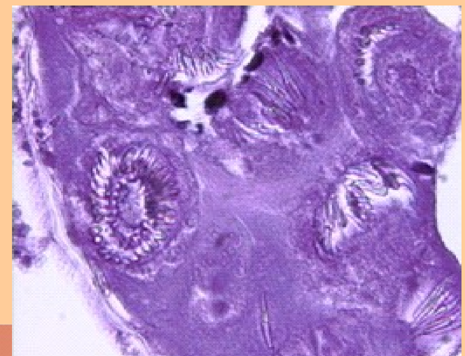
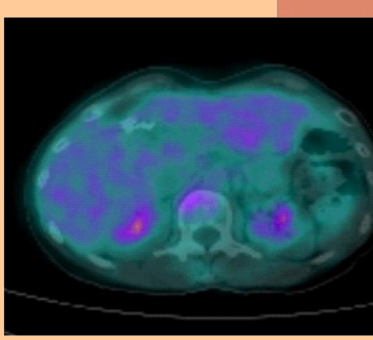
Topic 1

Introduction to Parasitology, Definition, History of Parasitology, Importance of Parasitology in Veterinary Curriculum





Prepared by Dr. Saidul Islam

Introduction to Parasitology

Since the beginning of human culture, mankind was aware of parasites. Man noted the activities of ectoparasites (e.g., ticks, lice, fleas, mosquitoes, flies, etc.), which is known from the early written records. Endoparasitic worms which were passed out through stool and macroscopic in size were also observed by human being. Various human endoparasitic worms such as ascarids (e.g, large round worms), oxyurids(e.g., pin worm) and tapeworms were known to the early physicians of Egypt (2000 B.C.) and Greece (e.g., Hippocrates) and the Greek naturalist Aristotole (384 - 322 BC). Later their knowledge on parasitology was passed on to the Romans. Romans called the round worms lumbrici teretes and the plathyhelminths lumbrici lati. From Romans, the knowledge was transmitted to later human societies especially by propagation of manuscripts in Christian cloisters or by translations of Greek books that were being used and preserved by physicians in the Near East.

The available remedial measures against parasitic infections were very few, for example, combing (Fig. 1), catching of parasites, bathing in water and/or hot sand or eating special plants or spicy food, which were felt to decrease intestinal worm populations, as, for example, pepper does (Fig. 2).

The ancient Egyptian kingdoms knew the fatal symptoms of the schistosome-derived diseases (schistosomes are group of flat worms or flukes found inside the blood vessels of animals and man), however, the process of transmission and treatment were not known to them. About 3000 years later the Holy Hildegard of Bingen (1098-1179) recommended that worms be treated with, for example, extracts of stinging nettles, dandelions and walnut-tree leaves, as described in her book ``*Physica*" (1150-1160), chapter “On the causes and cures of diseases” (*Decausis et curis morborum*). The treatment of dracunculosis by removal of the whole worm from human skin was, however, much more successful.

Fig. 1. A medieval engraving showing a house wife delousing her husband with a comb like instrument © *Encyclopaedic Reference of Parasitology, Biology, Structure, Function.* Heinz Mehlhorn (ed) 2nd edition, Springer

The use of a wooden splinter (Fig. 3), onto which this so-called Medina-worm was wound by physicians in the Near East, probably gave rise to the Aesculap-stick of our days - the symbol of an increasingly successful caste- although it is not long ago that the use of leeches were universal remedies (Fig. 4). At the end of the Middle Age, a new interest arose among educated people to study the natural world, and this newly awakened curiosity led people to make detailed investigations of plants and animals. Even human beings were a subject of investigation, provided religion did not prevent this (e.g. dissections of humans - even of executed and thus lawless people - were forbidden for centuries in Christian and Moslem countries). Thus at first, descriptions of the outer morphology of plants, animals and humans became available and later - after the development of microscopical techniques structural ground-plans and histological insights into organisms were obtained. However, it was not until the middle of the 19th century that the theory of ``de-novo creation", (latin: generatio aequivoca et spontanea), the creation of organisms from dead or an organic material (e.g. worms develop from intestinal slime) became replaced by the idea of cellular organisation and the self-reproduction of organisms as postulated in Virchows thesis (1858): “omnis cellula e cellula” - each cell derives from a cell. This growing spirit of investigation led to the discovery of numerous species of plants and animals and to the differentiation into pro- and eukaryotic organization of organisms. The knowledge derived from the cell-dependent life of viruses or prions is a fruit of our century. According to their morphology and life cycles, the study of which is not completed even today - species of bacteria, fungi, plants and animals were characterized and systematical classifications and phylogenetic trees were established. Such investigations provided a basis for the establishment of phylogenetical theories such as those of Lamarck or Darwin. Moreover, most of the species of parasites still valid today were described in those times and the term parasite (greek: parasitos = eaters at the court = meal taster) became fixed as the word to describe those organisms that live on other animals or humans. According to the different life-cycle adaptations the latter may become: - final (definite) hosts, intermediate hosts, transitory/accidental/paratenic hosts or vectors representing blood sucking parasites such as arthropods or leeches which transmit other pathogens and/or parasites during their blood meal. The constant refinement of microscopical techniques (including the establishment of electron microscopy) and the development of a broad spectrum of molecular biological methods led (especially in the last 30 years) to an explosion of the knowledge on the organization of the parasites, on the parasite-host interface and on host immune reactions, which altogether were used to establish control measurements and to develop prophylactic strategies, drugs and/or vaccines.

Parasitology is an interdisciplinary subject, ranging from the populational and macroecological to the microecologic and biochemical levels. World Health Organization has in recent years proclaimed that six major diseases complexes are unconquered, i.e., schistosomiasis, malaria, filariasis, African trypanosomiasis and leishmaniasis , that are traditionally considered parasitic. The sixth disease, leprosy, is caused by a bacteria. As a consequence, the importance of medical parasitology has been rekindled among the biomedical scientists. Also , because of the realization of the economic implications of parasitic infections among domestic animals, the importance of veterinary parasitology has been recognized. Thus parasites and parasitism is important not only from the view point of the advancement of knowledge but also from the practical viewpoint.

Fig. 2. Engraving of a Renaissance pharmacist equipped with his helper plants and therapeutical animals which included snakes and leeches. © *Encyclopaedic Reference of Parasitology, Biology, Structure, Function.* Heinz Mehlhorn (ed) 2nd edition, Springer

Fig. 3. Human patients suffering from Dracunculosis showing the the lesion on right (left) and left (middle) leg. The traditional way of treatment of Dracunculosis by using a wooden splinter onto which the worm is wound round (right).
Photograph courtesy : Dr. S.S.Das , Pudducherry

Definition of certain terminologies

Parasite:

Organisms which lives at the metabolic cost of the other organisms, e.g., *Plasmodium falciparum* (protozoan parasite), *Boophilus microplus* (arthropod parasite), *Ascaris suum* (nematode parasite), *Fasciola gigantica* (trematode parasite), *Taenia solium* (cestode parasite)

Parasitism :

Parasitism is the phenomena of the relationship between parasites and hosts.

Parasitology:

Parasitology is the branch of science which deals with the study of parasitism.

Host :

Host is an organism, which provides shelter to the parasite. Host may be of different types, e.g., definitive host, intermediate host, paratenic host etc.

A detailed discussion on various terminologies used in parasitology has been given in topic *Definition of parasites, Types of parasites, Types of hosts eg., final hosts, intermediate host, paratenic host, reservoir host, natural host, unnatural host*.

History of Parasitology

Parasites have borderlines. Hence it is an international and interdisciplinary science from its beginnings in early human cultures. Philosophers, theologians, natural scientists, pharmacists, physicians and veterinarians gave birth to deep insights into the world of parasites. Some of the highlights (Mehlhorn, 1988) are listed below :-

1500 BC : The Egyptian papyrus Ebers reported on human worms and schistosomiasis.

500 BC :The Greek poet **Herodotus** reported that the Egyptians use fine nets against mosquitoes.

430 BC **Hippocrates** (460–399 BC) described *Ascaris*, *Oxyuris*, adult *Taenia* and Malaria.

342 BC The great Greek natural scientist **Aristoteles** (384–322 BC) established a first classification system for animals (*Historia animalium*).

62 AD In his "*Historia naturalis*", the Roman **Lucius Columella** (40–88 AD) reported on parasitic animal diseases.

Plinius Secundus (23–79 AD) also wrote on this subject.

158 AD The Roman physician **Claudius Galen** (129–199 AD) propagated the knowledge of Hippocrates.

480 AD The Roman **Vegetius Renatus** (450–510 AD) published his "Ars veterinaria" with detailed descriptions of intestinal worms.

1000 **Avicenna** (Abu Ali El-Hosein Abdallah Ibn Sina, 980–1037). This Persian theologian and physician reported in his book "*Liber canonis medicinae*" on malaria and on many worms, especially on *Dracunculus*, which today in French is still called *fil d'Avicenne*.

1150 **Hildegard of Bingen** (1098–1179). This German nun published methods of treating worms in her "*Decausis et curis morborum*".

1220 **Albertus Magnus** (1193–1280). This German theologian and physician reported in his 26-volume opus "*De animalibus*" on Aristoteles' insights.

1498 **Savanorola** (1452–1498). In his "*Tractatus de vermibus*", this Italian scientist described the occurrence and treatment (by mercury) of worm-infected humans.

1520 The German physician P.A.T. **Bombastus** von Hohenheim, called **Paracelsus** (1496–1541) introduced inorganic salts (e.g. zinc salts) as anthelminthica.

1552 The Belgian physician **Cornelius Gemma** (1534–1579) published the first picture of a human tapeworm.

1583 Discovery of quinine for malaria treatment by an unknown Peruvian (Indian) and the Augustinian monk **Antonio de la Calancha**.

1674/81 The Dutch optician and autodidact **Antonie van Leeuwenhoek** (1632–1723) described oocysts of the later established genus *Eimeria* and several *Giardia* stages taken from its own feces.

1684–98 The Italian physician and philosopher **Francesco Redi** (1626–1697) described in his book "*Osservazioni interno agli animali viventi*" about 108 different worms and published (in 1698) a detailed study on *Fasciola hepatica*. Due to his leadership he is considered the **Father of Parasitology** – the name "rediae" for special trematode developmental stages honors this.

1699 The Dutchman **Nicolaas Hartsoeker** (1656–1725) and the Frenchman **J. Andry** (1658–1742) proposed that helminth infections derive from oral intake of excreted worm eggs.

1717 The Italian **Lancisco** postulated that malaria is caused by bites from mosquitoes.

1739–1778 The Swedish physician **Carl von Linné** (1707–1778) created within the different editions of his book “*Systema naturae*” a comprehensive system of classification of animals and plants.

1756 The English physician **Alexander Russel** (1715–1768) discovered in Aleppo the skin leishmaniosis.

1766 The German physician and natural scientist **Peter Simon Pallas** (1741–1811) was the first to begin the experimental transmission of parasites to animals.

1782 The German theologian **J.A.E. Goeze** (1731–1793) initiated the taxonomy of helminths.

1790 The Danish pharmacist and veterinarian **P.C. Abildgaard** (1740–1801) experimentally transmitted *Diphyllobothrium*-larvae to chicken.

1801 The German physician and natural scientist **Carl Asmund Rudolphi** (1771–1832) published his “*Entozoorum historia naturalis*” with a taxonomy of all available parasites.

1801 The French natural scientist **Jean Baptiste Lamarck** (1744–1829) presented the first general theory of the evolution within his “*Philosophie Zoologique*”.

1820 The French scientists **Pierre Joseph Pelletier** and **Joseph Lavendou** isolated quinine from plants.

1835 The English medical student **J. Paget** (1814–1899) and his teacher **R. Owen** described trichines in human muscles. Since the name originally given, *Trichina*, was prefixed for an insect, the worm name was changed in *Trichinella* by Railliet (1895).

1838 The German scientists **N. Schleiden** and **Theodor Schwann** (1810–1882) formulated the **cell theory**, which became the dead end for the former “de-novo-creation-theory”.

1841 The Swiss scientist **G.G. Valentin** described the first trypanosomes in the blood of a salmonid fish.

1848 The American **Josiah Nott** postulated again that mosquitoes were vectors of malaria and yellow fever.

1849 The Swiss **G. Gross** discovered *Entamoeba gingivalis* as the first parasitic amoeba

1853 The German **C.T.E. von Siebold** (1804–1885) showed the life cycle of *Echinococcus granulosus*.
1859 The Germans **Rudolph Virchow** (1821–1902) and **Rudolph Leuckart** (1822–1898) independently found the life cycle of *Trichinella spiralis*.
1859 The English philosopher, theologian and natural scientist **Charles Darwin** (1809–1882) published his "*Origin of the species*" – another landmark of the evolution theory.
1865 The Bohemian monk **Gregor Mendel** (1822–1884) formulated the basic laws of genetics.
1869 The German physician **Otto Wucherer** (1820–1873) discovered in Brazil microfilariae and schistosome eggs in human urine.
1875 The German physician **F.A. Lösch** described at the Court in St. Petersburg (Russia) for the first time stages of *Entamoeba histolytica*.
1878 The Scottish scientist **Sir Patrick Manson** (1844–1922) working in China showed that *Wuchereria bancrofti* is transmitted by mosquitoes (*Culex* sp.).
1880 The French man **Charles L.A. Laveran** (1845–1922) showed malaria stages within erythrocytes.
1882 The Russian scientist **Ilja Metchnikoff** (1845–1916), working in Italy, was the first to describe the phenomenon of phagocytosis and to develop the concept of cellular immunity (Nobel Prize 1908).
1885 **A.L.J. Railliet** (1852–1930); this French zoologist described a large range of protozoans and helminths.
1888 The French physiologist **Charles Richet** (1855–1935) formulated the basic concept of humoral immunity (Nobel Prize 1919).
1890 The German veterinarian **Robert von Ostertag** (1964–1940) described a large variety of parasitic nematodes in animals.
1893 The Americans **Theobald Smith** and **F.L. Kilbourne** identified the transmission of *Babesia bigemina* by ticks (*Boophilus annulatus*).
1895 The English military physician **David Bruce** (1855–1932) showed that the tsetse

fly is the vector of animal trypanosomes.

1897 In India the English Army doctor **Sir Ronald Ross** (1857–1932) proved that avian malaria was transmitted by *Anopheles* mosquitoes (Nobel Prize in 1902). In the same year the Italians Bignami, Bastianelli and Grassi did the same for human malaria.

1898 The German physician and discoverer of the agent of tuberculosis (*Mycobacterium tuberculosis*) **Robert**

Koch (1843–1910) described *Theileria parva*, the agent of East Coast fever (Nobel Price 1902).

1898 The French man **P.L. Simond** succeeded in demonstrating the transmission of plague by rat fleas.

1900 In Cuba an American group working with **Walter Reed** demonstrated the transmission of yellow fever by *Aedes aegypti*.

1903 The English scientists **W. B. Leishman** and **C. Donovan** independently described *Leishmania donovani*, the agent of Kala Azar disease.

1904 In Cairo the German helminthologist **Arthur Loos** (1861–1923) discovered the transmission of the hookworm.

1906 The American physician **Howard T. Ricketts** (1871–1910) recorded the tick *Dermacentor andersoni* as being a vector of the agents of the Rocky Mountain spotted fever.

1906 The German zoologist and discoverer of the agent of syphilis **Fritz Schaudium** (1871–1906) described *Entamoeba histolytica* as a human parasite.

1907 The American **E. E. Tyzzer** described stages of the genus *Cryptosporidium*.

1907 The German chemist **Paul Ehrlich** (1854–1925) – the father of chemotherapy – proposed the drug trypan-red against trypanosomiasis (Nobel Price 1908).

1908 In North Africa the French military doctors **Charles Nicolle** (1866–1936) and **L. H. Manceaux** described *Toxoplasma gondii* in a rodent.

1909 The Brazilian **Carlos Chagas** (1879–1934) discovered the life cycle of *Trypanosoma cruzi* and described *Pneumocystis carinii*.

1909 Teams working with the Frenchman **Charles Nicolle** (1866–1936) (Tunis) and the American **H.T. Ricketts** (Mexiko) proved that the louse *Pediculus humanus corporis* is a vector of the typhus-causing rickettsia.

1910 The Italian **Carini** discovers *Pneumocystis carinii* in rats.

1914 The Japanese scientists **M. Miyairi** and **M. Suzuki** worked out the life cycle of *Schistosoma japonicum.*

1916–1920 Development of Suramin (B205) against trypanosomiasis (Bayer Co., Germany).

1917 The Austrian psychiatrist **Julius Wagner Ritter von Jauregg** (1857–1940) tested a live vaccination using *Plasmodium vivax*-stages (Nobel Prize 1927).

1925 The English natural scientist **D. Keilin** elucidated the electron cascade (cytochrome) system while using parasitic insects and worms as models.

1934 Discovery of chloroquine as a malariacidal drug at Bayer Co. (Wuppertal, Germany

1938 The German scientists **Helmut** and **Ernst Ruska** developed the transmission electron microscope at Siemens Co. (Berlin) (Nobel Prize 1985).

1939 Sulfonamides were introduced as anticoccidial drugs and the Nobel Prize was awarded to their discoverer **Gerhard Domagk** (1895–1964) (Bayer Co., Leverkusen, Germany).

1944 **Erich Reichenow** and **N. Mudrow** (Leverkusen, Germany) demonstrated the liver stages of avian malaria.

1950 In the USA **C. Bueding** demonstrated the carbohydrate metabolism in *Schistosoma mansoni*.

1953 The Americans **J.D. Watson** and **F.H.C. Crick** described the structure of DNA.

1955 DDT, which had been developed in 1939 by the Swiss **Paul Müller**, was introduced as an insecticide.

1956 The English scientists **P.C.C. Garnham** and **S. Short** demonstrated the liver stages of *Plasmodium* within humans.

1959 The English natural scientist **J.D. Smyth** and **J.A. Clegg** elucidated the egg shell formation in flat worms.

1960 **Erich Scholtyseck** (Bonn, Germany) and **Datus Hammond** (Logan, Utah) started systematical electron microscopic studies on Coccidia.

1961 The American **L.S. Diamond** cultured *Entamoeba histolytica* axenically.

1961 First reports on chloroquine resistance in Asia and Africa.

1963 The Americans **F.M. Fischer** and **R.M. Sanborn** demontstrated that the microsporidian *Nosema* produces juvenile hormones for its insect host.

1963 The Americans **C.P. Read**, **A.H. Rothman** and **J.E. Simmons** demonstrated the basics of the membrane transport in cestodes.

1964 The American **R. Damian** proved molecular mimicry in schistosomes.

1965 The Australian **W.P. Rogers** discovered the role of enzymes in the moulting of nematodes.

1966 Introduction of benzimidazoles as broad spectrum anthelminthica.

1969 The American **Jack Frenkel** (Kansas) and the Indian **J.P. Dubey** together described the cat as final host
of *Toxoplasma gondii*. **Work** and **Hutchinson** (Scotland) and **Overdulve** (Holland) independently achieved the same result.

1972–1977 German research teams led by **Micheal Rommel**, **Alfred Otto Heydorn** and **Heinz Mehlhorn** discovered
and described the life cycles of several *Sarcocystis* species and related cyst forming species.

1975 **Georg Köhler** and **J. Milstein** developed the hybridoma technique for the production of monoclonal antibodies (Nobel Prize 1986).

1975 The English biologist **C. Cross** characterized the glycoprotein surface coat of trypanosomes.

1975–1978 German research teams led by **Eberhard Schein**, **Karl Friedhoff** and **Heinz Mehlhorn** discovered the complete life cycles of 10 *Theileria* and *Babesia* species.

1976 The Americans **Trager** and **Jensen** succeeded in establishing continuous in-vitro cultures of *Plasmodium falciparum*.

1976 The Americans **C.H. Zierdt** and **J. Tan** introduced *Blastocystis* as a parasite.

1978 The Scottish scientists **Keith Vickerman** and **G.A.M. Cross** demonstrated antigenic variation in the surface coat of trypanosomes.

1981 Introduction of ivermectin.

1981 The Swiss **Burgdorfer** recognized *Ixodes* ticks as vectors of *Borrelia* bacteria, the agent of Lyme disease.

1982 American scientists defined the first malaraia antigen-circumsporozoite antigen.

1983 Research teams led by **J. Eckert** (Switzerland) and **H. Mehlhorn** (Germany) together proved that *Echinococcus multilocularis* may grow metastasis-like due to reproduction and dislocation of undifferentiated cells.

1984 The threat of AIDS was growing and the importance of **opportunistic parasites** became recognized.

1988 The Colombian microbiologist **M.E. Pattarroyo** presented a synthetic vaccine against *Plasmodium falciparum*.

1989 RNA-editing was found to occur in trypanosomes.

1990 The reasons for sequestration in *Plasmodium falciparum* were detected.

1991 The function of nitric oxide in human malaria and other parasitic infections was detected.

1993 **M.E. Pattarroyo** reported on first successful malaria vaccine trials in South America (failures occurred later).

Veterinary Parasitology

Veterinary parasitology deals with parasites and parasitism that includes different aspects like classification and taxonomy , habit and habitats, life cycle and developmental biology, pathogenesis of parasitic diseases, diagnosis (parasitological, serological or immunological) of parasitic diseases, treatment and control of parasitic diseases in domesticated animals and birds.

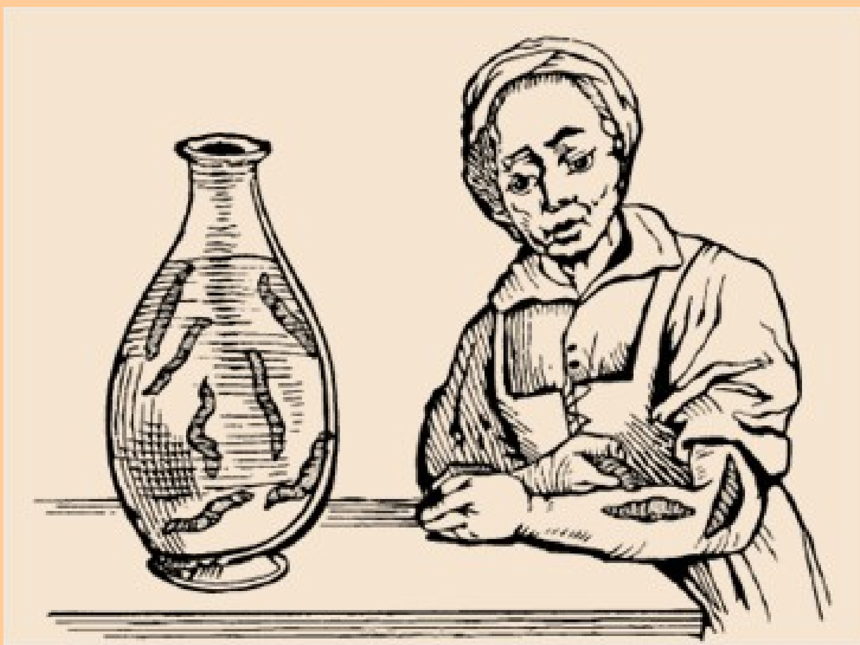


Fig. 4. Redrawn reproduction of a medieval engraving demonstrating the therapeutic use of the leech, *Hirudo medicinalis*, even in middle-class-households.

Importance of Parasitology in Veterinary Curriculum

Domesticated animals and birds are variously affected with different ecto and endoparasites. The impact of parasitic infection in domesticated animals and birds vary considerably depending upon the type of pathogenicity of the parasite species involved. For example, some adult tapeworms (*Taenia* sps.) are relatively less harmful than the blood or tissue feeding nematodes (*Ancylostoma* , *Necator*, *Bunostomum* sps.). The outbreak of clinical disease is mostly due to the infection with larval stages of the parasite which may lead to deaths of birds and animals, e.g., the migrating larvae of Ascarids, Strongyle larvae of horses and ruminants, larval tapeworm cysts as well as immature stages of flukes (*Fasciola*, Paramphistomes) . Thus the parasitic infection initiates a heavy economic loss to the entire livestock industry. The loss may be in terms of death or chornic illness leading to reduced growth rate, decreased meat, milk , egg or wool production, loss in hide cost, and reduced work performance of the animals. Moreover, there are certain parasites which are being shared by both animals, birds and man and communicable *vise versa*, known as zoonotic parasites. A detailed study on such zoonotic parasitic diseases is also necessary for the benefit of human community. Therefore this course has tremendous importance in veterinary curriculum.

References

Jain, P.C. 2002. General Veterinary Parasitology . Jaypee Brothers, Medical Publishers (P) Ltd. New Delhi.

Mehlhorn, Heinz (ed). 1988. Encyclopaedic Reference of Parasitology. Biology, Structure , Function. First Edition, Springer

Further Reading

Bhatia, B.B. 1997. History of Parasitology with Special Reference to Veterinary Parasitology in India . *Journal of Veterinary Parasitology*, 11(2): 111-124.

Cheng, Thomas C. 1999. General Parasitology. Second Edition, Harcourt Brace & Company Asia PTE Ltd. Academic Press.

Noble , Elmer R. and Noble, Glenn A. 1982. Parasitology . The Biology of Animal Parasites . Fifth Edition , Lea & Febiger. Philadelphia.