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Scope and Method of Study: Description, life cycle, history, prevalence, transmission and treatment of five of the most common roundworm intestinal parasites of man occuring worldwide. The five roundworms included in the report are; pinworms, giant intestinal roundworm, trichina worm, whipworm and the hookworm. Information for this report was obtained from reference materials contained in parasitology texts and journals. The terminology has been simplified as much as possible in order that the average high school biology student might be able to read and understand the content.

Findings and Conclusions: These intestinal parasites are much more prevalent than the average person realizes. They are easily transmitted from one person to another and usually as a result of poor personal hygiene. Their existence is usually associated with unsanitary living conditions. Because of much scientific research in the past, they are not a menace today as they were during the days of our ancestors.

ADVISERS APPROVAL James H. Tate

COSMOPOLITAN INTESTINAL ROUNDWORMS OF MAN

By

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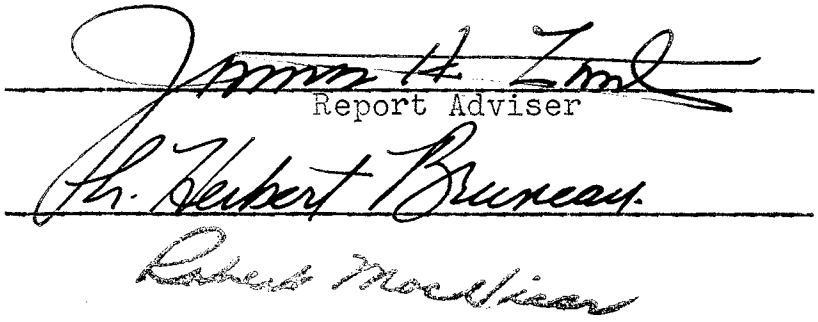

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TABLE OF CONTENTS

CHAPTER I

INTRODUCTION

All animals are parasites, predators, or scavengers; they either live on or in other organisms, kill them to secure food, or feed on their leavings. Parasitism is a mode of life and a parasite is an organism with specialized requirements, that is, they cannot make food for themselves. The parasite cannot alter these requirements, and if they should become altered or unobtainable, the parasite will die. Parasites do not normally destroy the animal which they parasitize, rather they tend to strike a balance with the host and the longer this relationship has been established the more perfect is the balance. Parasites do not normally cause diseases in the normal host; it is only under abnormal conditions that parasitic diseases occur. This generalization is true only for the parasites in the host in which they reach maturity. It is not so true for the larval stages of parasites in the intermediate host; in fact it is often rather to the advantage of the parasite to damage this intermediate host.

Parasitism, being a mode of life, is not confined to any one group of animals, and there is scarcely a phylum which does not contain some parasitic members.

Most of those forms which attack man, however, belong to one of five phyla of the animal kingdom; Protozoa, Platyhelminthes, Nemathelminthes, Annelida and Arthropoda.

The intention of this paper is to cover only a few of the many parasites of man, that is, the intestinal parasites that belong to the phylum Nemathelminthes. The only class covered by this report is the class Nematoda, (the roundworms).

This report can be used to supplement the high school biology text in presenting to the students a broader knowledge of the distribution, life cycle, prevalence, history, effects on the body and transmission of the more common helminths that occur world wide.

In some parts of the world these worms are a serious problem and peoples' ignorance of the life of the parasite allows the worms to prevail. Much work has been done by the Rockefeller Foundation, United States Military Services and many health organizations to educate the people of backward countries as to how they may prevent spreading the many helminths that burden them. However, many will not cooperate but continue their unsanitary conditions of living and provide a good habitat for the parasites.

In the United States helminths are not a serious problem as they have been in the past. Many individuals are carriers of one or more different species. In certain states there are more persons infected than in others and in institutions where many people live

together the percentage of infection is much greater.

The effects of most of these helminths are not very serious; however, if a person has a heavy enough infection of some, they may cause death. The BIBLE speaks of King Herod being eaten by worms, and according to B. W. Johnson's Commentary, these were intestinal parasites. There are other cases in history of deaths caused by intestinal parasites. These are the most serious cases that result in death. Many people do not realize they themselves are infected because of not really being ill. The infected person occasionally tires easily because of the parasite consuming some of the needed energy and very often intestinal disorders result from the infection.

CHAPTER II

PINWORMS
(Enterobius vermicularis)

Enterobius vermicualris, the human pinworm, thread-worm or seat-worm as it is called, is a parasite that inhabits the caecum and large intestine of man and manages to strike a close balance with its host. This species has been found only in man, (other than in a chimpanzie, a gibbon and a marmoset in the London Zoo), but closely related species have been found in other animals. Cases have been found in all parts of the world and not just in a specific climate as is the case with many other parasites.

Pinworms have been known since ancient times. They were not described until 1758 when Linnaeus studied the worm and wrote a complete description. In 1865, Leuckart determined the life cycle which led to Hall's work with the parasite in developing a cellophane swab, a means of detecting the eggs in diagnosis for the disease. From 1943 to 1949 Swellengrebel and Schuffner worked with the parasite and stressed how it is transmitted, how infection occurs and how reinfection takes place.(1)

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(1) C.J. Hackett, Manual of Medical Helminthology, Cassell and Company, Inc., London, 1954, page 217.

These are only a few of the many men that have done important work in connection with the pinworm. There are many others from the past and many today who are doing research for foundations developed to study intestinal parasites.

DESCRIPTION AND LIFE CYCLE:

Pinworms are small white worms that can often be seen wiggling very actively in stools passed by infected persons. Through a semitransparent cuticle can be seen the esophagus with a bulb at its posterior end, and the uteri and coiled ovaries. The head has three small lips and is set off by lateral expansions of the cuticle. The females, 1/2 to 5/8 inch long, taper at both ends, but the tail is drawn out into a long, fine point. The males are much smaller, 1/8 to 1/4 inch long, are less numerous than the females and are rarely seen since they do not move down the large intestine as do the females. The diameter of the worms is about that of an ordinary pin.

The life cycle of the pinworm is a very simple one with no intermediate host involved. The complete development from the egg to the adult occure in the intestine of man. As the uteri of the females fill with eggs, the females move down to the anus to deposit her eggs. As the female becomes stimulated from contact with the air she begins depositing her eggs around the anus and the peri-anal regions. She usually returns to the rectum but sometimes she crawls completely out of the anus and be-

cause of drying, explodes liberating all the eggs from her body cavity. Very often gravid females are found in the feces. Some workers claim the female makes nightly trips down the intestine to deposit her eggs. The females seem to lay their eggs principally at night and this activity causes intense itching around the anus. The eggs are very seldom found in the feces, only when the female dries and explodes. Eggs adhere to the skin and the scratching that results from the itching transfers them to the hands of the host. It has been estimated that a female liberates about 11,000 eggs in her lifetime. When the eggs are deposited they contain a partially developed embryo which quickly develops, but stays inside the shell until swallowed by a new host. After about six hours the larva, one in each egg, reaches the infective stage. When the egg containing the infective larva is swallowed, the larva breaks out of the shell and burrows into the mucous membranes of the duodenum. They then move on down to the lower part of the small intestine where fertilization takes place. After fertilization has taken place they move on down to the caecum where they attach themselves to the intestinal wall. The males remain there but the females occasionally move on down to the anus to deposit their eggs. The adults are attached to the wall of the intestine but do little damage to the membranes.

The eggs are quite small, only 55 x 25 microns

in diameter, and oval shaped. They are very resistant and can live outside the body two or three weeks at a temperature from 62 - 68 degrees Fahrenheit, or from four to five weeks at a temperature of 57 - 62 degrees. Antiseptics and other chemicals have very little effect on the eggs because of their resistant covering.

The complete life cycle (from the ingestion of the egg until the female begins to deposit her eggs), is approximately one month. Although the range of their life span is only 37 - 53 days, reinfection does occur.

HOST AND TRANSMISSION:

From the life cycle one can see that infection is through the mouth. It is very unlikely that infection could occur within the intestine since development of the eggs and fertilization of the eggs occur at different places in the digestive tract. There are various ways in which the eggs are conveyed to the mouth but the hands seem to be the most common means. Itching around the anus causes scratching which results in eggs being attached to the hands and under the fingernails. These eggs can easily be transferred to the mouth if the hands are not washed before eating. The eggs can get into dust and be inhaled in the air. The extent to which the eggs become scattered in an infected household is almost incredible. Not only are the eggs present in the air, but on clothing, bed linen, towels, washcloths, furniture, floors and soap. The smaller

the living space the greater the concentration of contamination of the home. Relatively humid conditions at about 78 degrees Fahrenheit with minimum ventilation provides optimum conditions for parasite's survival.

EFFECTS AND PREVENTION:

As can be seen from the way the worm liberates the eggs and the eggs ability to survive, treatment to eradicate the pinworm is very difficult. A household has to comply with a two fold treatment in order to stop the infection. If anyone in the household is infected, then all are and must be treated. There are chemicals that can be taken to kill the adults. The treatment involves taking medicine for seven days to kill the adults at that time. This is followed by a rest period of seven days in order for the larvae to develop. After the rest period, the medicine is again taken for seven days to kill the newly developed worms. The chemical treatment alone is not sufficient, there must be a sanitation program along with it. It has been suggested that the sanitation program consist of; keeping fingernails short, change bed linen daily, wash hands before meals and after using bathroom, and bathe daily.

Prevalence in the temperate zones is quite high. In institutions and other places where people live together the percentage of infection is much higher than under normal living conditions. School children have a greater percentage of infection than non-school children.

Females have a greater rate of infection than males and infection is greater in urban areas than rural areas.(2) In Washington, D.C. it has been shown that the incidence in school children is 50%, preschool children 35%, and adults 22%. Scuffner, in 1944, stated that he thought the incidence to be 100% for the children in Ireland. In North America it is estimated that over 40% of the white population is infected. Neghume estimated that about 60% of the school boys in Chile are infected.(3) In 1943, Alan Donaldson examined a group of children in the Ohio Institution For Children and found that only 39% were infected, whereas most institutions have about 63% infected. He stated that sanitation was well above average which probably accounts for less infection.(4) It has been estimated that there are more than 200 million persons in the world infected with pinworms.

If pinworms were dangerous, one would have a major problem, but as far as is known they provide no real danger to the health of the host. Their effects seem to be limited to itching around the anus and irritation of the skin causing loss of sleep, restlessness, nervousness and some sexual disorders. Immature worms may cause digestive disorders and some abdominal pains.

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(2) State Board of Health, Rapid City, South Dakota, Pinworm infection among children of rural communities. Journal Parasitology. 1945:31.288

(3) Asa Chandler, Introduction to Parasitology, John Wiley and Sons Inc., New York, 1949, page 429

(4) Donaldson, Alan. Intestinal parasites of children in Ohio State Institution for Children, Journal Parasitology. 1943:29.278.

Very often heavy infection may result in a child being anemic and show signs of sluggishness. These symptoms do not appear in all cases, but at least some of them are evident in heavily infected persons.

CHAPTER III

HOOKWORM
(Necator americanus)

Hookworm infection has been one of the major diseases of mankind in warm moist climates since prehistoric times, only exceeded by malnutrition and malaria in production of human misery and economic loss. Hippocrates described hookworm anemia in 440 B.C., however, it was not until 1838 that the organism was named by Dubini. The hookworm described by Dubini was later found to be Ancylostoma duodenale, a species not occuring in North America. The species occuring in North America was first named and differentiated by Stiles in 1902 and named Necator americanus, known as the new world hookworm. Epidemics had broken out in Europe and Asia and infection was quite high in the United States, so in 1909 the Rockefeller Sanitary Commission was formed to combat the hookworm disease. By studying the life cycle, transmission, and optimum contitions, this commission was able to educate the people how to keep the disease under control and to a minimum.

Stroll, in 1947, estimated that about 25% of the world's population suffers from hookworm infection. He estimated that 359 million persons in Asia, 49 million in Tropical Africa, 2.8 million in USSR, 42 million in

Tropical America, 1.4 million in Europe and 1.8 million North America.(5) The two main factors that account for this distribution are; the climate of the country and the level of education of the people. In the United States the most favorable climate is in the southern states.

DESCRIPTION AND LIFE CYCLE:

The adult worms are greyish-yellow, at times with a reddish undertone. The males measure 7-9 mm. in length and have a diameter of about 0.3 mm, whereas the females form 9-11 mm. in length and a diameter of about 0.4 mm. On the anterior end of the cylindroidal shaped body is a small buccal capsule provided with a ventral and dorsal pair of semilunar cutting plates in place of teeth. Within the buccal capsule are a pair of very long cephalic glands, the secretions of which may serve to digest the tips of villi to which the head is attached or possibly to secrete an anticoagulant for extravasated blood. Immediately internal to the buccal cavity there is a powerful, muscular esophagus, having a length of about 1/15 that of the entire body. Contraction of the esophagel musculature serves to anchor the head securely to the intestinal wall of the host, while dilation followed by contraction sucks blood from the host's intestinal capillaries into the worms's own digestive tract.

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(5) E. Faust, Animal Vectors and Agents of Human Diseases, John Wiley and Sons, Inc., New York, 1955.page 232

After fertilization of the eggs by the male the females may discharge as many as 9,000 daily. The fertilized eggs when discharged are unsegmented but by the time they are discharged in normal stool, they are in the 2 to 8 cell stage of segmentation. Occasionally in constipated stools embryos in the tadpole stage may be found and less commonly the eggs may contain motile first stage larvae. When feces is mixed with urine, death usually occurs to the embryos.

Ideal conditions for the hookworm embryos to develop is a primitive type of living conditions. The feces is deposited in a moist, shady, warm place where decaying vegetation covers a sandy loam soil. Here the eggs hatch from 24 to 48 hours and the larvae emerge and begin feeding on bacteria and organic material. After about 3 days of feeding and growth the larva sheds its cuticle and grows to a maximum of 0.5 to 0.6 mm. in length. Usually between the fifth and eiththh day the mouth becomes closed, the esophagus elongates and the larva becomes transformed into a non-feeding filariform type. This stage is infective to man as soon as it has shed its old cuticle and may remain viable in the soil for several weeks. The larva may migrate several inches in the soil, but seldom burrows below the humus.

HOST AND TRANSMISSION:

During the period of viability the filariform larvae, on contact with exposed human skin, usually between the

toes of the feet, secures lodgment in the hair follicles. More commonly the infection occurs under scaling fragments of the epidermis and penetrates down to the subcutaneous tissue where some of the larvae enter the superficial venules. Larvae that do not reach the venules usually die within a short time. Those that invade the blood stream are carried to and through the right heart to the lungs where they soon break out of the capillaries into the air sacs of the lungs. They are then carried up to the epiglottis, pass over into the digestive tract and down to the small intestine where they attach themselves to the intestinal wall. A period of about five weeks or more elapses form the time of the initial infection until the female begins to release her eggs.

Although mature filariform larvae, when swallowed, will develop into mature worms, possibly even without lung passage, this is not the usual course in nature. In the absence of reinfection about 70% of the worms may be expected to be elimenated within one year, although a few may persist for as long as nine years. Continuous reinfection commonly occurs through infected feces.

EFFECTS AND PREVENTION:

The damage of the hookworm is much more serious than the pinworm. At the sight of entry of the larva there is some mechanical damage to the skin layers, but as the larvae burrow down to the blood capillary beds considerable local damage occurs to the tissues. If

bacteria enters the skin with the larvae, an open lesion may develop and is commonly called, "ground itch". Little damage results to the air sacs of the lungs unless large numbers pass through the sacs at the same time. After the worms reach the upper part of the small intestine they actually swallow the tips of the villi to which they are permanently attached and begin digesting the distal portions of the villi. Erosion of tissue and ulceration develops at the sight of attachment and blood from the capillaries of the villi is pumped through the digestive tract of the worm. The need for oxygen seems to be one of the main purposes of the worm getting the blood from the host. Old sites of attachments, which are no longer productive for food, are abandoned and remain open. These form indolent ulcers, particularly if invaded by bacteria.

It seems that the continuous withdrawl of blood from the host by the worm causes anemia which possesses all the characteristics of iron deficiency anemia. Malnutrition seems to go along with hookworm disease and about 96% of the cases in Puerto Rico gave a history of having ground itch at many places on the body and during migration of the larvae in the body they seemed to have an urticarial rash over the body.(6) In moderate cases or moderate blood decomposition, symptoms consist of heartburn, flatulence, feeling of fullness in the abdomen, and epigastric pain. There may be intermittent

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(6) David Belding, Textbook of Clinical Parasitology, Appleton-Century-Crofts, Inc., New York, 1942. page 297

fever, vasomotor disturbances, dyspnea, palpitation of the heart and hemic murmurs.

In severe cases there is constipation or diarrhea, food poorly digested, skin dry and harsh, decreased perspiration, yellow skin, the patient stays cold, craves bulky materials to relieve pain in the intestines, hair is dry and lifeless, edema of the face occurs, and pot belly is a typical symptom with children. In late cases the pulse becomes weak, mental dullness begins, puberty is delayed in children which may even result in impotency. Untreated cases may result in physical exhaustion and cardiac failure which terminates in death.

A person's physical resistance to the effects of the parasite determines the severity of the disease. It seems that children are less resistant to the disease than adults, and females seem to be less resistant than males. The health of the host plays an important part in killing the parasite. Treatment for most cases of hookworm infections is not very difficult and quite effective for most cases. Many chemicals have been used to kill the hookworm but reinfection is very common.

Prevention and control of the parasite can be accomplished by education the people as to sanitation and the life cycle of the worm. The propogation of human hookworm infection depends on these four major points; (1) adequate source of human infection, (2) habits of defecation so that eggs will be deposited in

favorable locations, (3) apprcpriate conditions of the environment with soil containing an abundant amount of humus, (4) opportunity for the filariform larva to come into contact with human skin.(7) In tropical and sub-tropical countries, conditions are favorable the entire year while in temperate zones,as in the United States, conditions are favorable for the larvae only during the warm months. Prolonged dry or cold seasons or extensive rainfall are unsatisfactory conditions for the development of the hookworm. In many endemic areas of the world the use of human feces as fertilizers spreads infection. Feces soiled clothing may serve as a source of infection for laundrymen in moist tropics.

As can be seen from the conditions necessary for the development of the hookworm, sanitation is of utmost importance in the control of the disease. Prevalence of the hookworm is not nearly as great in the United States as is the pinworm but much more serious.

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(7) Ernest Faust and Paul Russell, Clinical Parasitology, Appleton-Century-Crofts, New York, 1957. page 312.

CHAPTER IV

GIANT INTESTINAL ROUNDWORM (Ascaris lumbricoides)

Ascaris lumbricoides is the most widely prevalent of all the human roundworms and occurs in all parts of the world except in cold dry climates. Although highest frequency is found in tropical areas, at times approaching saturation, it is also common in many temperate regions, including both rural and urban areas in southeastern United States.

This parasite has been known to man since the dawn of history because of its large size and extensive distribution. In 1863 Davaine discovered that the eggs of the worm hatch in the intestine of man which led to much research by such men as; Stewart (1916), Ransom and Foster (1917), Koino and Koino (1921), Loeffler (1932), and Etteldorf (1950). These men worked out the life cycle of the worm and discovered some treatments to be used in killing the parasite.(8)

DESCRIPTION AND LIFE CYCLE:

The white or reddish-yellow adult worms are elongated nematodes, tapering posteriorly and anteriorly to

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(8) C.J. Hackett, Manual of Medical Helminthology, Cassell and Company, LTD, London, 1954. page 226

conical extremities. The head has a terminal mouth, surrounded by a broad dorsal and two subventral oval lips. The lips bear sensory papillae on their lateral margins, two on the dorsal and one on each ventral, and are finely denticulated. The male, 150 to 310 mm. in length by 2 to 4 mm. in diameter, is distinguished from the female by its smaller size. The females measure form 200 to 350mm. in length and 4 to 6 mm. in diameter, although specimens sometimes reach a considerably larger size.

The life cycle of Ascaris is similar to the other roundworms. They mate, lay eggs which develop into larva and are ingested into the alimentary tract of the host. After mating the females lays her eggs, daily output about 200,000 which are removed form the body of the host with the feces. These eggs are broadly oval shaped and measure about 60 x 45 microns. The shell is thick and transparent, which makes the eggs very resistant to desiccation and putrefaction. About two weeks after the eggs are laid an infective larva has developed inside each egg. If the eggs are in moist loose soil that is shaded, the larvae may survive three or more years, but if the soil is dry and sandy with sunlight striking it, the eggs will die within about 24 hours. The eggs are able to survive freezing and are moderately resistant to being in contact with most antiseptics.

When the infective larvae are ingested in man, they develop in the small intestine. The young larvae

penetrate the mucosa and are carried through the liver and heart to the lungs, whence, after two moults, on the sixth or tenth days they migrate up the air passages and are swallowed to reach the small intestine. During this period of migration they grow considerably. After reaching the small intestine, they undergo a fourth molt and mature. They attach themselves to the mucosa only temporarily, since they are capable of moving about in the alimentary canal. Occasionally during migration they will get lost and not complete the migration cycle in the length of time stated above. They obtain their nourishment from the semidigested food of the host and possibly from the epithelial cells of the intestinal mucosa. They live inside the host about a year, however, reinfection is continually taking place which can cause the disease to prevail.

HOST AND TRANSMISSION:

The only natural host of the Ascaris lumbricoides is man. There is a strain of this species that has been found in hogs but is not able to mature in healthy hogs. There is a physiologically difference in the two strains of this species.

As has been mentioned, infection occurs only through the mouth by ingestion of the infective larva. This is sometimes considered a disease of human filth since unsanitary conditions are ideal for the spreading of the infective larvae. In areas where there has been a high

degree of infection, it has been found that the major source of infection has been by small children defecation on the floor and around the house. It has also been found that the use of human waste as fertilizer is a major source of infection. Infected hogs constitute a minor source of infection, however, it can be transmitted by ingesting hog's meat that has cyst in the tissue.

EFFECTS AND PREVENTION:

Normally the worms inhabit the small intestine, but they may migrate anywhere in the alimentary canal and they cause some damage to the walls of the organs. Masses of the worms may cause intestinal obstruction, gangrene or intussusception. They may enter the appendix and cause inflammation or penetrate the bowel wall and cause peritonitis. They sometimes enter the liver, pancreas and stop the flow of enzymes from these organs by clogging the ducts. Lesions may be caused by the larvae as they move through the lungs, by the adults in the intesttine and by the adults wandering from their usual habitat. In the lungs petechiae may arise when the larvae enter the alveoli and in heavy infections Ascaris pneumonia may result. Worms have been found in just about all organs of the body, including the brain, and can cause death in severe cases. Occasionally the toxins given off by the worms, under heavy infections, are very damaging to the host. Presence of the worms complicates any surgical procedures of the host.

Sanitation is the major tool to be used in preventing and controlling this giant intestinal roundworm infection. Chemotherapy can be used to eliminate the adult worms from the intestine, but has no effect upon the migrating larvae or extra-intestinal adults. Nutrition is an important factor in treating a person infected with this parasite. When conditions are unsuited for reinfection and a well balanced diet is maintained by the host, the Ascaris usually disappears within 15 months without the continued use of anti-helmintic drugs. If treatment is not closely followed, the disease may linger for the life of the host.

CHAPTER V

TRICHINA WORM
(Trichinella spiralis)

Trichinella spiralis is a parasite of rats and pigs transmitted to man by eating uncooked or insufficiently cooked pork. It is probably an ancient disease, although authentic records are lacking. The encysted larval worm in man was first noted in Germany by Tiedemann in 1822 and later in England by Peacock in 1828 and by Hilton in 1833. The larval worm, dissected by Paget, was described by Owen in 1835 and he gave it the name, Trichina spiralis which was later changed to Trichinella spiralis. Other cases of human infection were soon reported from England, Europe, and North America. In 1855 Leidy in Philidelphia observed the larval form in pork. Feeding experiments by Leucart in 1855 and by Virchow in 1859 established the fact that the viviparous larva reached maturity within a few days in the intestine of experimental animals.

The worm, however, was regarded as merely commensal in man until Zenker in 1860 demonstrated its association with disease following ingestion of infected pork. German investigators from 1881 to 1889 uncovered numerous cases of trichinosis, many occuring in epidemic form. This brought about inspection of pork by the United States

Government before exporting it to Germany.(9)

DESCRIPTION AND LIFE CYCLE:

The adult is a small worm with a slender anterior end. The male is fro 1.4 mm. to 1.5 mm. long and 0.045 mm. broad. There are two lobular caudal appendages on the posterior end of the male that serve as a copulatory organ. The female is larger, being 3 to 4 mm. long and 0.06 mm. broad. The worm has a small orbicular, non-papillate mouth. The larva, with a spear shaped burrowing tip at its tapering anterior end, measures 90 to 100 microns at birth and grows but little until it has entered a muscle fiber where it attains a maximal length of 1 mm. The encapsulated larva has a digestive tract similar to that of the adult, and while the reproductive organs are not fully developed, it is often possible to differentiate the sexes.

The larvae require a minimal development of at least 16 days to become infective. When infected larvae are ingested by man, they pass to the small intestine where the capsules are dissolved and the larvae released in a few hours by the action of the digestive juices. The young larvae attach themselves to or invade the intestinal mucosa. Within two days the worms reach sexual maturity and mate in the small intestine, when the female is about half the maximal size. After fertilization the

(9) David Belding, Textbook of Clinical Parasitology, Appleton-Century-Crofts, New York, 1942. page 249

male dies and the female continues to increase in size, burrows into the mucosa of the intestinal villi and in about six days deposits successive broods of larvae into the lymph spaces. Occasionally larvae may be liberated into the intestine. From 1350 to 1500 larvae may be produced by each female.

The larvae move in the lymph spaces to the blood stream and burrow themselves into the muscle bundles of striated muscles of the host body. Larvae that enter the non-muscular tissues disintegrate and are absorbed.

The larva grows rapidly assuming a characteristic spiral shape and attains a length of 1 mm. within 16 days. An ellipsoidal capsule is formed around the larvae, within 15 to 20 days. The capsule or cyst may remain viable for a long period of time, 11 years in the hog and up to 31 years in man, but ultimately undergo calcification.

HOST AND TRANSMISSION:

The Trichinella spiralis is found in man, hogs,rats, bears, dogs and cats. The same animal acts as the intermediate and final host, harboring the adult parasite temporarily and the larva for long periods. In order to complete the life cycle flesh containing the encysted larvae must be ingested by another host. Most animals may be experimentally infected, but the embryos do not encyst in the muscles. Birds and poikilothermal animals may

harbor the adult worms but need an intermediate host for larval development.

EFFECTS AND PREVENTION:

The effects of trichiniasis is very often diagnosed as typhoid, ptomaine poisoning, intestinal influenzia and other intestinal disorder diseases. The first symptoms are diarrhea, abdominal pains, nausea and other gastro-intestinal symptoms. These are usually accompanied by weakness. Later stages results in the larvae penetrating into the muscles and then becoming encyst which may lead to death of the host. The patient becomes anemic, skin eruptions occur, the muscular pains subside, and the swollen portions of the skin often scale off. Pneumonia is usually a complication that develops with the disease. In very severe cases of heavy infection, death usually comes in the fourth to sixth week.

In 1943, Kerr and Jacobs examined 5,313 persons in the United States, and from their data estimated that one out of every six individuals was infected. In 1947 an epidemic occured in Greenland, with 300 cases and 33 deaths. The source of infection was found to be walrus meat. In Maine 71 people eating a single hog became infected and of this group 56 were ill, 26 very ill and 2 died form the infection.(10)

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(10) David Belding, Textbook of Clinical Parasitology, Appleton-Century-Crofts, New York, 1942. page 260

Much concern has been taken to prevent people from getting trichnosis by passing laws to watch that the hogs are free from infection. The United States Government has been inspecting all meat sold as well as requiring the farmers to cook the garbage fed to hogs in order that they not get infection from the food. Man gets the disease principally from pork. To prevent getting the infection one should cook all pork well done because high temperatures will kill the cyst before they enter the body.

CHAPTER VI

WHIPWORM
(Trichuris trichiura)

Whipworm derives its name from its whiplike form, having a thick posterior part of the body and a longer lashlike anterior part occupied only by the esophagus. The name Trichuris was given to the worm by Roederer of Germany in 1761, when he first described the worm. The genus means, "thread like tail," which Roederer thought the whip to be a tail. In 1782, Goeze described the worm and found the head to be on the slender part and he re-named the genus to be Trichocephalus, which means, "thread head." In 1887 Grassi worked out the life cycle of the whipworm.

The human whipworm is found only in man and is most abundant in warm moist regions of the world. It is not as dangerous as most of the other parasitic roundworms, unless there is a heavy infection.(11)

DESCRIPTION AND LIFE CYCLE:

The body of the pinkish-grey adult worm is divided into an attenuate, whip-like anterior three-fifths, and a more robust posterior two-fifths. A spearlike

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(11) Sawitz, William, Medical Parasitology, The Bladeston Company, Philidelphia, 1950. page 61

projection at its anterior extremity enables the worm to penetrate and anchor itself to the intestinal mucosa. The mouth leads into a narrow esophagus which resembles a string of beads in its course through the slender portion with the anal opening at the extreme posterior end of the worm. The male, from 30 to 45 mm. in length, is distinguished from the female by its coiled caudal extremity. At its bulbous posterior end a single spicule, 2.5 mm. in length, protrudes through a retrictle sheath set with terminal recurved spines. The female, 35 to 50 mm. in length, has a bluntly rounded posterior extremity, which contains the sex organs.

The life cycle is similar to the other roundworms. The eggs, from 50 to 54 microns in length by 22 microns in breadth, are barrel-shaped, with an outer and inner shell and transparent polar prominences. The female output of eggs has been estimated at about 1000 to 5000 daily. The eggs are non-segmented and are passed with the feces of the host. About 3 to 5 weeks after the eggs are passed with the feces, the infective larvae have developed inside the shell. When these eggs are ingested by man, the shell is digested and the larva emerges in the small intestine. The larva penetrates the villi where it lies coiled and develops for a period of about one week. It then re-enters the lumen and reaches the caecum. The thin anterior end penetrates and is buried in the mucosa while the fleshy part penetrates into the

lumen. The females mature and eggs are produced about three months after ingestion of the eggs.

Conditions most favorable for the development of the larvae inside the eggs are; plenty of moisture, and shady, sandy soil. The eggs are less resistant to desiccation, cold and heat than those of Ascaris and are kill in a short time under extreme temperatures. The infections are not as well distributed in the United States as the Ascaris. They occur in places where there is more or less dooryard pollution, dense shade close to the house, a heavy rainfall and a sandy-clay soil to hold the moisture. The conditions in southwestern Louisiana and in the southern Appalachians seem to be the most favorable for the parasite's existence in the United States.

HOST AND TRANSMISSION:

Man is the principal host of the Trichuris trichiura, but it has also been reported in monkeys, lemurs and hogs. There are a number of similar species found in hogs, sheep, cattle, cats, rats and mice. The principal characteristic separating these species is the number of spines on the spicules of the adults.

Transmission is by man ingesting the eggs with food or on objects that are put into the mouth. In highly endemic areas, small children develop heaviest infection. The heavest infected countries are those where the people

practice primitive personal hygiene.

EFFECTS AND PREVENTION:

The adults living in the intestines and burying their head into the intestinal muscosa definitely causes some damage to the intestinal walls. They receive their nourishment from the host and in sucking the blood may cause hemorraging in the feces with a large infection. Chronic diarrhea, loss of appetite and weight, nausea, dysentary and anemia are all results of whipworm infection. One of the most serious conditions as a result of heavy infection is prolapse of the rectum which is very painful.

Treatment is a bit difficult since an orally administered medicine would not reach the mucus covered worm, however, a special treatment can be taken to kill the worm. One chemical is taken that will clear away the mucus and this is followed with another chemical that is taken to kill the worm. This treatment is repeated in one week in order to kill the worms that have developed since the first treatment.

Whipworm infection is controlable. Reduction to exposure can be accomplished by clean toilets for adults and children and educating the people so that they will improve their living conditions and practice sanitary personal hygiene.

CHAPTER VII

SUMMARY

In this report I have touched on a few of the many intestinal parasites that attack man. These few were selected because of their being some of the most common helminths occuring in the United States. These parasites have been with us since man's existence, but with the modern advancments of science and medicine there is no need for them to be a continuous burden on people anywhere. We do not consider them a problem here in the United States but many of the tropical countries where the climate is so favorable and the living conditions are unsanitary they are a serious problem. Much is being done by many organizations to improve the situations in these countries and eliminate these parasites. Sanitation is the main factor to consider in killing these parasites and controling them.

In the high school biology text very little is said pertaining to human intestinal parasites and it is my purpose to supplement the text with this information in this report.

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