

LECTURERS IN VETERINARY PARASITOLOGY

INTRODUCTION, NEMATODA AND SYSTEMIC PLATYHELMINTHES

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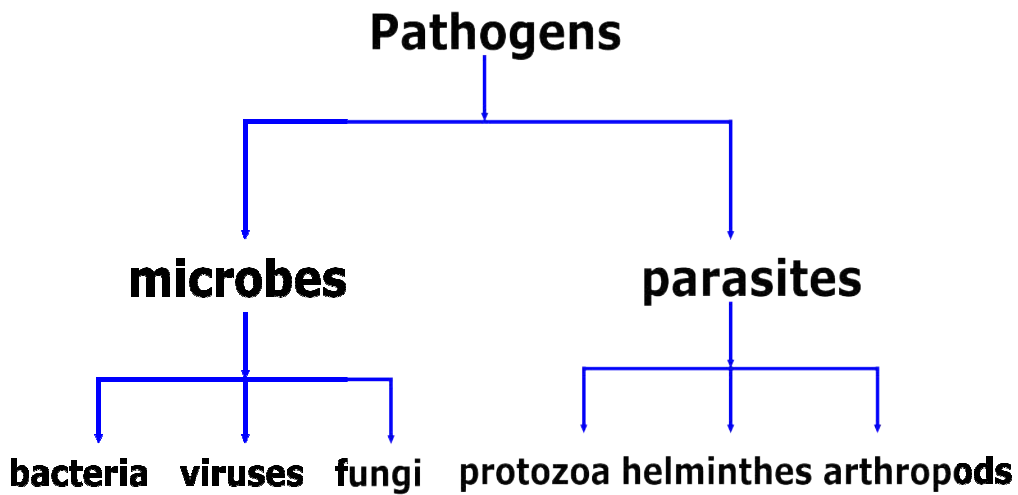
CHAPTER ONE

INTRODUCTION

A SPECIES IS BINOMIAL

Parasitology is the study of parasites, their hosts, and the relationship between them. As a biological discipline, the scope of Parasitology is not determined by the organism or environment in question, but by their way of life. This means it forms a synthesis of other disciplines, and draws on techniques from fields such as cell biology, bioinformatics, biochemistry, molecular biology, immunology, genetics, evolution and ecology. Before the beginning the fascinating topic of Parasitology, there tend to be one common deficiency that needs immediate remedy. Namely, the basic Linnaeus concept or rule that states that a species is binomial. This is a universal in zoology, botany, Parasitology, and bacteriology, but for some reason many students have failed to grasp this concept. The Swedish scientist Carolus von Linnaeus (1707-1778) developed the binomial system of nomenclature that is still in use today. As an example, let's use the species *Homo sapiens* ("humans" to you molecular biologists). *Homo* is the genus, *sapiens* is the trivial name (*nomen triviale* or specific epithet), and together they make up the species. The epithet *sapiens* is NOT the species, although some very basic texts erroneously say it is. Remember... a species is binomial ("two names").

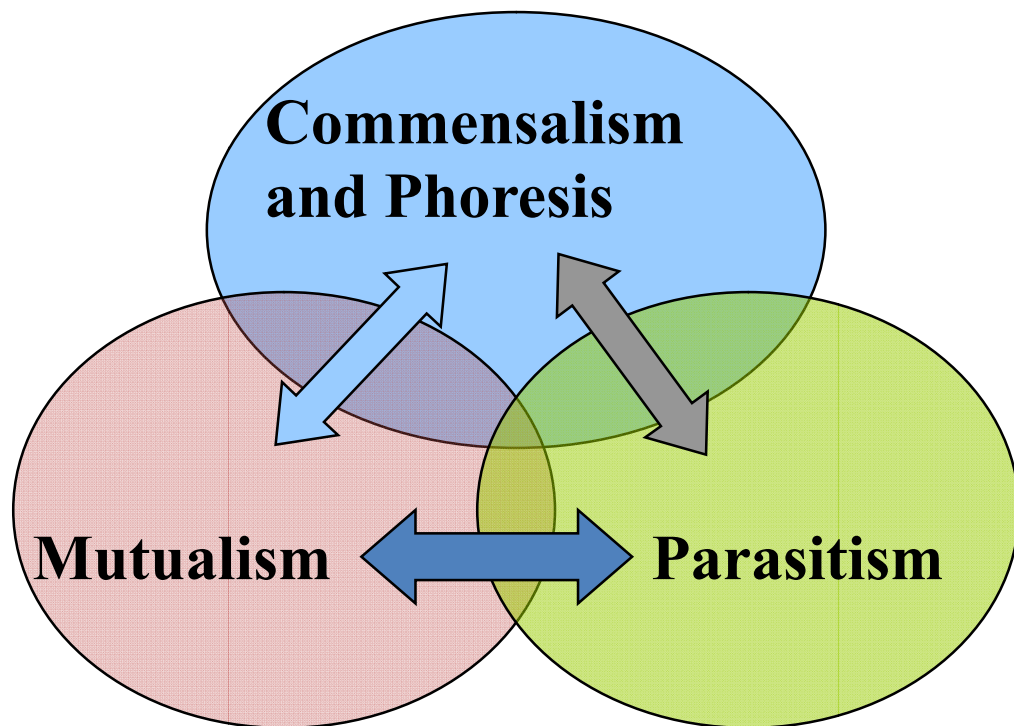
The taxonomically of pathogens classify according to the sachem below:



INTRODUCTION TO THE PARASITOLOGY

Medical parasitology traditionally has included the study of three major groups of animals: parasitic protozoa, parasitic helminthes (worms), and those arthropods that directly cause disease or act as vectors of various pathogens.

The relationship between organisms as in the sachem below:



Parasitology is a type of **SYMBIOSIS** that living together in the plant, animal, or protest, which is intimately associated with another organism of a different species; each member is termed a SYMBIONT. There are various type of symbiosis:

A. **PHORESIS** is a traveling together or to carry. A smaller organism is termed a PHORONT that is carried mechanically by a HOST for instance, bacteria, fungus, cysts, or eggs on insect legs or even passively within an arthropod gut.

B. **COMMENSALISM** means when one symbiont is named a COMMENSAL, benefits and the other animal is neither helped nor harmed True commensalism is difficult to find, and may not even actually exist. Close inspections usually reveal either a mutualistic or parasitic association. Perhaps *Entamoeba gingivalis* in mouth to some degree; some pilot fish and remoras associated with sharks

C. **MUTUALISM** means each member is named MUTUALIST, depends upon the other; obligatory or facultative in nature for instance, flagellates produce cellulose in gut of termites, ciliates in ruminants, algae and fungus forming a lichen; crocodiles and Egyptian teeth cleaning plovers.

D. **PREDATION** means where one member is named a PREDATOR, benefits and a smaller organism is called a PREY that is harmed and usually eaten. This association is not usually considered a type of symbiosis, but it technically falls under the definition. Examples include coyotes and rabbits, cats and mice.

E. **PARASITISM** means where one member is named a PARASITE, lives in or on another organism that is called a HOST.

However, **PARASITOLOGY** is the study of the relationship between a parasite and its host. This method of existence is the single most successful way of making

a living, and it has been estimated that no less than 80% of all species of organisms are parasites. Parasitic relationships may be temporary, facultative, or obligatory.

The Basic types of parasitism and terminology

- **ECTOPARASITE**: lives on surface of the host, appropriate terminology includes the terms "infected" and "infested" [i.e. ticks, lice, fleas].
- **ENDOPARASITE**: lives within the host, appropriate terminology is "infected;" infested is inappropriate terminology [i.e. roundworms in gut, tapeworms in gut].
- **HYPERPARASITE**: parasite within a parasite [i.e. malaria in mosquitoes; tapeworm larvae in fleas].
- **VECTORS**: transmits parasites from host to host, and this is divided into:
 - o **BIOLOGICAL VECTOR**: essential in life-cycle of parasite.
 - o **MECHANICAL VECTOR**: unessential in life-cycle of parasite phonetic.

Class of Parasites

1. **Temporary Parasite**: Visits it's host for a short period.
2. **Permanent Parasite**: Leads a parasitic life throughout the whole period of its life.
3. **Facultative Parasite**: Leaves a parasitic life when opportunity arise.
4. **Obligatory Parasite**: Cannot exist without a parasitic life.
5. **Occasional or Accidental Parasite**: Attacks an unusual host.
6. **Wandering or Aberrant Parasite**: Happens to reach a place where it can't live.

Types of Hosts:

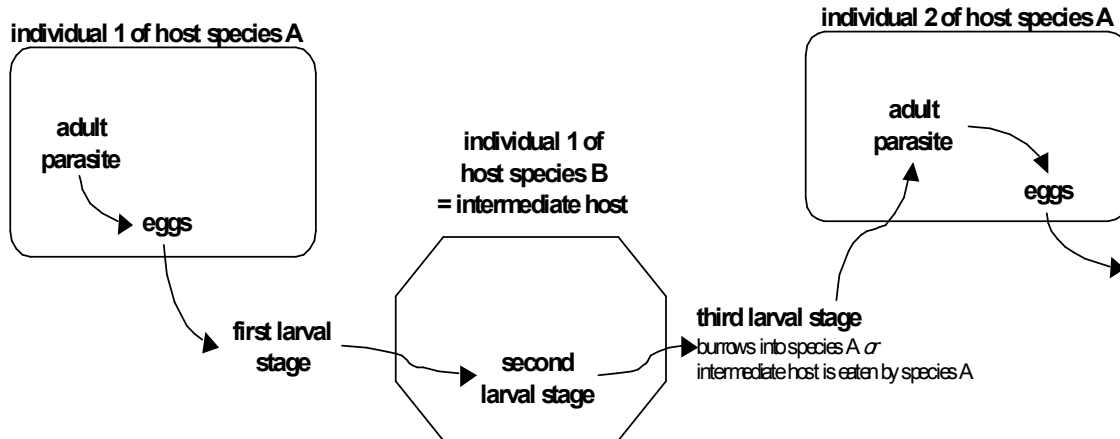
- **Definitive or Final Host** : Host in which parasite reaches sexual maturity and reproduces.
- **Intermediate Host**: Some development in host, but does not reach sexual maturity, often asexual stages.
- **Paratenic or Transport Host**: No parasite development; but parasite continues to live and is infective to next host, for instance and pseudophyllidean tapeworm larvae in fish.
- **Reservoir Host**: Non-human animals that serve as sources of infection to humans.

Types of Life Cycle:

- **Direct Life Cycle**: Infective stage is reached in the environment.
- **Indirect Life Cycle**: Infective stage is reached in an intermediate host.
- **INFECTION**: Parasites maybe endoparasites especially protozoa that inside cells of the host.
- **INFESTATION**- Parasites such as worms and ectoparasites that outside cells of the host or on the host.

Scheme of Complex Life Cycle

Two or more host species and parasite exploits food chain relationships of hosts
- increases chances of locating hosts and reduces chances of super-infecting host.



Nomenclature of Parasites:

Each parasite possesses two names, a generic and a specific that the former begins with an initial capital and the latter with an initial small letter, after which comes the designator's name followed by punctuation and finally the year. The generic and specific names are in italics but not the designator's name. For example:

The common name of intestinal roundworm of hors is named *Parascaris eqourium*, Linnaeus, 1758. This means that it belongs to the genus *Parascaris* and the name of species *eqourium* was given by Linnaeus in the year 1758. When the name assigned to the parasite is later transferred the correct name is written as usual followed by the original name with the year of parenthesis.

The describing animal parasites certain rules of zoological nomenclature are followed and each phylum may be further subdivided as follows:

SUPERCLASS SUPERFAMILY
 PHYLUM SUBPHYLUM CLASS ORDER FAMILY GENUS SPECIES
 SUBCLASS SUBORDER SUBFAMILY

IMPORTANT CONCEPTS OF PARASITIC INFECTIONS

- Infection = presence of an agent that has the ability to cause disease
- Disease = the occurrence of dysfunction
- Infectious = capable of causing infection
- Infection --- Disease --- Infectious

EXAMPLE:

- A. The dog showed no adverse symptoms to the 2 female *Dirofilaria immitis* in its right ventricle(Infection).
- B. 1,000 juvenile *Haemonchus contortus* were causing severe anemia in the lamb(Infection + Disease).
- C. Cats suffering from large bowel diarrhea due to *Tritrichomonas foetus* pass active trophs in their feces(Infection+ Disease+ Infectious).
- D. The cat passed several active proglottids of the flea tapeworm, *Dipylidium caninum*(Infection).

Parasitic Mode of Transmission

1- Direct transmission

The parasite is passed directly from one animal to another

Examples

- A. Animal ingests infected feces or vomit
- B. Parasite enters through the skin

C. Mother passes it to the offspring through transplacental or transmammary routes

2. Indirect transmission

The animal ingests a Paratenic host, an animal that can harbor parasites without becoming infected, the parasite remains inactive in the paratenic host until the appropriate host ingests it.

Examples

Rodents, Birds, Rabbits, Flies

SOME TYPICAL CHARACTERISTICS OF PARASITISM

There are different ways or characteristics of parasitism:

1. High reproductive potential, i.e. multiple fission in Apicomplexa; hermaphroditism of trematodes; parthenogenesis in *Strongyloides* spp.; i.e. strobilation of tapeworms for high ova output; and overall high ova/larval output of many worms.
2. Often unique morphological or physiological specializations, loss of structures, like:
 - a. loss of digestive tract of tapeworms
 - b. loss of wings of fleas and lice
 - c. loss of many sensory structures of nematodes

- d. development and refinement of a TEGUMENT; a living external layer of digenes, cestodes and acanthocephalan that allows digestion and other functions across body surface
 - e. development of special holdfast organs, including hooks, suckers, teeth, clamps, cutting plates, spines
 - f. production of anti-coagulants in leeches and hookworms
3. Often special site specificity.
 4. Usually, but not always, non-lethal to host.
 5. Generally more numerous than hosts.
 6. Generally much smaller than host if larger, then termed a predator.
 7. Often have evolved methods of evading host immune system, like:
 - a. Antigenic variation of trypanosomes.
 - b. Tough tegument of acanthocephalans.
 - c. Intracellular habitat of coccidian and *Trichinella* larvae.
 - d. Antigen acquisition of Schistosoma.
 - e. Suppression eosinophiles or neutrophil migration to the site of the parasite.
 - f. Encystment.
 - g. Ability to cleave antibodies or consume complement.
 - h. Ability to trigger certain arms of the immune response, which may in turn damage host tissue enough to facilitate parasite invasion.
 8. Level of pathology due to the parasitism, like:
 - a. **Physical trauma**: Cells-tissue destruction because of the migration of nematodes through tissues, ulceration of intestinal wall and liver by cysteine

proteases of *Entamoeba histolytica*, displacement of tissue or structures by hydatids, protease digestion of epithelial cells by *Trichomonas vaginalis*, ulceration due to insertion of hooks and spines into intestinal wall.

- b. **Nutritional diversion**: Such as giardiasis results in diarrhea and malabsorption and *Diphyllobothrium* absorbs vitamin B12.
- c. **Toxins/Excretory products/Immune complexes**: African trypanosomes slough antigen/Ab complexes that are absorbed by RBC's, complement activated, massive RBC lyses, as a excretory products of some trematodes and cestodes causing anaphylaxis as a fibrosis and inflammation around *Schistosoma* eggs in the granulomas, fibrosis, edema against adult filarids.

9. **Blood loss**: hookworms which causing anemia.

TYPICAL WAYS OF PARASITES TRANSMISSION

INGESTION from food or water / inhalation included **VECTORS** or/ and **DIRECT PENETRATION** of skin from environment.

10. Some additional terminology to be used in class of **Anthroponoses in the** human diseases that can be transmitted to animals.

EPIDEMIOLOGICAL TERMS:

-**Epidemic** is a disease that affects a large number of humans and spreads rapidly.

-**Epizootic** is a disease that affects a large number of non-human animals and spreads rapidly.

-**Epizoic** is a living on the surface; a skin parasite.

-**Incidence** is the number of cases of an infection occurring during a given period of time in relation to the population unit in which they occur.

-**Infection** is a parasitic invasion resulting in injury and reaction to injury.

-**Latent** is a non-visible infection.

-**Monoxenous** is a (single host life cycle.

-**Parasitemia** is a parasites in blood.

-**Pathogenic** is a results in disease or morbid symptoms.

-**Premunition** is a resistance to super infection; depends upon survival of parasites in host and disappears with their elimination.

-**Prevalence** is a number of organisms in a population infected with a parasite at any one time.

-**Virulence** is a relative infectiousness of a parasite.

-**Zoonosis** is an animal diseases that may be transmitted from animals to humans.

GENERALLY:

Many parasites are now being shown to change host behavior. Growing number of scientists believe that many ecological studies need to include Parasitology as component as much animal behavior can be explained by level of parasitism. Especial behavior of some insects harboring larval stages of parasites, bird behavior in response to both ectoparasites and densities of some intestinal worms.

HOST SPECIFICITY

Some parasites have specific host that only infect specific animals, which often sensitive to body temperature or other environmental conditions as well as another might attack any host available such as fleas.

IMMUNOLOGY

The study of immunology, a broad field encompassing both research and clinical applications, deals with antigens, antibodies and cell-mediated host defense functions, especially as they related to immunity disease, hypersensitive biological reactions, allergies and rejection of foreign tissues.

IMMUNITY AGAINST PARASITES

Parasites possess three major characteristics that make them difficult for a host to control immunologically: their size, their elaborate life – cycles and their antigenic complexity. The Protozoa are most have complex life cycles and the various stages of either antigenically distinct, as in the malaria parasites, or variable as in the African trypanosomes. Protozoa inhabit the gut, blood or other tissues, including macrophages and the immune responses elicited are more appropriate to the site of infection than to the nature of the parasites themselves.

In the helminthes infestation, the nature of the surface of the worm, which is the part available for immune stimulation and attack is important. In Digeneans and Cestodes it is the tegument of the worm that is exposed while in nematodes the outer surface is a protective cuticle, the antigenic nature of which may vary during the life cycle. Like protozoa, different Helminthes occupy different sites usually

the gut, but sometimes the blood or other tissues and the immune response is again more appropriate to the site of infection than to the actual parasites.

A further complication in helminthes infections is that during it's life cycle that worm may not only change its form but may also change its site of infection several times. In *Ascaris lumbricoides* infections, larvae pass through various internal organs before maturing in the gut, the net result of these variations in the expression of antigens and frequent changes in site of infection is that the immune responses elicited may be against antigens that are no longer present or in places where the parasites no longer live.

PARASITISM ASPECTS

- Each animal can be a host of many parasites; thus, there are far more parasitic organisms on earth than there are non parasitic organisms.
- It has been estimated that more than 50% of all living plants and animals are parasitic at some stage during their life cycle.

VETERINARY IMPORTANCE OF PARASITES

- A poultry farmer can be wiped out by Coccidia.
- Cattle, pigs, and sheep infected with parasites fail to gain weight and may not reproduce.
- Dogs may become infected with heartworm and die if untreated.
- Cats are infected by many species of protozoans and helminthes.
- In Africa, cattle cannot be raised in an area equal to that of the U.S. due to trypanosomes.

WHY DO WE STUDY PARASITES?

Generally, parasites provide as a unique examples of biological phenomena not found in free-living organisms and distribution in all the world and found even in plants, so, a different importance can be found, like:

- Medical Importance: When infect or infest human and causing severe disease some time leading to the death.
- Veterinary Importance: When infect or infest different animals such as wild, domestic, birds and different mammals and causing economical losses or sever disease or complicated disease like viral, bacterial and rektkticial leading to the death.
- Economic Importance: When infect or infest different animals of domestic and birds that causes economical losses of meat and milk product, egg product, or other products.

SCHEME FOLLOWED IN PARASITOLOGICAL STUDIES

The study of animals' parasites infecting animals or human and producing manifestation should include the following:

1. History of discover the parasite.
2. Geographical distribution.
3. Habitat inside the host.
4. Morphological and life cycle.
5. Modes of infection, reservoir host, source of infection, portal of entry, vehicle of transmission.
6. effect of the parasite: pathogenic lesions, clinical manifestation.
7. Immunological response.
8. Method for diagnosis.
9. Therapy.