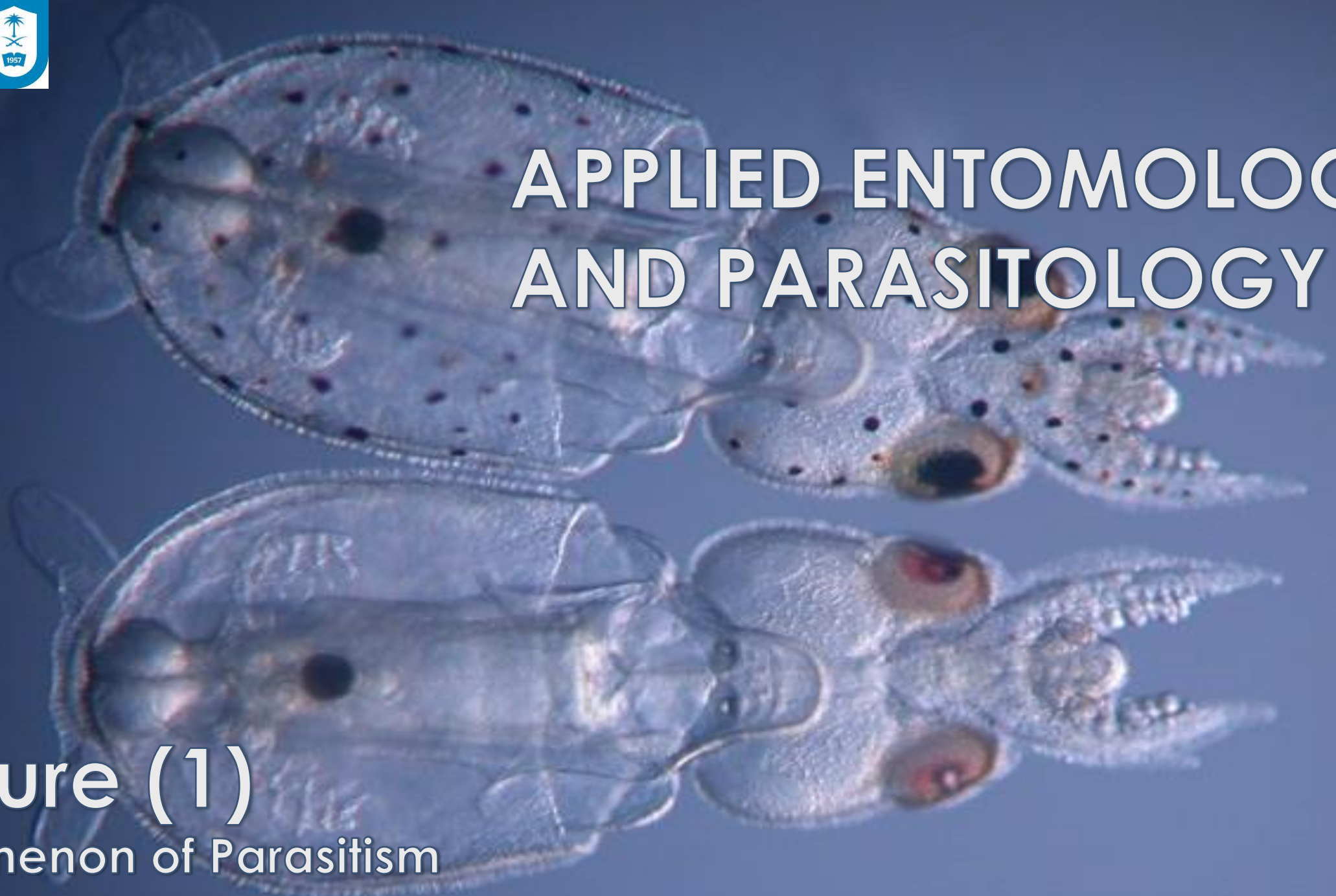


APPLIED ENTOMOLOGY AND PARASITOLOGY

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Lecture (1)

Phenomenon of Parasitism



Who Are Parasites?

The name “parasite” comes from the Greek term *parasitos* (*para* = close by, besides; *sitheisthai* = eating), thus describing an individual, which participates at a meal.

Parasites and Their Hosts

According to the activities of the recent spectrum of parasites, it can be differentiated between *ectoparasites* and *endoparasites* depending on their preferred sites of feeding.

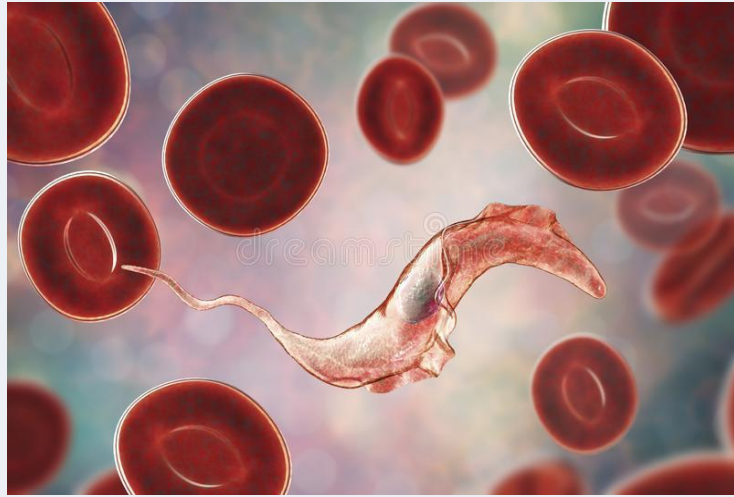
Ectoparasites can live exclusively *stationary* (e.g. mites, lice) or *temporary* (e.g. mosquitoes) on their hosts. there exist also *intermediate groups* such as ticks and some flea species (e.g. sand fleas), which stay for longer periods on the same hosts.



The pathway to **endoparasitism** was probably started by parasitic stages like today's existing species such as scabies mites and fly larvae that penetrate into the skin like *Gasterophilus* species or *Hypoderma* species.



Intercellular parasites live in spaces within the host.



Intracellular parasites live in cells within the host.



PARASITES have developed life cycles which may include one or several hosts in a fixed order. One-host parasites have *monoxenous* life cycles, while those with several hosts are described as *heteroxenous*.

The latter parasites may be classified according to the amount of different hosts as *di-*, *poly-* or even *heteroxenous*.



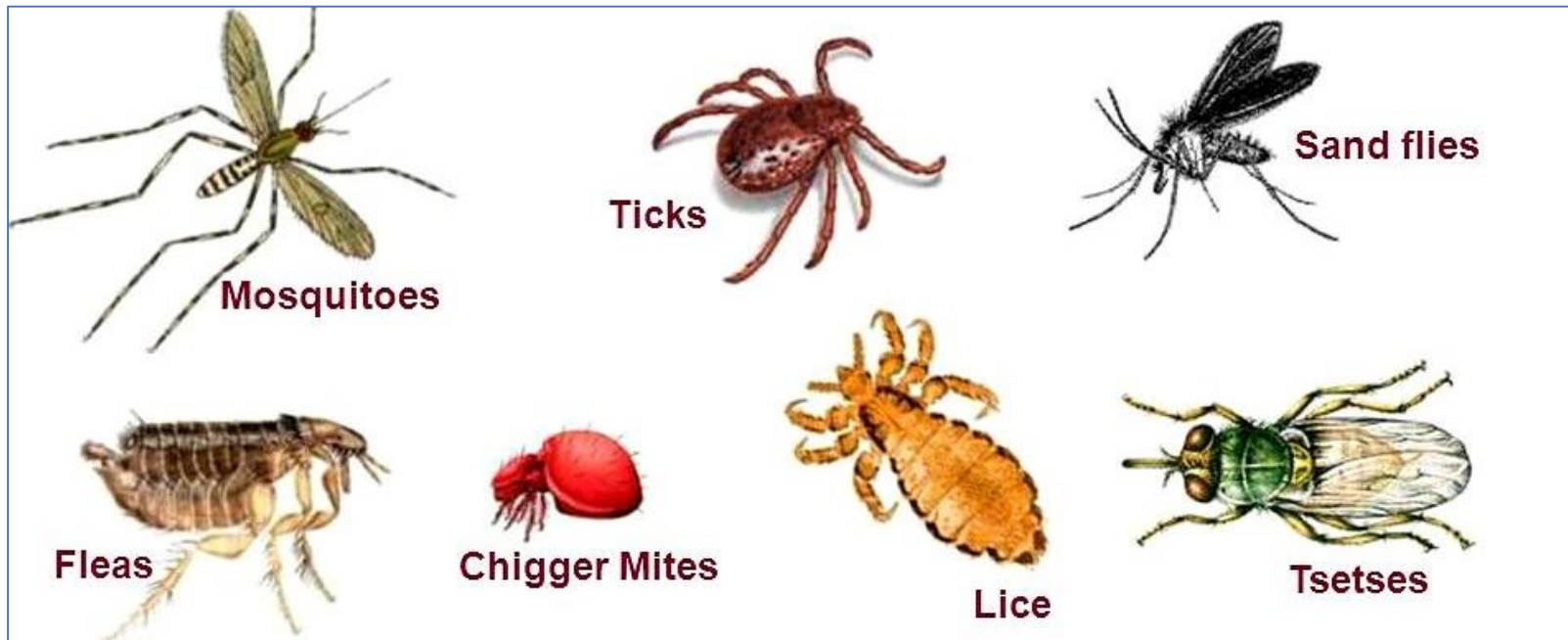
If a host change is absolutely needed, it is called *obligatory*; if several hosts may be selected just by occasion, the host-parasite relation is called *facultative*.

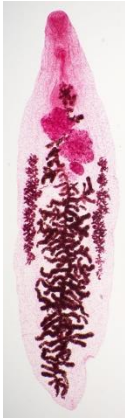


Hosts are furthermore categorized according to the fact, whether they harbour the sexual stages of the parasite (= *final host*, *definitive host*) or whether they contain asexually reproducing stages (= *intermediate hosts*).

Several species of ectoparasites (mosquitoes, flies, ticks, mites) are described acting as **VECTORS**, which are able to transmit agents of disease to humans and/or animals. Inside these vectors even the **sexual development** of agents of disease may occur (e.g. *Plasmodium* species). However, others let only transport their **asexual larvae** to new hosts (e.g. Humans/animals), in which they develop and reproduce in the sexual stages.

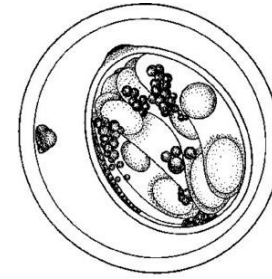
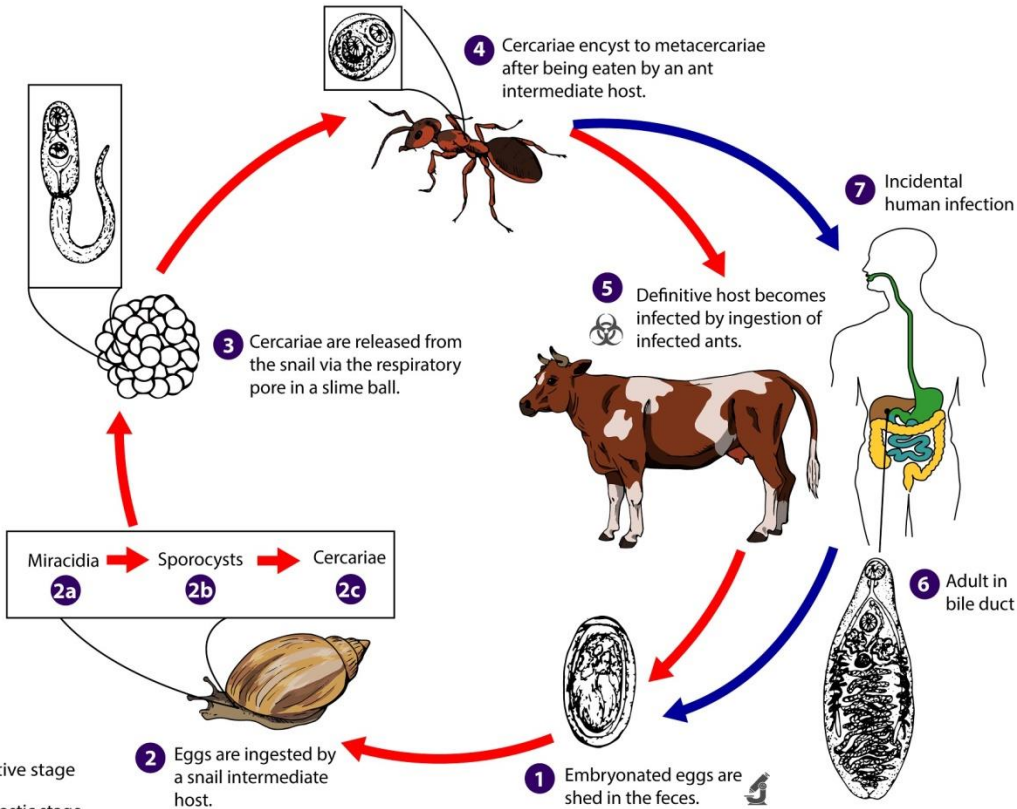
Originally, it was thought that they would transmit only on a mechanical pathway by entering their contaminated mouthparts into the skin of a host.



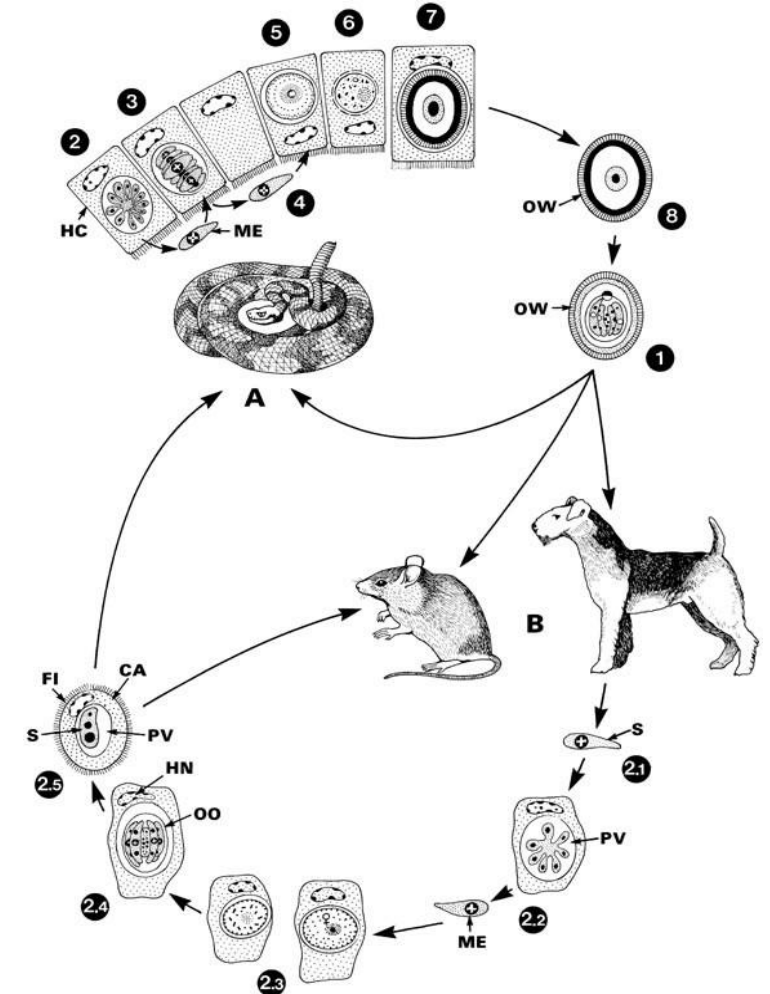


During the developmental cycle of most *multihost parasites*, mostly only *a single type of final hosts* occurs (e.g. carnivores), while *several types of intermediate hosts* may follow each other.

For example, in the case of the trematode *Dicrocoelium dendriticum* grass feeding ruminants act as final hosts, while snails act as first intermediate hosts and ants second intermediate hosts.



In the case of the protozoan parasite *Caryospora bigenetica*, there exist *two different final hosts*, since there are sexual processes in the *primary final host* (snakes) as well as in a *secondary final host* (rodents).



If these stages are ingested by dogs, oocysts can also become developed in their skin.

Thus, this parasite is extremely flexible and cannot be submitted clearly into the normal final and intermediate host system.

The **PROPAGATION** of parasites in a given region among peculiar hosts is furthermore supported by the help of further host types, which, however, may also act as final or intermediate hosts at the same time:

Reservoir hosts

These are vertebrate hosts such as dogs and rodents, which, in the case of human leishmaniasis, harbour parasite stages which can be transmitted through bites of sandflies back to humans.

Incompetent host or Erroneous host or accidental host

This term describes hosts, wherein an accidentally penetrated parasite cannot develop further on and are unable to leave again this host. Examples are the cercariae of various water bird schistosomes in the skin of humans.

Transportation host or paratenic host

This term describes intermediate hosts wherein no reproduction occurs, but which accumulate parasitic stages, so that these are ingested in high numbers by a final host thus increasing the chance for a successful transmission. For example, this mosquitoes of the genera *Aedes* or *Culex* belong to this host type since they ingest larvae 1 of filarial species and inject larvae 3 of these species into other vertebrates.

Host Specificity

The above-described host types are based on the varying adaptations of a parasite species at a given host species. This relation may be:

VERY CLOSE, so that only one single host species is accepted (e.g. *Isospora hominis*; pig tapeworm in humans)

VERY LOOSE, so that many hosts are accepted (e.g. many blood sucking ectoparasites, many trematodes or *Cryptosporidium* species)

LOOSE with respect to intermediate hosts, but **VERY CLOSE** with respect to final hosts (e.g. *Toxoplasma gondii* has only felids as final hosts, but humans and many mammals and birds may act as intermediate hosts)

CLOSE with respect to intermediate hosts and **LOOSE** with respect to final hosts (e.g. *Plasmodium* species occur only in humans as intermediate hosts, but many *Anopheles* species may be final hosts)

Ontogenetic Development of Parasites



The development of parasitic species may occur in different manners:

- 1) **DIRECTLY** (i.e. without reproduction) from egg via larva; stages looking rather similar to the adult stage (e.g. by metamorphosis in the case of some insects or nematodes).
- 2) **INDIRECTLY**, including different reproduction processes (e.g. Coccidia, trematodes), With several generations. This follow-up of different generations may occur **obligatory** (e.g. *Sarcocystis* species) or **facultatively** (e.g. *Strongyloides stercoralis*).

Follow-Up of Different Generations



During the life cycle of parasites, very often an **alternation of generations** occurs. In the case of many protozoan species, a so-called **primary follow-up of generations** can be observed, since cell divisions induce a repeated reproduction of single cells, while in the case of metazoans cell reproduction leads only to the increase of an individual. Only in cases, where such multicellular organisms divide, a new generation occurs **secondary follow-up of generations**.

1) Typical primary follow-ups of generations occur in Coccidia covering a sexually reproducing generation and one up to several generations with an asexual reproduction.

2) In the case of the secondary follow-up of generation two different types can be observed:

a) Metagenesis: Here occurs a follow-up of a bisexual generation and a single one or of even several generations which are reproduced asexually.

b) Heterogony: This term describes the follow-up of a single female=parthenogenetic generation and a bisexual generation (e.g. *Strongyloides stercoralis*).

Speed of Development

The larval development of **ECTOPARASITES** depends on the local temperature, while in the case of **ENDOPARASITES**, host defence reactions may have considerable influences limiting on growth and ability to reproduce.

The period, which is needed by a parasite to reach maturity (and production of transmittable stages), is called **PREPATENT PERIOD**.



The following period until the end of the production of transmittable stages is named **PATENCY**. The patent period of a parasitic species is always species specific and may last a few days (e.g. *Coccidia*) or even years (e.g. *Taenia* species, large filariae such as *Onchocerca volvulus*).



The period between infection day and the first occurrence of clinical symptoms is termed **INCUBATION PERIOD** (Latin: incubate=embedding). This period may be short (e.g. hours in case of amoebiasis) or even years (e.g. echinococcosis, schistosomiasis, filariasis).

Adaptations

Ectoparasites have developed peculiar mouth parts and digestion systems in order to obtain and digest the food taken from their hosts. Often they are also using the help of a broad spectrum of endosymbionts.

Endoparasites, however, have to solve several more problems. *They must develop:*

- ✓ Sophisticated invasion mechanisms
- ✓ Techniques of anchoring themselves inside a host
- ✓ Mechanism to protect their progeny inside the host organs
- ✓ Mechanism to place their eggs/larvae inside their hosts at places from where they may reach outside places and thus have the chance to become transmitted to other hosts

INVASION MECHANISMS

The infection of a host by an endoparasite may occur passively by oral uptake of persistent stages such as oocysts, eggs, cysts or tissue cysts, by means of an injection process using ectoparasites as vectors or actively by the use of own enzymes that enable them to pass the body surface (e.g. miracidia larvae of trematodes or larvae of nematodes).

ATTACHMENT AND FOOD UPTAKE

Parasites developed different structures helping their attachment and fixation at inner and outer host tissues and make them able to take up food (as hooks, thorns, claws, suckers).

Food uptake of metazoans done via an intestinal system. However, several intestinal worms (e.g. cestodes, acanthocephalans) are able to take up all needed substances via their own surface layers. Protozoans take up their food by the help of peculiar cytostomes or just via vesiculation at the surface.

PROTECTION FROM HOST INFLUENCES (IMMUNE-EVASION)

Endoparasites live in the intestines of their hosts protect themselves from the host's digestive fluids by the help of a layer of mucopolysaccharides, which form together with other chemical compound a very resistant **surface coat**.

Many parasites developed as peculiar protection of their surface the so-called **molecular mimicry**, which is based on the inclusion of host derived components into their surface.

Parasites settle in host tissues, which have a low immune-activity such as brain, this phenomenon is described as **sequestration**.

Since these systems are rather rough methods to escape host's immune defence, some parasites have developed further methods.

Thus some block or suppress completely the activity of the host's defence system by production and excretion of large amounts of antigenic material which binds the limited number of antibodies produced by the host.

HOST SPECIFICITY

The host specificity of parasites may be strong or rather loose depending on the species.

Some parasitic worms have lost their ability to produce *de novo* lipid complexes. Then they depend on the lipids of the host and thus depend strictly on this host species.

If another host does not offer the needed lipids, they cannot survive therein.

On the other side, a dependence on peculiar carbohydrates and proteins is much less common among parasites, since these compounds may be produced using rather non-specific molecules.

BROOD PROTECTION

The successful parasite is able to protect its progeny not only from the aggression of the host's defence system, but also outside of the body. This is, for example, done by the development of thick shells around eggs.

Furthermore it is needed to depone their progeny in a parasitized body at places, from where the young generation has the chance to get out of the host's body.

Parasites may harm their hosts in many ways:

- 1) **Destruction** of cells or organs (e.g. *Plasmodium* species, *Onchocerca volvulus*, *Ancylostoma*, hydatids of tapeworms)
- 2) **Stimulation** of malign tumours (e.g. liver flukes, *Echinococcus* species);
- 3) **Withdrawing** of essential compounds (blood flukes, *Diphyllobothrium*=withdrawal of vitamin B12)
- 4) **Intoxication** by excretion of metabolically active substances (*Trypanosoma* species, *Plasmodium* species, ticks)
- 5) **Transmission** of agents of diseases (viruses, bacteria, protozoans, worms)

The effects of parasites and their clinical importance depend on several factors. One of them is the so-called **virulence**. Host-adapted parasites lead in general only to low-graded diseases, while rather freshly introduced parasite may induce **severe diseases**.

any parasitosis starts with an **acute phase** showing significant and severe symptoms, which after activation of the immune systems become reduced and this initiate the so-called chronic phase, which often ends in an **asymptomatic phase**.

Anthroponosis diseases are considered, which are induced by parasites, which are exclusively transmitted from humans to humans.

Zooanthroponosis a peculiar form of zoonosis are diseases where arthropods transmit agents of diseases via **direct mechanical transmission** (without reproduction) (e.g. some trypanosomes) and **cyclic transmission** (metazoonosis) with reproduction inside the insect vector.



Pathogenicity



Diseases

**Any
questions**

