

Relationships in Parasitology

Part II of II

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HELMINTH INFECTIONS

Helminth infections included mostly tapeworms (Cestoda) and roundworms (Nematoda) at markedly lower prevalences than major unicellular parasites. These worm infections were identified from the presence of their ova (eggs) (or larvae in one nematode species) in fecal smears. Only one patient was infected with the liver fluke *Fasciola* or *Fasciolopsis* (Trematoda) (eggs are indistinguishable).

Ascaris lumbricoides, the cosmopolitan giant round worm, was the most frequently detected nematode species in the population sampled. Over 1.2 billion and 3 million human infections are estimated world-wide, and in the United States, respectively. Ascariasis is present in southern United States in epidemic proportions.³²

Adults may reach as long as one foot and multiple infections are common. The distinction of these worms from those of the pig, *Ascaris suum*, is based only on host specificity as they are practically identical morphologically. New infections are acquired when food or water contaminated with the microscopic infective eggs are ingested. This is usually associated with eating unwashed fresh fruits or vegetables, ex., lettuce, that have been grown on farms contaminated with human fertilizer (night soil). More children are infected by eating dirt or placing soiled fingers or toys in their mouths. Eggs can live longer than 10 years in typical houseyard situations.³² Even airborne dust can carry *Ascaris* eggs into nasal mucosa and mouths.³ Once eggs are ingested, the second stage larvae hatch in the small intestine, penetrate the intestinal lining, and enter the lymphatic or blood stream. They subsequently reach the liver through the hepatic portal system within 8-18 hrs. Two molts occur as the infection progresses from the right

side of the heart to the lungs. The last phase of migration is completed with the last molt producing adults in the small intestine. Fertilized and unfertilized eggs are subsequently produced by breeding adults and passed onto the soil with feces. As many as 27 million eggs can be produced by one female. Egg development outside the body ceases at temperatures below 15.5° C. [59.9° F.] and are killed at temperatures above 38° C. [100.4° F.]² which explains the geographical distribution of *A. lumbricoides* within the warm belt of the world.

At the Diagnostic and Educational Lab, *A. lumbricoides* infections were found in urban and rural patients alike; consumption of fresh produce grown south of the border appears to be a common denominator. Human ascariasis has often been described as a household and backyard infection depending on the state of sanitation. In our sample, infections were more prevalent in males, children and immune compromised patients than in others.

Initial infection and penetration of larvae through the intestinal lining do not usually cause significant pathology; 85% of cases are symptomless.² Allergic responses in some patients to the metabolic byproducts of adult worms are known to cause asthma, insomnia, eye pain, and rashes. Aberrant larval migration can cause inflammatory reaction in spleen, liver, lymph nodes and brain. Pulmonary hemorrhagic foci may be accompanied by coughing, fever, and difficulty breathing. Fatal pneumonitis is a possible complication. Mechanical blockage may be caused by a large number of adults in the intestinal tract. A mass of two hands-full of adults caused the death of a two year old African child.³² Adult worms occasionally penetrate the intestinal wall or appendix causing local hemorrhage, peritonitis, and/or appendicitis. In Cape Town, South Africa, 35.5% of all deaths from acute ab-

dominal emergencies of children were attributed to ascariasis.²⁴

Ascaris infections are usually treated by mebendazole. Alternate drugs include pyrantel pamoate or piperazine citrate; about 85% of patients respond to a single dose. In the case of concurrent infections with *G. lamblia* and *E. histolytica*, patients should be treated for ascariasis first to avoid provoking worm migration, intestinal perforation, or worm-knot-up.^{2,25,32}

Hookworms (*Ancylostoma duodenale*, *Necator americanus*) eggs were mostly detected in adults and children of both sexes of one very large rural family that lives on a farm. Hookworm infections are restricted to the warmer parts of the world with up to one billion people estimated infected. Not all infections cause disease. Only over 25 *N. americanus* adults can cause disease and usually only conditions of poor nutrition. White people are known to be ca. 10 times as susceptible as black persons.³²

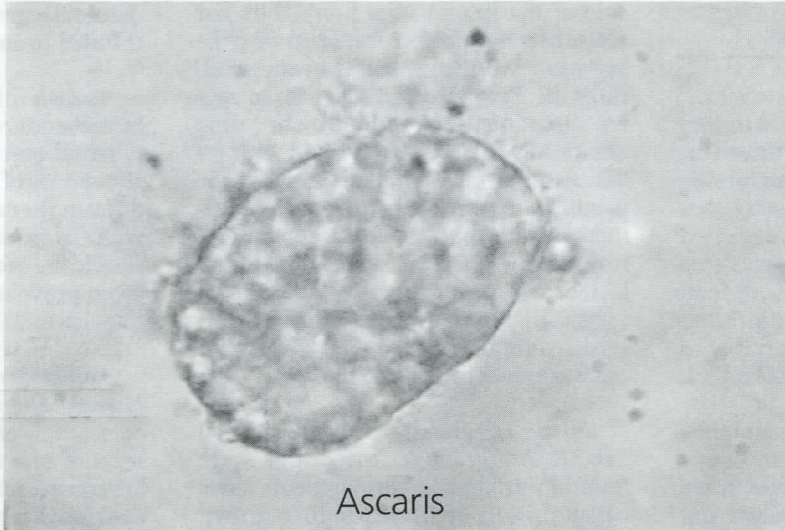
Infection with hookworms begins with penetration of the filariform larvae into the skin of humans walking barefoot on moist seeded soil. The larvae enter the lymphatic and blood circulatory system then the right side of the heart, lungs, and trachea before undergoing two molts bringing them to the esophagus then the small intestine as sexually mature adults. The eggs, including larvae in early stages of development, pass onto the soil with feces where they molt and develop to infective larvae.

The initial penetration of infective larvae into human skin causes an urticarial condition known as ground itch. The migration phase produces hemorrhaging, a dry cough, and sore throat. Actively feeding adults cause iron deficiency anemia, intermittent abdominal pain, loss of appetite, and occasional craving to eat soil. Heavy infections may produce secondary

bacterial infections, severe anemia, protein deficiency, dry skin and hair, edema, distended abdomen especially in children, stunted growth, delayed puberty, mental dullness, cardiac failure, and even death.² Cutaneous larva migrans (Creeping eruption) is a condition caused by invasive juvenile hookworms that normally infect animals other than man. Upon entering the wrong (human) host, they may cause considerable subcutaneous damage before they become contained by the human immune system.

The drugs of choice are Mebendazole and pyratel pamoate. Iron therapy is indicated to bring hemoglobin levels up to normal.²⁵

Stroglyoides stercoralis filariform larvae were found in three patients all of whom had recent foreign residence experiences in the Middle East and South America. Infections could, however, have been acquired in the U.S., which falls within the known range of distribution of *S. stercoralis*. The life history and pathology of this round worm are comparable to those of hookworms except for three differences: (1) eggs hatch into larvae in the intestine before passing in feces, (2) larvae can mature into filariforms and cause autoinfection, (3) a freeliving nonparasitic cycle can be established outside the human host.²⁵ Additional symptoms to those mentioned in hookworms include diarrhea, malabsorption, ulceration of intestinal mucosa including ulcerative colitis, and bloody stool. Autoinfection may lead to chronic infections that may last for years.²⁵ Infections with *S.*



Ascaris

stercoralis are often asymptomatic, but asymptomatic carriers are known to develop serious pathology years after initial infection. In immune compromised individuals, ex., AIDS, chronic fatigue, or malnourished patients, the balance is altered in favor of the parasite and massive disseminated strongyloidiasis may result in fatality, particularly in patients treated with high dose steroid therapy.

Drugs of choice are thiabendazole, mebendazole, and cambendazole. Patients in endemic areas who are about to have immune suppressive drugs should have at least three stool examinations to rule out *S. stercoralis* infection and avoid risks of autoinfection.²⁵

Taenia solium (pork tapeworm) and *Taenia saginata* (beef tapeworm) were the most commonly encountered cestode species in the sampled population. There was no significant difference in prevalence among the subsamples tested. Humans acquire adult worm infections by eating inadequately cooked pork or beef containing larval cysticerci which develop into egg producing adults in the small intestine. *Taenia saginata* is common in

North America but *T. solium* is more prevalent in Asia, Mexico, and Latin America. *Taenia solium* may reach a few yards long and is known to live as long as 25 years.³² It is most dangerous because of the possibility of self-infection with cysticerci. Adults in the intestinal tract seldom cause appreciable symptoms other than abdominal discomfort, chronic indigestion, or diarrhea. Most patients become aware of the infection upon discovering proglottids (segments) or whole strobila in their feces. We

acquire the much more serious tissue stage (cysticercus) when eggs are accidentally ingested through direct or indirect fecal-oral contact with a tapeworm carrier. Cysticercosis may thus develop in individuals who do not eat pork. The localization of cysticerci in the central nervous system results in neurocysticercosis which may leave the patient with various degrees of neurologic damage including recurrent seizures or permanent disability. The World Health Organization estimates that 50,000 deaths are attributable to neurocysticercosis every year; many times that number are survivors.³¹

Prevention of cysticercosis depends on early detection, elimination of the adult tapeworm, and a high level of personal hygiene. Investments in social improvement in Mexico and the impact of the North American Free Trade Agreement will have serious implications on this disease and other public health issues. Only radiographic studies, exploratory surgery, visualization of cysts in the eye, or brain scans can diagnose neurocysticercosis. Intestinal *Taenia* infections are treated with niclosamide, prazi-

quantel, paromomycin, or quinacrine with reasonably good results.

Hymenolepis nana (the dwarf tapeworm) and *Hymenolepis diminuta*, the cestodes of mice, rats, and humans were also diagnosed in a few patients. *H. nana*, which utilizes only one mammalian host in its life cycle, infects humans in the egg stage contaminating food or water or via food handlers. Humans become infected with *H. diminuta* through the ingestion of cereals, grains, flour, and baking products containing infected arthropod intermediate hosts (meal worms, flour beetles). Rat and mouse feces are sources of eggs. Insects are infected when they ingest rodent feces containing worm eggs.

Light infections with *Hymenolepis* worms are usually symptomless but heavy infections may cause diarrhea, abdominal pain, headache, anorexia, and other unspecific complaints, particularly in children.²⁵

The treatment of choice for both species of *Hymenolepis* is praziquantel; niclosamide represents an alternative therapy.

Diphyllobothrium latum, the broad fish tapeworm, was diagnosed in two adult patients. Ingestion of uncooked or undercooked fish containing the larval plerocercoid (sparganum) is the source of infection to humans. Bear and other fish eating mammals are sources of eggs. Single infection with one worm is usual. The adult worm may reach the length of 30 feet and shed up to one million eggs per day for 10 years. Many infections are subclinical and may have unspecific symptoms such as diarrhea, abdominal discomfort, nausea, weakness, weight loss, and occasionally megaloblastic anemia due to the large amount of vitamin B-12 absorbed by the worm.³²

The drug of choice has been niclosamide (Yomesan). Parziquantel may also be used as a supplement.

Note that in this and in most other helminth infections discussed above, albendazole may turn out to be the ultimate drug of choice.²⁹

Blood parasites diagnosed will not be treated in detail because of their scarcity as well as space limitations.

Babesia-like organisms were detected in the RBCs of two middle-aged females with history of frequent tick bites in New England states (the endemic region of babesiosis in the US). One of the patients was treated for Lyme disease without recovery. Both patients were fatigued and at least partially immune suppressed.

Trypanosoma cruzi-like organisms, agents of Chagas disease, were observed in blood smears of two young adults who were severely fatigued and immune compromised. The haemoflagellates were, however, about half the normal size, and it is not evident if they may be the smaller variants of the real thing. One of the patients is a 29 year old female who was born in the Philippines and has continued to have recurrent seizures since she was three years old. History of insect bites has been documented since her early childhood years. *Trypanosoma cruzi* is known outside South America, including the Far East.³⁸ The other patient is a young man who spent time in Puerto Rico and has history of exposure and symptoms compatible with *T. cruzi* infections. It should be noted that sylvatic Chagas disease has been documented in wild mammalian reservoirs, ex., opossums and raccoons, and in *Triatoma* bugs in many states in the Union; most recent reports come from North Carolina.¹⁸ This is a disease waiting to happen. The in-

roduction of cases among unscreened imported domestic labor from south of the border serving as new sources of human infection can not be overstated.

Conclusions. It is clear that the notion held by many in the US that individuals are free of parasitic infections is but an illusion. That illusion is created by the fact that the topic is rarely discussed, as it is not the kind of topic refined people talk about. Some estimate that 55 million children in the US are infected with worms.³² Relevant issues include (1) the media, popular press, and lack of interest and information, (2) border treaties, importation of potentially infected foreign labor and goods, and international travel, (3) financial and human factors, pain, and suffering, and (4) the fact that the US is an endemic region of many zoonotic and other parasitic infections and diseases.

The underlying reality is that, in a large measure, we create our own diseases. To allow a state of imbalance between our physical, mental and emotional entities to depress our immune system will make us much more susceptible to parasitic infections and diseases. The keen eye can not overlook the impact on physical and psychological trauma. That imbalance is often generated by factors extraneous to the individual but not to the human race, ex., population density, pollution, poverty, wars, malnutrition, psychological and emotional pressures, etc.

Whether we are consciously aware of it or not, nothing can happen to us except in as much as we allow it to happen. The lesson becomes apparent: as we observe trees grow along their own grain, so we let events unfold in order to learn the kind of trees that we are, to become the observers and the subjects of our own

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observations, the unattached shapers of our own destinies, and today's makers of tomorrow's memories of positive energies; the substance of life.

I hope the readers will forgive the fact that I have not explored natural remedies in this article. I am presently doing my own exploration and hope to be able to address this and related topics in some possible future contributions.

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