Bio Factsheet

Number 53

Parasites

Parasitism is probably the commonest mode of existence on Earth, since nearly all organisms in nature have associated parasites. In most cases the association of parasite and host is well balanced and does not overwhelm the host, but in some cases the results of the parasitism have altered the course of history. For example, the association of black rat fleas and the plague bacillus (Black Death) has decimated human populations on a worldwide scale several times throughout history, and even today the association between the malarial parasite and the Anopheline mosquito results in many millions of people suffering from malaria.

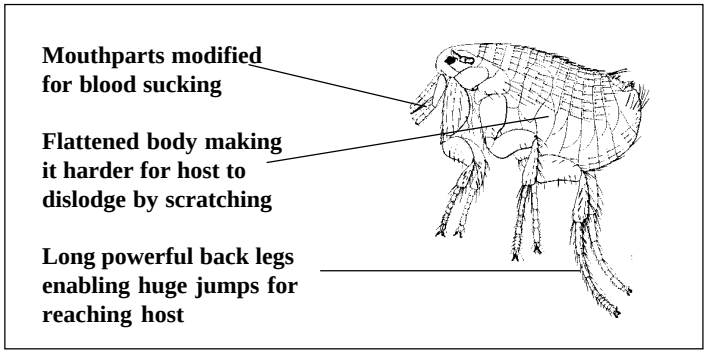
Definition of parasitism

Parasitism is an association between two dissimilar organisms, the **host** and the **parasite**, from which the parasite gains benefits, such as food and shelter, whilst the host is harmed or deprived in some way. Usually the parasite does not kill the host since this would also result in the death of the parasite.

A predator (carnivore) and a parasite are different since a predator kills its prey to eat it but a parasite does not usually kill its host. A parasite spends considerable time upon or in its host, thus a flea or a tick may take minutes or hours to suck blood from the host. In comparison, a mosquito only spends a few seconds on its prey to obtain a blood meal, and a such a brief association is not considered to be parasitism by many biologists.

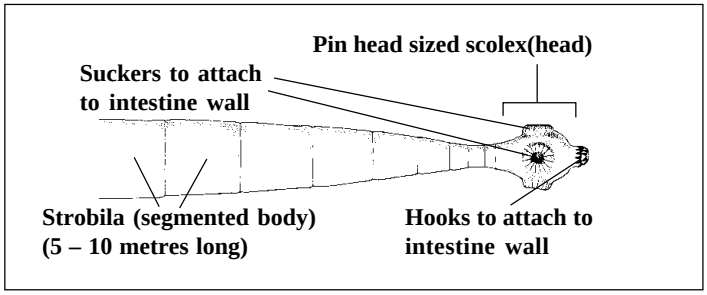
Ectoparasites tend to live on the outside surface of their hosts for part or all of their life. Examples of ectoparasites are fleas, lice, and ticks. A plague flea is illustrated in Fig 1.

Fig 1. Xenopsylla cheops (the plague flea)



Endoparasites tend to live inside the host, although certain life cycle stages may pass out of the host to enable dispersion to other hosts. Examples of endoparasites are Plasmodium (the malarial parasite), liverflukes, tapeworms and many roundworms. A tapeworm is illustrated in Fig 2.

Fig 2. Taenia saginata (beef tapeworm of humans)



Examples of parasites occur in almost all groups of organisms. Table 1 gives some examples of common parasites. (Viruses and pathogenic bacteria are usually included under the microbiology sections of syllabuses and so are not included here).

Table 1. Examples of parasites

Phylum	Parasite
Rhizopoda	Entamoeba (dysentery)
Zoomastigina	Trypanosoma (sleeping sickness)
Apicomplexa	Plasmodium (malaria)
Zygomycota	Pythium (damping off of seedlings)
Ascomycota	Aspergillus (Farmer's lung)
Platyhelminthes	Taenia (tapeworms)
Nematoda	Ankylostoma (hookworms)
Arthropoda	Ticks, mites, lice, fleas.
Chordata	Lamprey, cuckoo.

Obligate parasites have lost the ability to live a completely free life and must live in or on a host for at least some of their life. Examples are tape worms and the malarial parasite.

Facultative parasites can adapt to living a free life , often in decomposing tissue, if a living host is not available. Examples are many fungi which parasitise higher plants, but which can be cultured on growth media, such as Botrytis sps. (leaf disease of Broad Bean) and Penicillium digitatum (green mould disease of Orange).

Parasitic nutrition in the tape worm

Since many parasites have the advantage of using the digested food of the host as a source of nutrition, they frequently have reduced or absent digestive systems, and have reduced locomotory powers, since they do not need to move about to find food. Thus tapeworms that live in the intestine of humans, such as **Taenia saginata** (the beef tapeworm) or **T. solium** (the pork tapeworm) have virtually no muscular system and are only capable of small feeble movements. These, however, may help to bring them into contact with fresh nutrients in the host intestine. The segmented body is flattened and has a huge surface area relative to its volume. Thus nutrients

can diffuse into the segments very efficiently through the surface cuticle, from the intestinal contents. The flattened body causes little obstruction to the passage of intestinal contents along the gut.

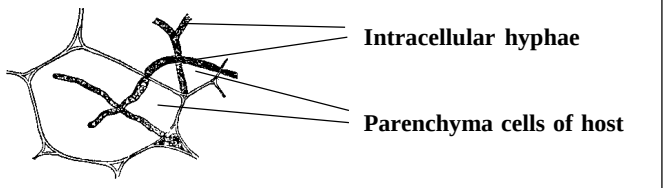
The tapeworm cuticle helps to protect the animal from the digestive enzymes of the host, and the tapeworm also secretes 'anti-enzymes' or enzyme inhibitors which prevent damage from the host's enzymes.

Pythium – a fungal parasite of plants.

The fungus, **Pythium**, infects young seedlings and weak plants, particularly if they are sown too thickly. It causes the disease known as **'damping off of seedlings'**. Various species of Pythium can attack many hosts, for example, cress, mustard, cucumber and potatoes.

The disease usually shows on the stem, just above the soil surface. It invades the cortex to such an extent that the stem cannot support the shoot. The hyphae of the fungus can actually penetrate the parenchyma cells of the cortex from which they absorb nutrients. This is illustrated in Fig 3.

Fig 3. Parenchyma infected by Pythium



Once the host is dead the Pythium can continue to feed saprophytically on the dead remains. Thus it is a facultative parasite.

General advantages and disadvantages of a parasitic mode of life.

The main advantage gained by parasites is that they have a ready source of food from the host. This food may be pre-digested (as for the tape worm) and will provide the basis of a well balanced diet for the parasite.

The parasite, particularly if internal, will be protected by the host, and be in an environment which will probably be optimal in conditions of temperature and pH for the parasite.

Any locomotory movements of the host will help to distribute the parasite. The main disadvantage faced by parasites is the difficulty of cross infecting or dispersal to new hosts. This is overcome by prolific egg production, and by complicated life cycles that involve secondary hosts or vectors. Some examples of secondary hosts which act as vectors are shown in Table 2.

Table 2. Parasitic hosts

Parasite	Primary host	Secondary host
Plasmodium (malaria)	Human	Female Anopheles mosquito
Taenia solium (pig tapeworm)	Human	Pig
Taenia saginata (Beef tapeworm)	Human	Cow
Trypanosoma (sleeping sickness)	Human	Female tsetse fly
Fasciola (liver fluke)	Sheep or cattle	Snail
Dipylidium caninum (dog or cat tapeworm)	Dog or cat	Lice or fleas

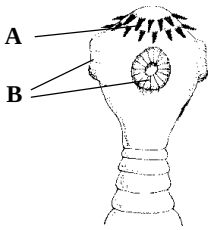
Exam Hint *- Candidates may be asked for adaptations of parasites for a parasitic life. Concentrate on positive adaptations (such as the hooks and suckers of tapeworms) rather than negative features (such as reduction in body systems which are no longer used to any great extent).*

Another disadvantage encountered by internal parasites is that they have to withstand immune attack from the hosts. Parasites may achieve protection in various ways, for instance:

- They may have evolved or have developed to be antigenically very similar to their hosts and thus do not provoke an immune response.
- They may coat themselves with host proteins and thus be 'invisible' to the immune system.
- They may be out of reach of host antibodies, for instance, in the lumen of the intestines.
- The immune response takes two to three weeks to develop a response, by which time the parasite may have completed its life cycle and moved on.
- They may actually produce chemicals that suppress killer and helper T-cell and B-plasma cell formation.

Practice Questions

1. The drawing below shows the head of the tapeworm Taenia solium (pork tapeworm).



(a) Explain the importance of structures A and B to the life of the organism. (3 marks)

(b) Describe how the adult tapeworm obtainsits nutrition. (3 marks)

(c) The adult tapeworm respires mainly by anaerobic means. Suggest why this is so. (1 mark)

2. Suggest ways of preventing:

(a) infections by Pythium in the greenhouse. (3 marks)

(b) accidental infection of humans with dog tape worms. (3 marks)

3. Greenhouse crops can be badly damaged by infestations of the White fly, Trialeurodes vaporiarum. This can be controlled by introduction of another insect, Encarsia formosa, which parasitises the White fly, reducing its population. Suggest why this is a more acceptable method of controlling White fly infestations than use of insecticides. (4 marks)

Answers
(Semicolons indicate marking points)

1.
(a) A are hooks and B are suckers;
these attach head/scolex to intestinal wall;
can embed **very deeply** into wall;
thus tape worm is not washed away by passage of gut contents;

(b) absorption through cuticle/body surface;
from digested food in host intestines;
ref diffusion/ possible active uptake;
uptake of water by osmosis;
gradients maintained since tapeworm uses up food and host eats more;

(c) virtually no oxygen present in lumen of intestines;

2.
(a) do not plant seedlings too densely;
do not overwater/get humidity too high;
do not get temperature any higher than necessary;
before planting, fumigate greenhouse thoroughly with a fungicide;
sterilise soil/compost before use;

(b) keep dog free of fleas and lice;
by regular combing/use of (suitable) insecticides;
the dog should be regularly de-wormed (using a recommended vermicide);
do not allow dog to lick humans, particularly on the face/lips (in case eggs/larval forms get transmitted);
do not allow dog onto beds or other furniture where fleas may be deposited which could then bite humans;

3. this is biological control;
which allows production of an 'organic' crop;
many consumers now prefer 'organic' fruit and vegetables;
insecticides contaminate the foodcrop;
especially if the are systemic in nature/absorbed into the plant tissues;

Acknowledgements;
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ISSN 1351-5136