human diseases
☐ Effects of urb	anization stress on human health
☐ The behavior	pattern health and diseases

#### 8.2 Animals in Relation to Human Health

Environmental conditions like air, water and food are necessary for man's survival. Apart from their availability their quality and quantity must be assured according to man's natural and acquired capacity for sustenance. Progress in industrialization has brought environmental hazards such as air, water, noise and radiation pollution. These have caused many health problems and diseases. The psycho-social environment is a unique creation of man himself. For example it been shown that lung cancer is caused by chemical substances, present in cigarettes but the habit of smoking is often due to psycho-social causes.

# Animal and human health are interconnected:

The health approach recognizes that the health of human, animals and their environments are interconnected. It has largely focused on zoonotic diseases. The health concept stresses the ecological relationship between human, animal and environmental health. The health approach to the microbiome allows for consideration of both pathogenic and non-pathogenic.

Urbanization of built environments leads to changes in the environmental microbiome which is a factor in human health.

# Environment microbiome affects on the human microbiome:-

The human microbiome can be affected by ingestion of food, water, inhalation contact with surfaces, animals and other people. The gut microbiota may also affect resistance of environmental exposures to parasites and other pathogens.

The microbiome of work environments may also affects the human microbiome. In the study of workers in animal research laboratories sources tracker analysis found that the work microbiome contributed to the oral, nasal and skin microbiome of workers.

Elements of microbial communities can transfer between both human and animals through close contact.

health impacts include.

□ reducing depression, anxiety and social isolation
□ encouraging exercise
□ zoonotic diseases eg. Ringworm, compylobacteriosis

Animals have both positive and negative impacts on human health. Positive

Zoonotic disease are infectious diseases that can be passed from animals to humans. Most emerging and re-emerging infectious diseases in the world are zoonotic. Microorganisms causing important zoonotic. diseases include the bacteria campylobacter, some strains of Escherichia coli, salmonella, leptospira, and the protozoa Giardia and Cryptosporidium, Leptospirosis is the commonest occupationally – acquired infectious disease in Newzeland.

Changes in environment factors such as rainfall and land use may lead to changes in the incidence and characteristics of zoonotic diseases.

Allergies and triggering of asthma may results from exposure to some animals such as cats or dogs. Antimicrobials (eg antibiotics) used to treat various infectious diseases in animals may be the same or similar to those used in humans. Resistant micro-organisms (eg, bacteria) arising in animals, human or the environment from antimicrobial use may spread from one to the other.

#### Animal is Relation to Human Health:

☐ allergies, antimicrobial resistance

There are some animals (including protozoa) which cause important diseases of man. These disease are infectious and of high incidence in tropical populations.

It may be seen that helminthic disease are highly prevalent in Africa,

There are two main groups of animals involved in human health (i) the protozoa (ii) the helminths.

The helminths include two phyla

- (a) Nematode (round worms)
- (b) Platyheminthes (flatworms such as cestode topwords and the trematoda flukes)

Many of these disease are <u>endemic</u> to particular populations ie. They are present all of the time at more or less constant levels of infection.

Other type of diseases are <u>epidemic</u> which arise suddenly sweep through the population and then disappear again.

#### **Diseases transmission:**

Diseases also differ in respect of the mode of their transmission. Some diseases are transmitted directly from one human host to another such as dysenteries

and intestinal nematodes. Others involve a second host, vector which transmits the disease from one person to another. The vector are also infected but by a different stage in the life cycle of the parasite. Many important tropical disease like malaria, onchocerciasis and the filariases have the blood sucking flies as vectors whereas schistosomiasis is transmitted by snails. These invertebrate vectors all have important aquatic stages in their life cycles, in other diseases as sleeping sickness vector are the terrestrial insects.

# **Parasite Adaptation of Flatworms**

**Adaptation.** Adaptation is the fitness of an organism to its environment. It is the characteristic which results in suitable and convenient morphological and functional correlation between an organism and its environment.

Parasitic flatworms (trematodes and cestodes) have undergone profound adaptation to suit their parasite mode of life. These adaptation termed parasite adaptation is such cases, are of morphological as well as physiological nature.

#### Helminths and Human Diseases.

Helmints are animals that belongs to the phyla. Platyhelminthes and Nematoda (Nemathelminthes.) Many parasitic forms of this group, popularly known as parasitic worms, are endoparasites of gut and blood in human body which cause diseases collectively called helminthiasis. Following there forms of helminthiasis are the most widespread: (i) nematodiasis, (ii) trematodiasis and (iii) cestodiasis

#### Nematode Parasite of Man and Animals

Nematodes are elongated, unsegmeted, triploblastic, pseudocoelomate animals, commonly known as "roundworms." They are widely distrubted free-living as well as parasite animals. Free living nematodes are found in all sorts of environments in sea, in fresh water and in soil on land. Parasite nematodes parasitize all kinds of plants and animals and display all degrees of parasitism. About 50 species of nematodes are known to occur in man, but only a dozen of these are of pathogenic importance. They are of utmost economic and medical importance to man.

1. Genetic Influences. All organisms inherit a set of genes called genome from their parents. Genes determine the physical and physiological characteristics of an organism. That is why a child resembles his parents. Some human beings are born with abnormalities. The inherited abnormalities are called hereditary diseases, which are passed on from parents to the offsprings. Examples of hereditary diseases are haemophilia, mongolism, sickle cell anaemia, phenylketonuria. There are other diseases such as allergies, diabetes, hypertension, schizophrenia etc. which are due to the interaction of genes with environment. These diseases are triggered and affected by nutrition, stress, emotion, hormones, drugs and other environmental interactions. In other words, they would not occur if the environment is favourable

for the person, he will remain unaffected and healthy. Such diseases are referred to as due to genetic influences.

#### 8.3 Water in Relation in Human Diseases

# Disease causing agents creating pollution in water

Water has been a potential carrier of toxic, inorganic and organic materials, non-biodegradable matters and pathogenic microbes which can endanger health. The potable water contaminated with municipal sewage is root cause of dangerous diseases in living organisms.

#### **Industrial Wastes**

Industry is the largest user of water. Industrial wastes waters contain a wide variety of toxic inorganic and synthetic organic pollutants, most of which are not readily susceptible to biodegradation. Solvents, oils, plastics, plasticizers, metallic wastes, suspended solids, phenols and various chemical derivatives are common. The quantity and chemical composition of domestic or industrial sewage varies from hour to hour and from day to day. Packing plant sewage is rich in nitrogenous organic matter as manure, blood, fresh grease and hair. Sewage from wood-pulp plant is rich in cellulose, lignin and bisulphates. Almost all industries (dairy, tannery, Cannery, distillery, oil refinery, textile, coal and coke, synthetic rubber, steel etc.) produce their own characteristic sewage. These are known to be highly toxic to living organisms including wildlife.

# **Effects of Pathogens**

Parasites are considerably harmful for man. Egg of nematodes, hook
worms and tap worms occurs mostly crude sewage. When such
sewages are discharge into water bodies without treatment,
contamination of water occurs with resultant danger to man and aquatic
life.
The enteric diseases are transmitted mainly by drinking contaminated
water or swallowing food. The pathogens most frequently transmitted
through water causes infection of intestinal tract like typhoid,
paratyphoid, amoebic dysentery cholera etc.
The disease causing organisms present in the faeces of infected people
get ultimately mixed with the water supply spreading chronic diseases.
Intestinal helminthes i.e. Ascaris lumbricoides and Trichuristrichiura
are also water borne. Entamoeba histolytica is the casual agent which
causes intestinal amoebiasis and several extra-intestinal diseases.
The guinea worm responsible for dracontiasis, is transmitted open
village wells and ponds infested with the copepod intermediate host.
Serveral human eoudenucs causes by disease contraminated water.
J

#### Infections transmitted from man to man

- ☐ Typhoid fever bacillary dysentery, cholera, poliomyelitis and hepatitis occur from contaminated water and food through inhalation.
- ☐ Staphylococcal and streptococcal infections occur from water, air, food or contact and inhalaition.
- ☐ Caxsackie and Echovirus diseases occur from water through ingestion.

# Effects of Radioactive pollutants in water

- ☐ Living organisms are considered as the prey for radioactive contaminations in water. As compared to organic poisons, injurious effects of radionuclides are exceedingly high.
- ☐ In aquatic animals, radiation damage makes cell membranes permeable so that abnormal interchange of materials through an cell membrane can result in temporary or permanent injury in them.
- ☐ Trances of radioactive materials present in water cause cancers, leukemia, eye cataract, DNA breakage and carcinoma in man.

# Susceptible person Pathogens in excreta Consumption of untreated water Fig8.1

# **Effects of Eutrophication**

☐ Many pathogenic microbes, viruses, protozoa and bacteria etc. grow on sewage products under anaerobic conditions. It result into spread of fatal water borne diseases such as polio, dysentery, diarrhoea, typhoid and viral hepatitis.

☐ The lake undergoing entrophication may become oxygen deficient destroying fish habitats leading to the elimination of several desirable aquatic species in water.

# **Effects of Biological Pollutions**

**Bacterial:** Pathogenic bacterial are the chronic disease carries which pose a serious threat to human health. Several diseases are transmitted to man by these pathogens through contaminated water supplies. The common and severe diseases are dysentery, typhoid fever, cholera, gastrocnteritis, jaundice, leptospirosis, which are transmitted in water polluted by animal discharges. The dangerous pathogenic disease spreading bacteria are salmonella typhosa, leptospira, vibriocholera, tuberculosis etc.

**Virus:** The common virus present in polluted waters and sewage are adenoviruses, Enteroviruses, Polioviruses, Hepatitisviruses.

**Parasites:** Deformities of body parts and mal-functioning of organs like liver, kidney and intestine take place by harmful parasites. Ascaris, round worms and helminthes parasites enter and multiply in man body by drinking such polluted water.

# Water Quality

The standard for potable water or drinking water recommend that it must be free from pathogenic microorganisms and chemicals that are harmful to human health. Most of our urban population is served by surface water (rivers, streams and lakes). The raw water obtained from these sources is frequently contaminated with (i) industrial wastes and (ii) domestic (chiefly human) wastes or sewage. These wastes are usually disposal of in the above said water bodies.

# **Human Waste (Sewage)**

The term sewage is sometimes used in collective sense for used water supplies of homes, communities or industries, or polluted water. The excreta of alimentary canal are called faces. Generally we use the term sewage for wastes from homes or communities especially faecal matter. They consist primarily of intestinal bacteria. Faeces are the most common pollutant of potable water. Many microbes produce bad taste and odour to water. These include algae, protozoa and iron bacteria. Some produce colour and slime which causes clogging of water filters and water pipes. Sulphur bacteria also produce foul smell to water.

#### **Contaminated Water and Diseases**

The potable water contaminated with faeces is the chief cause of some important diseases of man. The enteric diseases are transmitted mainly by swallowing food or drink contaminated with faeces. Typhoid fever, dysentery (bacterial and amoebic), cholera and other enteric diseases are caused by consumption of contaminated water.

# **Index Organisms of Faecal Contamination**

There are some parameters that indicate the level of water pollution by faecal matters. These are as follows:

# Coliform group

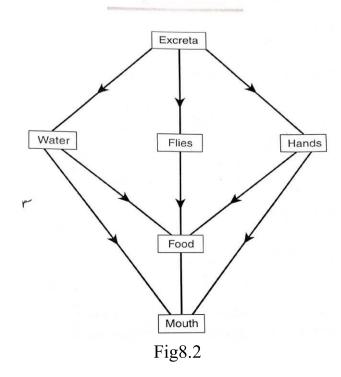
Among the most common organisms of the intestine or sewage (or faeces) are the bacteria of the coliform group. These are aerobes and facultative anaerobes, gramn-negative, non-spore forming rods that produce acid and gas from lactose fermentation within 48 hours at 35°C. The most prevalent in the group are strains of *Escherichia coli* followed by *Enterobacter (Aerobacter) aerogenes*. Their number in polluted water is in millions.

# **Other Index Organisms**

Other group of bacteria present invariably in human (and animal) faeces are (i) faecal streptococci, especially, *Streptococcus faecalis* (ii) *Clostridium*, espically *C. perfringens* and (iii) certain anaerobic bacteria as *Lactobacillus bifidus*.

**Water Pollution:** Whereas some Protozoa are helpful in water sanitation, other become responsible for water contamination or pollution. The protozoa of faecal origin belong to this latter category. Some free-living Protozoa (e.g., *Uroglenopsis*) also pollute water by producting aromatic oily secretion with objectionable odours which render water unfit for human consumption. Water supplies are usually treated with copper sulphate to kill these foul-smelling protozoans.

The Faecal-Oral Route of Disease Transmission



**Helpful in sanitation:** There are some putrefying bacteria found in polluted water, living on various waste organic substance which they decompose. Numerous holozoic protozoa, however, feed on such bacteria, thus helping indirectly purification of water. These protozoa play an important part in the sanitary betterment and improvement of the modern civilized world in keeping water safe for drinking purpose.

# Food and water related health problems

Polluted water may contain chemical agents (poyphenyls, phenols, PCBs, pesticited fertilizers, metals, nitrosamines etc.) and biological agents (bacteria, virus, protozoa, worm, parasites etc.).

1.	Chemical Hazards. Chemical hazards are due to solvent, detergents,
(	dyes, metals, pigments, organic and inorganic chemicals in public water
5	supply. Toxic pollution affect the health as follows:
	☐ Polycholorinated biphenyls (PCBs) causes fatigue, skin
	blemishes, temporary blindness, still births and are carcinogenic.
	☐ <b>Vinyl chloride</b> damages liver, bone, circulatory system, cancer
	of liver, brain lymphatic systems.
	☐ <b>Benzene</b> causes anaemia, bone marrow damage and leukemia.
	☐ <b>Nitrosamine</b> and dioxin are powerful carcinogens.
2.	Biological Hazards. In India 80% of the diseases are linked with
(	contamination water. Among water related diseases diarrhoea, jaundice,
9	guinea worm, Japanese encephalitici (brain fever), malaria, filariasis,
]	knock-knees, are more prevalent in our country.
SAC	Q 1.
(i)	Typhiod fever in human beings is caused by
(ii)	Some of the most common water borne disease in India are
. ,	and
(iii)	What is the most common disease caused by contaminated water?

#### 8.4 Urbanisation Stress and Health

Several studies have described local climate changes disruption of important ecosystems and ecosystem services, large scale deforestation and urbanization as drivers of a wide range of life threatening infectious diseases including dengue fever, yellow fever, malaria, trypanosomiasis, leismaniasis and leptospirosis in Brazil. Several areas for action have been identified, related to air and noise pollution, water protection, chemicals including harmful substances such as pesticides and improving the quality of life especially in urban areas.

Human activity is rapidly transforming nearly all of earth's natural systems.

Many infectious diseases of human including malaria dengue, cholera and schistosomiaisis are restricted to or more prevalent in ,tropical and subtropical zones. Within the tropics and subtropics, they are more prevalent at lower than at higher altitudes. Air quality is worse in urban area than in rural areas. The main sources are road traffic, industrial activates and the use of fossil fuels for heating and energy production.

The urbanization of human populations that could have microbiome effects. The household microbiome in rural villages differs from that the more urban settings.

Industrial expansion results into congestion. The pressure is building up on big cities in developed world. But the process is more complicated in third world countries, particularly tropical ones as ours where bacterial diseases flourish in an epidemic form. Congestion of cities leads primarily to air and water pollutions, that are the starting points for many disease. The unfortunate outcome of industrial growth has been the stress on urban areas due to migration of rural population.

Slum dwellers face environmental, social economic, health, educational and cultural problems. The most prone element are the children an account of poverty, malnutrition, poor drinking water and insanitary environment together with sickness and disease and lack of education.

Housing should not be taken as an isolated but it is interrelated with many aspects. The unchecked growth of metropolitan and other big cities needs to be drastically cut down. There is need to work out carrying capacity of urban areas not only in terms of physical space but also with reference to services, supplies (food, water etc.), transport and shelter etc. A scheme for Environmental Improvement of Urban Slums (EIUS) was launched in 1972. Also improvement in health services needs to be made under the plan "Health for all by 2000 A.D". On November 10, 1980 an "International Drinking Water Supply and Sanitation Decade" was launched to supply clean water and disposal of night soil as also dirty water. It is not only supply of piped water alone but also proper sanitation system as also health education. If water is supplied without proper sanitation, there will be dirty water and encouragement to vectors of diseases. More than 50% of water supply poses health hazard due to negative pressure whereby pollutants get sucked in. Water supply and sanitation programme was launched in 1954. The targets for India for 1990 five year plans are:

- (1) Urban water supply All people.
- (2) Rural water supply All area.
- (3) Sewage and Urban sanitation- 100% in class I cities; 50% in class II; overall coverage in each state would be 80% of the urban population.
- (4) Rural sanitiation 25% coverage

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(i)	What are the three causes of urbanization.
	and

(11)	What	are	the	positive	,	• • • • • • • • • • • • • • • • • • • •	and
	negativ	ve		,		effects of urbanization	on?
(iii)	What i	is urb	an hea	lth problem	n?		
				,			and

#### 8.5 Behaviour Patterns of Health and Diseases

We can define three categories of health behaviour

- (1) <u>Preventive health behaviour</u>- Any activity undertaken by an individual who believes himself (or herself) to be healthy, for the purpose of preventing or detecting illness in an asymptomatic state.
- (2) <u>Illness behaviour-</u> Any activity undertaken by an individual who perceives himself to be ill, to define the state of health and to discover a suitable remedy.
- (3) <u>Sick-role behaviour</u>- Any activity undertaken by an individual who considers himself to be ill, for the purpose of getting well. It includes receiving treatment from medical providers, generally involves a whole range of dependant behaviours and leads to some degree of exemption from one's usual responsibilities.

The environmental microbiome as well as microbiome of animals in close contact can affect both the human microbiome and human health. Such the transfer of microbiome can take place in the houses as well as at the workplaces.

Increase use of cigarettes and bidis and pesticides has caused more diseases.

- (1) Infectious disease caused by poor hygiene and lack of basic health care. Though not uncommon, such disease are not peculiar to tropical countries.
- (2) Disease mostly in developed countries are not infectious and may be related to urban and industrial cultures. These often become manifest in middle or old-age and include disease like, diabetes, obesity, heart diseases, cancers, hypertension etc.
- (3) Major infectious disease of high incidence in tropical countries. These are caused by bacteria (food-poisoning), typhoid and paratyphoid fevers, cholera, various types of gastro-enteritis), viruses (yellow and Lassa fevers), protozoa (malaria, amoebic dysentery) and animals (various helminthes diseases caused by roundworms, hookworms, filarial, tapeworms etc.)

#### Protozoa and Human Diseases

The parasitic species of *Bacteria, protozoa, Fungi, Viruses, Helminths* and *Arthropods*, some are pathogenic for man. Diseases occur as a result of interaction between pathogens (parasites) and human host under specific environmental conditions. This interaction is referred to as a *infection* or *infectious process*, the manifestation of which is always some *infectious disease*. Diseases is caused when pathogenic parasites alters the human body's normal vital activities as a result of morphological and physiological damage.

Pathogenic parasites belonging to various groups of animals kingdom, share the following common characteristic features are:

- (1) All are *obligatory parasites*, i.e. they depend for their existence upon their hosts.
- (2) All show host specificity i.e., they harbour selective hosts.
- (3) They secrete toxic substances which causes the particular diseases.
- (4) They complete their life cycle in one or more than one host.

Parasitic species occur in all classes of Protozoa. Approximately 15 different genera have been found living a parasites within the human body. While the majority of these have relatively little effect upon their hosts, certain pathogenic parasites cause some of the worst human diseases.

**Pathogenic Protozoa.** Parasite Protozoa producing diseases are termed *pathogenic protozoa*, and they occur in all the classes of Protozoa. More than 25 difference species of parasitic Protozoa are known to live in man alone, responsible for several dreadful and fatal human disease. They have caused untold suffering among human populations since the time of primitive man.

Temperature continues to rise due to climate changes and greenhouse gas emissions.

Temperature and rainfall are the most important abiotic factors affecting dengue prevalence in brazil as well as the breeding sites for the mosquito vector some vector- borne diseases including malaria, African trypanosomiasis, tick borne encephalitis, yellow fever, plague and dengue fever all have expanded ranges following increased temperatures.

Types of disease

Diseases can be of two types

- (i) Infectious diseases
- (ii) Non infectious diseases

<u>Infectious:-</u> Diseases that spread from one person to another are called communicable diseases. They are usually caused by microorganisms called pathogens (fungi, rickettsia, bacteria, viruses protozoans worms etc.)

when an infected person discharge bodily fluids, pathogens may exit the host and infected a new person (sneezing, coughing, etc). Examples include cholera, chickenpox, malaria etc.

<u>Non-infectious diseases</u>:- Theses diseases are caused by pathogens but other factors such as age nutritional deficiency gender of an individual and life style also influence the disease. Example include hypertension, diabetes and cancer. Alzheimers, asthma and heart disease are other non-infectious diseases.

Climate change includes varions in temperature, precipitation, wind and sunshine that may affect the survival reproduction or distribution of diseases, pathogens and their hosts. Higher incidence of cases of chikungunya and zika virus infection in Brazil is associated with areas with more frequent rainfall and sever droughts, since both increase breeding sites for the vector aedes species and culex species.

Temperature change alone or together with other variable changes such as rainfall, may alter the transmission of diseases.

#### **Ecological Changes and Diseases**

Cultural changes brings about major ecological changes. Resulting ecological changes consequently may increase the severity of diseases. Cultural changes from rural to urban settlements brought about major ecological changes. The resulting urbanization stress has affected human health. From on ecological viewpoint, there are good reasons to predict that disease burdens will be higher among settled population for example, for a successful transmission, all disease need a threshold level of host population density. The spread of an epidemic needs very dense population. Transmission is also enhanced by permanent settlement because the infective stages or vectors are in contact with the human hosts.

There is much direct evidence that changes to more industrialized forms of agriculture is developing countries have caused much great incidence of some of the debilitating tropical disease. There are many examples of such diseases. We shall briefly examine the interrelationship of ecological and cultural changes with the prevalence of two diseases viz. **malaria** and **trypanosomiasis**.

#### Malaria:

Malaria parasite (*Plasmodium spp.*) are spread by bloodsucking female mosquitoes of the genus *Anopheles*. Standing water is needed to complete the

life cycle as they have an aquatic larval stage. Felling of forest for agriculture produces many permanent or temporary bodies of water at ground level of varying dimensions. Even in deforested areas, changes in agricultural patterns may change the potential for malarial mosquitoes. In western Kenya when irrigated rice fields replaced scattered maize cultivation, seasonal swamps, and water holes with profuse plant growth the propoints of malaria causing mosquitos increased.

Industrial agro-ecosystem basesd in indiscrimate heavy applications of pesticides has resulted into resurgence of malaria in Central America and the Indian subcontinent. In the 1960s and early 1970s the number of infected to people was much higher upto several millions of India. During the same period, in both areas the occurred large scale cash cropping of cotton and other similar crops which demand high pesticide application.

Malaria is causes by the species of *Plasmodium*, the sporozoan parasites. It is transmitted through bite of female anopheles mosquito. In man the parasite attacks liver cells and red blood cells. A toxic substance, *haemozoin*, released by parasite causes malaria.

Malaria is most destructive for man. It is widespread in the temperate, tropics and subtropics. It is characterized by the periodic attacks of fever. The fever is repeated in tertian malaria caused by *P. vivax* every third day; in oval malaria caused by *P. ovale* every third day in quartan malaria caused by *P. malariae* every fourth day and in malignant tertian malaria caused by *P; P. falciparum* every third day Various drugs which are now used in the treatment of malaria include *Quinine, Atebrin, Chloroquine, Camoquin, Pamaquine, Paludrin, Daraprim, etc.* 

# **Trypanosomiasis**

Trypanosomiais which causes sleeping sickness in Africa and Chags' disease in Latin America are transmitted by biting flies and bugs respectively which have wholly terrestrial life cycles. All trypansomiasis in Africa are transmitted by tests flies which are ecological segregated to some extent by environment and by the species bitten.

Both the African and Latin American disease have spreed due to increase of favourable habitats for the vectors.

Trypanosomiasis is caused by the species of Traypanosoma which are flagellate parasites of blood (in vertebrate host) and gut (in invertebrate host). These are most dreadful of all pathogenic protozoans. Sleeping sickness is a dangerous disease of man in tropical Africa. Its causative agent is T. gambiense which is transmitted by a tsetse fly, Glossina palpalis. Infestation of the lymph

system leads to glandular swelling which is symptomatic for sleeping sickness. Later, the parasites penetrate into cerebro-spinal fluid, cause damage to brain.

Environment is the sum total of all social economical biological, physical and chemical factor which constitute the surrounding of man; Environmental science is multidisciplinary in nature involving chemistry, physics life sciences, agriculture, medical science, engineering and public health. The knowledge of environmental science is essential not only to the scientists engaged in various scientific and engineering activities but also to the personnel involved in resource planning and material management.

**Behavioural Influences.** Alcoholism, smoking, drugs, chewing tobacco or irregular food habits etc. result in various kinds of ill health. These depend upon self responsibility nutritional awareness, stress management, physical fitness and environmental sensitivity of an individual.

**Environmental Influences.** Environmental influences on health are physical chemical, biological, sociological and psychological.

#### SAQ 3.

(i)	Alcohol consumption has been linked to
(ii)	Disease of the heart, joints and nervous system are
	called
(iii)	One of the bacterial disease is
(iv)	is a type of bacterial disease
(v)	Infection of Ascaris usually occurs
	by
(vi)	Malignatn tertian malaria is caused by plasmodium
(vii)	Which disease is viral as well as transmitted by
	mosquitoes

# 8.6 Summary

- World Health Organisation (WHO) defined health as a state of complete physical, mental and social well being and not merely the absence of disease or infirmity.
- The physical, biological and social environment keeps on changing throughout the life of an individual, good health involves a process of continuous adaptation to such changes.
- The health of an individual is affected by genetic, behaviourable and environmental influences. Diseases represents a maladjustment of human being to their environment.

- Zoonotic disease are infectious diseases that can be passed from animals to humans. Most emerging and re-emerging infectious diseases in the world are zoonotic.
- The urbanization of human populations that could have microbiome effects. The household microbiome in rural villages differs from that the more urban settings.
- Air quality is worse in urban area than in rural areas.
- Diseases that spread from one person to another are called communicable diseases. They are usually caused by microorganisms called pathogens.
- Theses diseases are caused by pathogens but other factors such as age nutritional deficiency gender of an individual and life style also influence the disease. Example include hypertension, diabetes and cancer.
- Due to the lack of affordable housing settlements with very poor living conditions called Slums develop in urban areas.

# Q 1. What are example of behavioral patterns that contribute to diseases? Q 2. What is human behaviour in health and illness? Q 3. What is the common water borne disease in India? How does contaminated water affect the humans.

Q 4. How to protect yourself from water born disease and what is the difference between diarrhea and dysentery?

Q 5.What are five problems that can come out of Urbanization? Why urban areas have health issues.
Q 6.Describe in detail some common water related diseases.
Q 7. State the difference between infectious and non infectious diseases.
Q 8. How does smoking tobacco in human lead to oxygen deficiency in their body?
Q 9. What is deficiency disease.
Q 10. Why are diseases like cholera, typhoid, dysentery etc. more common in overcrowded places?

	Q 11. What bacterial diseases can you get from contaminated drinking water?					
	How is animal health related to human health?					
•••••	True and False					
(i)	Rapid industrial growth in and around the city leads to lack of job opportunities.					
(ii						
(ii						
·	cultural and social services than in rural areas.					
8.8 A	nswers					
SAQ1						
(i)	salmonella typhi.					
(ii						
(ii	i) Diarrhoea.					
SAQ	2.					
(i)	Economic, Political and Social issues.					
(ii	Positive effects include economic development and education.					
	Negative effects crime prostitution and drug abuse					
(ii	i) Diabetes, Hypertension, Cancers.					
SAQ	3.					

- (i) liver cirrhosis
- (ii) Degenerative disease
- (iii) Tuberculosis
- (iv) Diptheria
- (v) Drinking water cantaining eggs of ascaris
- (vi) Falciparum
- (vii) Yellow fever and dengue.

# Ans. 13 True and False

- (i) F
- (ii) T
- (iii) F

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