15 Diseases from protozoa and worms

In chapter 1 the diagram is given of protozoa and helminthes.

Protozoa

A. Rhizopoda

Amoebiasis (Entamoeba) (water based)

The amoebas produce protoplasm- runners (fake feet), which they are able to walk on, at least move over surfaces. Important for us are *Entamoeba histolytica* ('tissue dissolver') and *Ent.coli* ('from the large intestine'); this last one is not pathogenic and is therefore not discussed.

E. histolytica

This amoeba usually lives innocently as a guest in our intestines, which we call the minuta form (10-20 mu). Sometimes, for unknown reasons, pathogenic forms occur that float through the body. This histolytica form is between 20 and 40 mu big. She forces herself in tissues of the intestine, but can also get to the liver through the bloodstream; lungs and heart can also be affected. These lively amoebas produce abscesses that destroy tissue. The patient has symptoms of diarrhea with slimy, bloody faeces. This amoeba dysentery used to be called 'red run'. It is very similar to faeces of shigellosis infection that also is called 'bacillary dysentery'.

Peculiarly enough the pathogenic form of *E.histolytica* is not able to infect other people; she dies very quickly outside the body. The innocent minuta form only is able to live outside the body by the forming of cysts ('capsules'). The cysts are able to live outside the body for days. The transmission is through contaminated (drinking) water or fecal-oral, from the hand of faces to the mouth.

Amoebas meningitis (and encephalitis) (water borne)

In amongst others Australia free-living amoebas can cause dangerous infections of cerebral membrane and brain tissue. Especially swimmers are warned to squeeze their noses before they jump into the water (up straight). The amoebas can as it happens get high into the nostrils with a wave and from there can enter the skull through the ethmoid bone (lamina cibrosa).

B. Flagellates ('whip carriers')

Giardiasis (*Giardia lamblia*) (water borne)

The pathogen of giardiasis or lambliasis are prevalent everywhere. She is best known from the (sub) tropics through bad water quality, but also from the States, the Russian Federation and Japan. The trophozites that live in the intestine are vulnerable; they are not often seen in faeces. They can form cysts ('capsules') and can stay infectious for weeks up to months under preferable circumstances. Their number determines how much trouble they can cause. The patient has flocky watery faeces and suffers from windiness. The disorder is usually self-limited, which means that the patient barely has problems after a few weeks. However "sprue" might develop, which is a reaction of the intestine to certain tingling; this also can be food components such as grains. The admission of food substances from the intestine is totally disturbed.

One of the three world citizens has the *Giardia lamblia*. Giardiasis is one of the most important causes of diarrhoea by children in developing countries**.**

Trichomonas

We find three types by humans, *T.tenax* (oral cavity), *T. hominis* (lowest part of thick intestine) and *T.vaginalius* (vagina, prostate). Only the last one is pathogenic, depending on the condition of the host/hostess (compare *E.histolytica*). The female patient undergoes an unpleasant discharge (fluorine). This disorder as well as giardiasis is self-limited. The parasite is spread out over the whole world. Sexual intercourse plays the main role in the distribution.

Trypanosoma (water related arthropod borne)

The pathogen of the infamous sleeping disease. There are three main forms: *T.gambiense*, *T.rhodesiense* and *T.cruzi*. The first is the most important one for us because of the biotope of

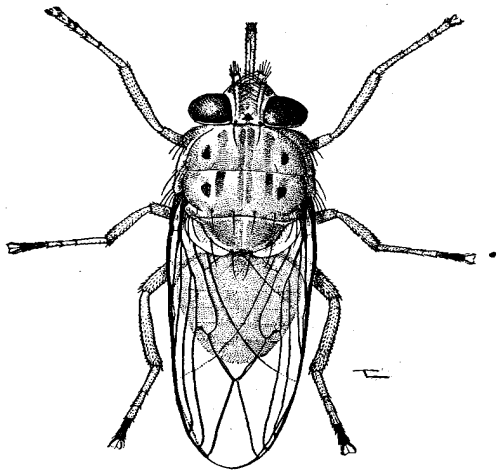

Fig. 37. A Tsetse Fly (*Glossina longipennis*) in the resting attitude assumed by the living fly. Note the position of the wings. × 4. (After Austen)

Fig.

the carrier, the tsetse fly (Glossina). The fly lives in bushes along the rivers and water ways in West and Mid Africa south of Sahel. The human is the only host. The fly sucks blood from the human, but just like the mosquito bites of yellow fever and malaria, it first injects things in the skin; *T.gambiense* can then get into the bloodstream. At this place a trypanome occurs, a local infection, from where the flagellates swarm off. After a period of six months up to a year they could have forced themselves into the nervous system. The patients become slow to lethargic (encephalitis lethargica= sleeping disease)**.** Because they eat badly and cannot care anymore for themselves, all sorts of super infections (infections on top of) get the chance. The patient usually dies from that. Without treatment the CFR is 100 percent (do you know any more infectious disorders with such a high CFR?).

T.rhodesiense and *T.cruzi* occur respectively in East Africa and in Mid and South America (see diagram). The carriers are again Glossina, and bug types (arthropods). The pathogens cause respectively the 'East African sleeping disease' and the disease of Chagas' (from which 10 million people suffer). In both cases meningo-encephalitis occurs (infection of cerebral membrane and brain tissue); with Chagas' disease the heart is also involved. In Africa 50 million people live in tsetse areas, in America 95 million people are exposed to danger of infection by *T.cruzi* (one fifth of the population).

Leishmaniasis (Leishmania) (arthropod borne)

These parasites are transmitted by little mosquitoes (Phlebotomus= blood vessel striker) and not by flies, although the animal is also wrongly called 'sand fly'. The mosquito itself has trouble from flagellates as well, they can partly or totally block his gullet (compare the fate of the flee with plaque bacteria). That is why he when pricking in a vessel possibly is not able to suck up blood and it will flow back in the vessel with the parasites. The *L.donovani* affects the liver and spleen, *L.tropica* the skin and *L.braziliensis* as well as the skin as the mucous membranes. *L.donovani* occurs in East (China) and South Asia, Middle East, the Mediterranean, North and Middle Africa except of the Sahara and South America; *L.tropica* in the same area except of America and China; *L.braziliensis* in Mid and South America (see diagram..).

L.donovani is the most dangerous one. The patients die from this feverish disease of disorders in the defense system and of anemia. *L.tropica* causes festers; usually recovery follows. *L.braziliensis* causes infections in the area of nose, mouth and lips; in Suriname they speak off 'forest-yaws': 'forest festers').

C. Ciliata

These are not discussed.

D. Sporozoa

Plasmodium (water related)

This parasite and its caused disease, malaria, are discussed with in another chapter.

Toxoplasmosis (*Toxoplasma gondii*) (hygiene/ cats)

Through the intestine of a cat, in which the sexual reproduction of the parasite takes place, the human gets in ooccysts through the mouth; sometimes this happens from food that is not been cooked properly. In a couple of days sporozytes develop from these cysts. These can infect many organs through blood; usually the infection occurs subclinically (unnoticed). Damage is only done in tissues of organs as eyes and brains. During the early stages of pregnancy this can also be harmful for the embryo (which we also know from German measles and cytomegalo virus). Humans and several other mammals are intermediate hosts, the cat is the final host; only there the sexual cycle can occur. Especially pregnant women should be near cats or clean the cat's box as little as possible. In The Netherlands however half of the young adults already have antibodies (which makes infection impossible during pregnancy). Suspected are that approximately one percent of pregnant women in our country get a toxoplasma infection; in a number of cases the embryo becomes infected as well.

Pneumocystis carinii

Until the eighties hardly anything was known of this parasite; one knew that healthy people barely had a chance of infection. Then it turned out that many people with HIV infection got an opportunistic infection (pneumonia) with this sporozoon from which they eventually died. The combination of antibodies against HIV and *Pneumocystis carinii*- pneumonia (PCP) is one of the AIDS defined situations. However it is still the case that many AIDS patients suffer from PCP, in spite of good prophylaxis (preventative) and antibiotic therapy. The majority of people with HIV infection die from (opportunistic) infections.

Helminthes (worms)

A. Nematodes

Strongyloides stercoidalis

This special micro organisms can develop itself in various ways. Just like the *Entamoeba hystolytica* the condition of the host is important. Adults of the worm live in the middle part of the thin intestine (jejunum). The females lay their eggs, which hatch in the intestine; the larvae develop in earth. They grow and become adults (then still only 1 mm big) and can sexually reproduce. Sometimes grown larvae develop infectious characteristics. The temperature then is important; below 15 C nothing happens, the best temperature is between 23-30 C.

Larvae with infecting ability force their way into the humans through skin. Via blood and lymph vessels they arrive in the heart from where they are pumped to the lungs with the small blood circulation. Then they can climb upwards to the larynx and can be swallowed to subsequently arrive in the stomach and intestines (the miracle ways of nature; see below also hookworm and round-worm). In the jejunum they become adults in a few weeks. Because the eggs already hatch in the intestine an endogen infection cycle can occur: the larvae force their way through the intestine wall and peri anal skin and infect their mother's host again. These auto infections can go on for years.

The infection prevalence in the world is approximately 40 million people; because of the temperature sensitivity nearly all in the tropics. Evidently there is a task here for the civil engineer. Storage and handling of transport of faeces has to be effectively separated; contamination from untreated faeces of the ground in villages and of field has to be limited. People also should individually protect themselves, for instance with good feet ware.

Hookworms

There are various types of hookworms, that thank their name to the preferable biotope that mines formed in our areas: damp and warm; this means that the tropics are ideal for them. Humans can have thousands of them and together they can do a lot of damage in the intestine. Blood loss through little wounds made by them can lead to serious anemia. Over the whole world there are certainly 1 milliard people infected, a prevalence of one on five world citizens. In some (sub) tropical areas nearly everyone is a carrier. This means that over the world the weekly blood loss caused by these and other worms is much more than the yearly production of the blood banks.

For the human the important ones are: *Necator americanus, Ancylostoma duodenale* and *Ancylostoma ceylanicum*. *N. americanus* is the most frequent hookworm in the tropics. *A. duodenale* can get to 2 cm big; he is the real worm of the mines (in the past also in North Limburg!). *A ceylanicum* is the smallest one and limited to the tropics, for example Suriname. The parasite is polyxene (poly=many, xenos= strange), meaning not clingy: dogs and cats are also hosts. The infection route through the body is the same as Strongyloides and the roundworm.

Roundworm (*Ascaris lumbricoides*)

A big worm, which can occur everywhere, except in very cold or dry areas. About 1 milliard people are infected (a prevalence similar to the hookworm). Fields that are fertilized with human liquid manure cover vegetables and fruit with worm eggs. From the thin intestine the larvae start a time-consuming trip that finally ends in the thin intestine again. This trip however they need to make for their maturation process. It goes as follows: through the intestine wall via the portal vein to the liver and then to the heart; discharged in the lung through the small

blood circulation, where they stay a while and irritate: coughing up brings them in the gullet and so on (see also Strongyloides and hookworm).
The worms are approximately a half year old and live in the thin intestine and feed themselves with our food. They form clews that block the intestines or the exits of the liver and pancreas, where digestive fluids discharge. The infection often goes by without serious symptoms, but the carrier has problems with nausea, lesser appetite and diarrhea.

To ferment human faeces in tanks before handling as a fertilizer can make the eggs harmless (and also provide for domestic gas). The health engineer has a great contribution to break through many cycles of which one economically important cycle becomes harmless: utilizing liquid manure as a fertilizer.

Whip worm (*Trichuris trichiura*)
A wide spread worm that occurs in about half a milliard people. The worms force themselves with their front in the wall of the thick intestine. If they are with many the carrier will notice from the bloody and slimy faeces; a symptom that we already know by amoeba and bacillary dysentery. Via the faeces other people get infected by the eggs (which can stay infectious for years!); a warning of infection of untreated manure fluid is here also appropriate (see also Ascaris or roundworm). The cycle of eggs via the stadium of larvae into worms is unknown.

Trichinas (*Trichinella spiralis*)
About 50 million people have an infection of this little worm in North America and East Europe, which can live in all sorts of animals. The larvae sit in badly cooked meat; in the intestines they develop into trichinas. The trichina lives for several weeks in the thin intestine, where she has her larvae which swarm off via blood to the muscles in all parts of the body. There they nest and can slumber for a number of years. The migration from intestine to muscle can be accompanied by acute heavy symptoms, sometimes even death through brain and heart infection. Because the cycle can occur in all types of animals, like rats, foxes and pigs, the parasite has a wide distribution.

It is evident that strict meat inspection is important, but also sensible behavior of the consumer; also with respect to other organisms such as tapeworm, but also bacteria. Nowadays the outside enjoyment of almost raw meat or barely cooked is a dangerous hobby. Long and very high heating destroys all forms of life (see sterilization). But to even destroy priones (pathogenic proteins) of for example the mad cow disease (Bovine Spongioform Encephalitis) the steak has to be cooked so long that it will turn into carbonate (carbon).

Filariasis (water related)
The Filariidae are thin thread formed (fil=thread) nematodes; the males are 3.5 cm and the females up to 10 cm. Microfilariae need an insect for the maturation phase before returning

back to the human to develop into worms. The larvae are injected by a insect bite in the skin and mature there during approximately a year. From there they force themselves into the lymph glands, subcutaneous connective tissue and other deeper lying organs. The reaction of the body is an infection and in the long term verbindweefseling, with all its consequences. The larvae are called microfilariae; some types swarm in and out the bloodstream with characteristic periodicity (certain periods of night and day); this relates to the differences in concentration of oxygen in day time. This is more or less comparable to the fever peaks of malaria (chapter..). Various forms of filariasis occurs, with different pathogens and carriers.

Wucheria bancrofti causes the lymphatic filariasis and elephantiasis (= filariasis but scarier), *Loa loa* causes loiasis and *Onchocerca volvulus* the onchocerciasis (river blindness); The last parasite is found by research of the patient in subcutaneous connective tissue, the other one is found in blood.

Elephantiasis

This is according to WHO, along with a limited Southeast Asiatic form (the lymphatic filariasis), the only disease that is allowed to be called 'filariasis. The transmitting mosquitoes are the already known carriers of malaria (Anopheles) and yellow fever (Aedes) along with the Culex. The parasite festers itself mainly in lymph organs of legs and pelvis; they cause infections and obstruction of discharge of the lymph's. The well-known pictures show patients with elephant legs or swollen scrotum. The microfilariae are found in blood at night time.

Loiasis

Occurs in the West of Africa in tropical rainforest around big rivers. The intermediate host is a horsefly , the Chrysops (golden eye). Around the afternoon the microfilariae are found in the blood. The adult worms swarm in the lower layer of the skin. Sometimes weirdly enough you can see the worm (Loa loa) moving with your bare eye.

Onchocerciasis (water related carrier borne)

Also called river blindness, but usually the loss of eye sight is a complication that not happens to many patients. It is estimated that in equatorial Africa +/- 50 million people suffer from this disease and in South and Middle America, to which the disease was introduces in the times of slavery, another quarter of a million (this is a prevalence figure); five percent of them become blind, which means more than 2.5 million blind people. The blindness is caused by infections of the eye, such as the iris. Most patients get skin disorders (lizard skin).

The intermediate host is a fly of the genus Similium. This fly breeds along quick running water, that splashes and glitters attracting them. The engineer, who creates such a situation in the breeding area is not doing very well: he should provide for (optical) screening.

Other filarial types:

Dracontiasis (Guinea worm, Medina worm) (water based)

The nematode *Dracunculus medinensis* is a close relative of the Filariidea. The larvae mature in water flea's (Cyclops). Together with drinking water in which the flea's live the larvae get into the human's gastrointestinal tract, here they can nest in the connective tissue and grow into adults. The males impregnate the females after which they die. The females migrate after a pregnancy of approximately a year from the intestine to the subcutaneous connective tissue, preferably the legs. The worm bores through the skin with her head and on that place a blister occurs and later a little sore, often more than one. Next to the head of the 30 to 80 cm (!) long worm is the exit of the womb from which the new larvae are discharged. If patients are in water (to e.g. wash) those larvae get again in water flea's repeating the whole process; after 10-12 days in the flea the larvae are ready for 'the charge'. When all the larvae are discharged the worm dies; but in the mean time the patient had a possibility of infecting many others, through water flea's. Good drinking water facilities are therefore essential to break through the cycle (chlorination or closed distribution).

Already before the occurrence of blisters the patient can have fever and skin symptoms; the blister causes pain and heavy itching. Scratching is tempting but the patients must suppress themselves. Because breaking the worm leads to severe local infections; the best thing is to wound the worm slowly round a stick or match. A few cm per day can end up taking weeks. The symptoms can be reduced quickly by anti worm medicines, but it is uncertain if it increases discharge or death of the worm.

In the beginning of the seventies there was still over the world a point prevalence of about 50 million patients; in the Water Decade (1981-1990) about 10 million patients were measured in 1985 and in 1991 it was less than 3 million. Most important areas: West, Central and Northeast Africa, Mid East, Iran, Pakistan, India, the Northeast of South America and the Caribbean.

In 1993 more than 100 million people were still in danger of infection. The WHO decided that in 1995 it has to be over (the year before this lecture book was published). If WHO succeeds to kill of the Guinea worm, it will result in a second eradication success of WHO (first one).

Trematodes

Bilharzia (bilharziose) or schistosomiasis (water based)

This water based disease occurs in great parts of the world (diagram..), totally in 76 countries; the disease is still increasing to spread. Approximately 600 million people are exposed to danger of infection, about 200 to 300 million people are actually infected and 20 million of

them suffer from severe symptoms of this disease. The table below shows a comparison to malaria**.**

The intermediate host is a snail; the pathogen is a worm of the genus Schistosoma, which settles itself in humans in blood vessels of bladder or intestines or in the portal vein of the liver. They can become 30 years old. Males and females find themselves in a constant state of copulation; the resulting eggs are discharged. When there is no good sewer system snails can get infected from the eggs by these parasites. In the snail the larva develops through a number of stadiums into cercaria, a parasite that is able to swim. Bathing and swimming give the parasite a chance to enter through human's skin and get via blood to the veins of the previous mentioned organs.

Three types of Schistosoma can be distinguished, which occur in three areas: *S.mansoni* in the Northeast of South America, Africa and the whole of Middle East , *S. japonicum* in the Far East, the Philippines and several parts of Indonesia and *S.haematobium* in Africa and the Middle East. The most dangerous complication of the infection is the damage to the liver (liver fibrosis) and bladder cancer; the last one is the most important death cause of men between 20 and 45 years from Egypt.

Fasciola hepatica (liver bone)

This is our local variant of infection by cercaria. The disorder occurs for example in the mild.

C. Cestoda

Taenia (tapeworm)

This final discussed worm is known by everyone: the tapeworm, a resident of our thin intestine. The hermaphrodite worm can possibly become ten meters long and can live more than 10 years. He exists of segments (proglottiden), of which each are able to produce ten thousands of eggs. Per day a number of segments can be broken of and their eggs (they are in fact larvae) are discharged. These can be taken up by the intermediate host, the cow (in case of *Taenia saginata*) or the pig (in case of *T.solium*).

We also see in this case an interesting route: through the intestine wall of the animal to the bloodstream and from there to all sorts of organs, among which are muscles and brains. The larva grows into a developed tapeworm head that is encapsulated. Through bad abattoir inspections, but especially through individually careless handling of meat, the parasite is able to stay intact in our intestine. In this case it also counts that untreated human liquid manure should not get into the cycle: do not bring it to the fields in this case.