

VETERINARY HELMINTHOLOGY

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by

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Anterior end, lateral view, of Strongylus vulgaris

PREFACE

At the present time no textbook which deals exclusively with the helminth diseases of animals of veterinary importance in North America has been published.

Several very useful reference books have been written on the morphology and life history of helminth diseases of animals but those which are of importance to the veterinarian have not been readily available or concerned themselves with parasitic forms which occur in the United States.

During the past several years of teaching veterinary parasitology the writers have felt the need of a handbook for veterinary students, practicing veterinarians, investigators and agricultural students.

The present book is an attempt to fulfill this need. The volume gives a brief description of the helminth parasites of domestic animals and the diseases they cause. It is intended as a practical treatise with emphasis on morphology, life histories, pathology, diagnosis, treatment and control of the parasitic helminths which occur in the domestic animals of the United States. It may also be helpful and useful to helminthologists, zoologists, biologists, parasitologists and public health workers.

This book is an outgrowth of lecture material of courses on Veterinary Parasitology which the writers have given during the past few years to students in the College of Agriculture, University of Wisconsin and students in the School of Veterinary Medicine, Michigan State College.

Since the knowledge of certain helminth diseases of domestic animals is quite meager, as shown throughout this text, it is hoped that calling attention to these scientific gaps will stimulate investigators to pursue research further in order to obtain the solution to some of these perplexing but important problems.

The writers have collaborated and conferred with each other on all phases of this book for the purpose of obtaining adequate unification of the subject matter. Both authors assume responsibility for all of the chapters presented.

In a book of this kind errors will appear despite every effort to eliminate them. Consequently, the writers welcome any helpful suggestions or criticisms. Calling errors to our attention will prevent their appearance in future editions.

The order followed for the trematodes, cestodes and nematodes is systematic according to phylogenetic relationships. The arrangement of the hosts has followed more or less the order given by Benbrook (List of Parasites of Domestic Animals in North America, 1948; Burgess Publishing Co.) and Dikmans (Check List of the Internal and External Animal Parasites of Domestic Animals in North America, 1945; Amer. Jour. Vet. Res. 6:211-241).

The writers have leaned heavily on the publications of others in order to make the work as complete as possible. Textbooks, reference books and periodicals were consulted freely. Only the more important references were cited as it is realized that the undergraduate student does not have the time or the inclination to translate foreign languages.

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DRAWINGS

The majority of the drawings were made from material contained in the parasitological collection, Department of Veterinary Science, University of Wisconsin. Through the kindness of various colleagues, certain material was loaned to us. In cases where material was not available, drawings were borrowed from the literature.

The original trematode and cestode drawings were either made by drawing specimens from a projection apparatus or through detailed study with the microscope. The trematode and cestode materials were all drawn by Mr. E. L. Schiller. The life cycles for the most part were drawn diagrammatically. All of the original nematode drawings were made by the senior author with the use of a camera lucida. The pencil drawings were inked in by Mr. E. L. Schiller. The writers have attempted to show by the drawings the essential structures which are used for species identification.

CHAPTER I
GENERAL INTRODUCTION

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Chapter I

GENERAL INTRODUCTION

Parasitology is the science which deals with parasitism. Parasitism is the relationship between parasites and their hosts. Parasites, as a rule, are organisms which live temporarily or permanently on or within other living organisms for the purpose of obtaining food. In this manner the parasite benefits by this close association at the expense of the host. Parasitology from a comprehensive viewpoint may include bacteria, fungi, protozoa, helminths, arthropods, spirochetes and viruses. Helminthology is the study of worms, especially the parasitic forms. Helminth is a dignified term for worms. This book will be limited to helminths of veterinary importance in the United States. An animal infected with worms is suffering from helminthiasis (a disease in which worms are present in the animal body).

The science of helminthology in regard to disease has been developed and expanded by zoologists, parasitologists, entomologists, physicians and veterinarians. The first three groups of scientists mentioned have studied broadly the fields of taxonomy, morphology, physiology and life cycles of parasites, while physicians and veterinarians have been more interested in the reactions of the host to the parasite (symptomatology, pathology) and treatment of the infected host. The progress made by veterinary medicine, medicine and zoology, especially during the late war, has continually increased the importance of parasitology, especially in the prevention, control and chemotherapy of parasitic diseases. The veterinary medical aspect is concerned primarily with the parasites of domestic animals and their public health significance. Many studies on the parasites of animals have led to discoveries in the field of human parasitology. Even the study of free-living forms in the animal kingdom may provide valuable information on little known or less understood parasites.

Veterinary helminthology is an applied biological science and has wide-spread practical application. A knowledge of helminths is a necessary tool for the practicing veterinarian. Further study of the morphological characteristics of parasites is important for aid in the diagnosis of every parasitic disease. Many helminths which look similar may vary greatly in their pathogenicity and may require different measures for prevention and control. The diagnosis of any parasitic disease should be confirmed by the identification of the parasite, either as an adult form or immature stages, such as larvae or eggs.

Further knowledge, such as the pathogenicity of the parasite, pathogenesis, symptoms, treatment and control, is needed by the veterinary parasitologist. Prevention of parasitic diseases by eradication of the parasites, especially the pre-infective stages, or of intermediate hosts, should be a primary objective. Treatment of animals infected with parasites should be considered mainly as a measure for the prevention and check against further spread of the infections. Treatment should never be thought of as the final measure in the control of parasitism. Consequently, one of the most important phases of veterinary helminthology is an intimate working knowledge of the life cycles, habits, habitats and ecology, as this information is the ground work on which to base intelligent measures of prevention and eradication.

Our knowledge of the distribution and economic importance of most animal parasites in the United States is very meager. A conservative estimate by the United States Department of Agriculture in 1942 on the annual losses to livestock owners due to internal parasites was set at 125 million dollars.

Losses caused by helminths affect producers of livestock, the meat industry and other concerns which utilize animal products for commercial purposes. By far the greatest loss is suffered by livestock producers in the form of unthriftiness in stock, stunting of growth and death of young livestock. This loss involves money paid by the livestock owner for medication and waste of feed.

At the present time death losses due to helminths are difficult to estimate as no mechanism is available to gather this type of information. Losses due to stunting and general unthriftiness are even more difficult to estimate.

Wild animals in captivity present various problems to the veterinary helminthologist. Also, wild animals may be infected with parasitic diseases introduced by domesticated stock. Wildlife reservoirs of parasitic diseases are a constant menace to domestic animals and are a public health problem. The scope of veterinary helminthology during the past 20 years includes helminths of animals transmitted to man, helminths of fish, birds, wild animals; animals kept in zoos as well as domesticated stock.

HISTORY OF VETERINARY HELMINTHOLOGY

Veterinary helminthology is one of the youngest of the biological sciences. Very little true scientific information concerning the parasites of domestic animals was available 50 to 60 years ago. Some of the larger parasitic worms of animals, because of their size, were noticed and studied as a possible cause of disease. Hippocrates (430 B.C.) mentioned the occurrence of the pin worm (Oxyuris equi) in horses. Aristotle (384-322 B.C.) in his "Historia Animalium" refers to roundworms and flatworms of animals, especially in the dog. Celsus (53 B.C.-7 A.D.) also distinguished between roundworms and flatworms. Columella (100 A.D.) is said to have first observed an ascarid from a calf and Vegetius (400 A.D.) an ascarid from the horse.

During the next several hundred years nothing was contributed to the science of helminthology. Little was done except for the compilations of previous Greek, Roman and Arabic information in the general field of medicine. During these dark ages Paulus Aegineta (600 A.D.) was noted for his compilations. Following this, another blank period of about 400 years went by. Avicenna (980-1037) observed ascarids in animals. Later, Albertus Magnus (1200-1280) discovered nematodes in falcons. This appears to be the first mention of roundworms in birds.

Modern veterinary helminthology probably commenced when Jehan de Brie discovered the liver fluke (Fasciola hepatica) in sheep about 1379. Caesalpinus (1519-1630) stated that Redi discovered Dioctyophyma renale in the kidney of a dog. Vinegia (1547) recorded helminths from the skunk, lion and fish. About the year 1600, differentiations were made between two types of tapeworms (Taenia and Diphyllbothrium). Redi also recognized several cysteri as being animal parasites.

Some of the early parasitologists who worked with helminths of veterinary importance included Andry (1750), Frohlich (1789-1802), Leske (1779-1784), Werner (1782), Rudolphi (1808-1819).

One of the first mentions of internal parasites as being important was the reference of Aristophanes to "measled" pork (Cysticercus cellulosae). During the middle ages German provinces introduced laws concerning measly pork. The gid was well known to old shepherds but was thought to be a degenerate form of Oestrus ovis until 1780 when Leske showed its true relationship. The hydatid tapeworm was found by Goeze in 1782 to be closely related to Taenia. It was not until 1863 that the life cycle was known.

In 1758, the Swedish botanist Linnaeus introduced the binominal system of nomenclature and Rudolphi (1808) started collecting and compiled information which might be looked upon as the science of parasitology.

In 1773 Muller described cercaria from pond water. He mistakenly thought they were protozoa. Bojanus (1818) actually described sporocysts and redia from snails. Mehlis (1831) was first to see miracidia. Amphistomes which are present in the rumen of sheep and cattle were eaten raw by African natives for years but were not mentioned in the literature until 1789 by Zeder.

The first life cycle of veterinary importance involving an arthropod intermediate host was that of the double-pored tapeworm in the dog (Dipylidium caninum) which was solved by Leuckart and Metchnikoff (1869). The secondary host was the biting louse of the

dog. Braun (1882) demonstrated that the broad fish tapeworm required an infective stage in fish but the copepod host was not discovered until 1917.

The first animal species of helminth which was found to require the mosquito as an intermediate host was Dirofilaria immitis. This was observed by Grassi and Noe in 1900.

The human hookworms were not described until 1842 and 1902. The sheep hookworm was described by Rudolphi in 1808. Chabertia, the large mouthed worm of sheep, was recorded in 1788. Ancylostoma caninum of dogs was noted in 1859.

In 1846, for the first time in North America, Leidy discovered Trichinella spiralis in the muscles of pork. The life cycle was solved by Leuckart (1855) and Virchow (1859). The life history of Echinococcus granulosus was studied and the cycle pieced together over a period of years, from 1852-1863, by Siebold, Kuchenmeister and Leuckart. Also in 1855 Kuchenmeister and Leuckart solved the life history of Taenia solium. The first trematode life cycle, Fasciola hepatica, was determined independently by Leuckart and Thomas in 1883. The life cycle of Diphyllbothrium latum was learned by Rosen and Janicki (1917). Complete studies of the life cycle of Ascaris lumbricoides was recorded by Ransom and Foster in 1920.

Until about 1900 it was generally accepted that only two species of strongyles were found in horses. In 1901 Looss in his classical monograph described 10 distinct species. Since this work over 60 species of strongyles embracing 14 genera have been described. Ransom (1911) showed that the house fly acted as the intermediate host for the horse stomach worm (Habronema).

The oldest branch of veterinary medicine is the treatment of worms. Some of the drugs which were used before the time of recorded history are still used today. The Greeks contributed male fern, the Indians and Chinese presented areca nut and pomegranate bark, the Arabs demonstrated kamala and the American Indians, oil of chenopodium. These drugs probably were used against tapeworms. One of the most important contributions to veterinary parasitology was that of Hall (1921) who introduced carbon tetrachloride for the treatment of worms. Later Hall and Shillinger (1925) utilized tetrachlorethylene. Drugs of fairly recent origin include: arecoline hydrobromide for tapeworms, copper sulfate for stomach worms in sheep and hexylresorcinol as a general anthelmintic. Recent developments have been phenothiazine for nodular worm in sheep, sodium fluoride for swine ascarids and lead arsenate for sheep tapeworms.

TYPES OF PARASITES

The term parasite may be used in a broad or restricted manner. Animal parasitism may include any association in which one species of animal depends upon another. In a narrow sense, parasitism usually means damage by the parasite to the host animal.

Symbiosis strictly speaking implies the permanent association of two different organisms which are so dependent on each other that one cannot exist without the other. The most classical example of symbiosis is that of the protozoan fauna in the intestines of the termite. These protozoa change the wood material which the termites eat into a digestible form. Without this help termites cannot live.

Commensalism is an association whereby the animal parasite (commensal) is benefited but the host is neither benefited or harmed.

The term mutualism is occasionally used in parasitology. This denotes an association whereby both the host and the parasite derive mutual benefit from each other.

Parasitism is the condition when the parasite benefits and the host is harmed. The term parasite should be used to indicate a plant or animal that lives upon or within a host and maintains itself at the expense of the host. Helminth is a term usually applied to a parasitic worm.