

## Estimated Prevalence

Hookworms	740,000,000
<i>Ascaris lumbricoides</i>	1,472,000,000
<i>Trichuris trichiura</i>	1,049,000,000
<i>Wuchereria bancrofti</i>	107,000,000
Schistosomes (all)	200,000,000

Source: American Society For Parasitologists 2003

## Morbidity and Mortality



**Table 1.** Estimated global prevalences and associated morbidity and mortality due to soil-transmitted helminths and schistosomes.

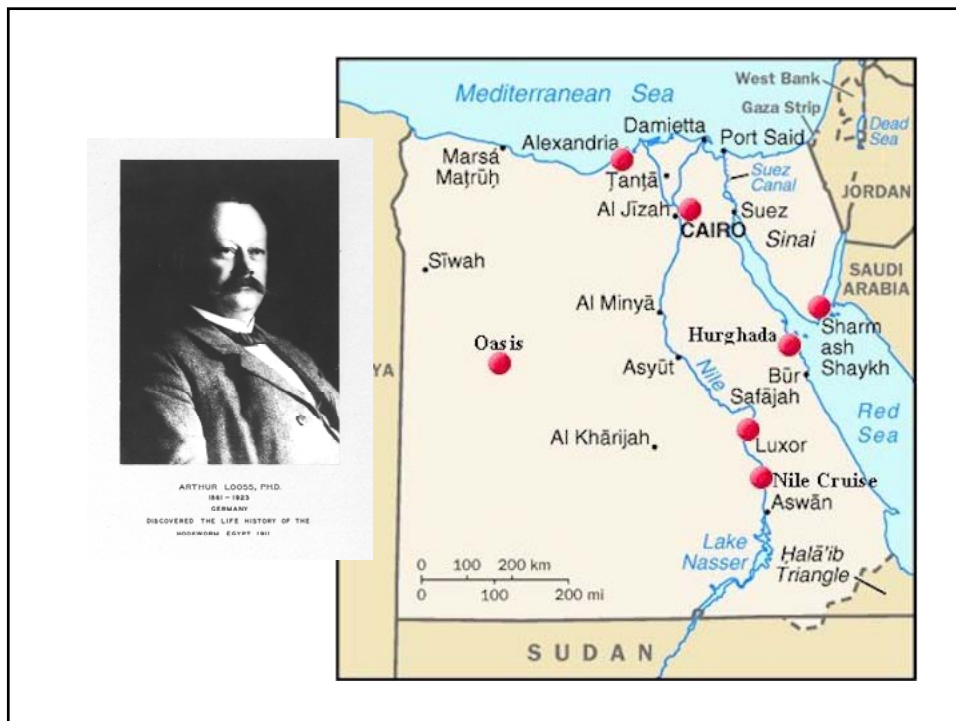
Parasite	Prevalence of infection (cases, millions)	Mortality (deaths, thousands)	Morbidity (cases, millions)
<i>Ascaris lumbricoides</i>	1450	60	350
<i>Trichuris trichiura</i>	1050	10	220
Hookworms	1300	65	150
Schistosomes	200	20	20

# Helminths Nematoda:

## The Hookworms

*Ancylostoma duodenale*

*Necator americanus*



## Antonie Dubini\* and the Saint Gotthard Tunnel Hookworm Epidemic of 1880

QuickTime™ and a  
TIFF (Uncompressed) decompressor  
are needed to see this picture.

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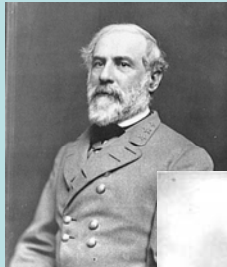
Length - 15 kilometers  
Depth - 1,700 meters

"An effort..... to build a rail tunnel through the St. Gotthard massif was treacherous. That construction between 1872 and 1882 was plagued by bad rock and flooding. It killed 310 workers, incapacitated 877 others and bankrupted the contractor".

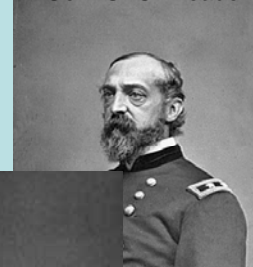
\* Dubini, A. Ann. Univ. Med. Milano. 1843 106:5-13. First record of disease caused by hookworm

## Civil War -1861-1865

Gen. R. E. Lee



Gen. G. G. Meade



Pickett's Charge

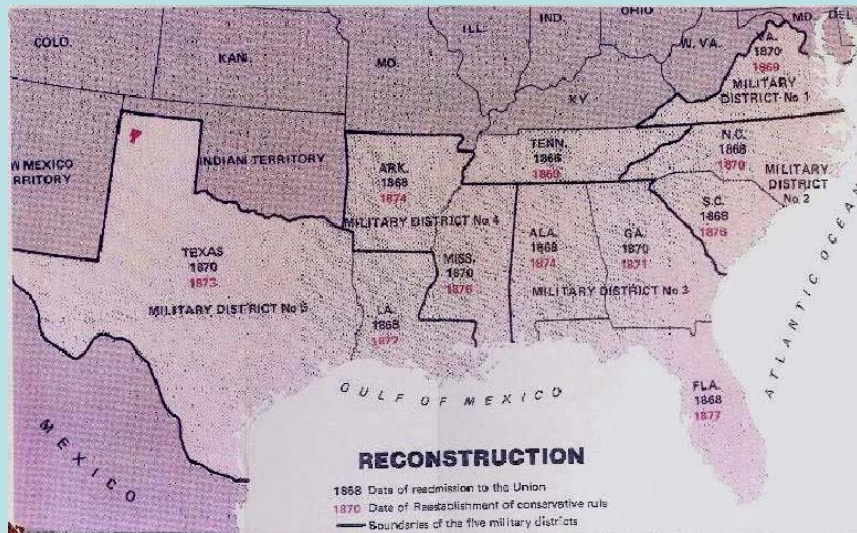
## Distribution Of hookworm up to 1927

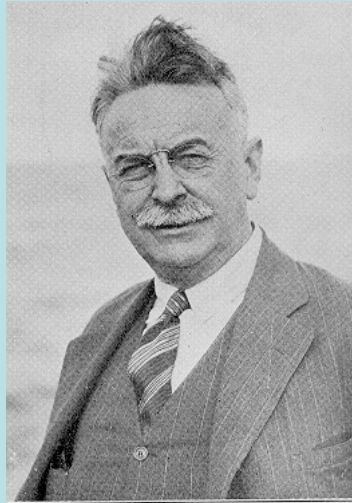


One theory suggests that hookworm disease may have influenced the outcome of the civil war. Southern troops grew up with the infection and had little in the way of sturdy clothing or shoes. Hookworms were brought to America from Africa in the early 1800s via the slave trade. They have been here ever since.

Coelho, Philip R. P. and Robert A. McGuire. "Biology, Diseases, and Economics: An Epidemiological History of Slavery in the American South," *Journal of Bioeconomics* 1:2 (1999):151-190.

## Economic recovery was slow following the Civil War, and J. D. Rockefeller wanted to know why!

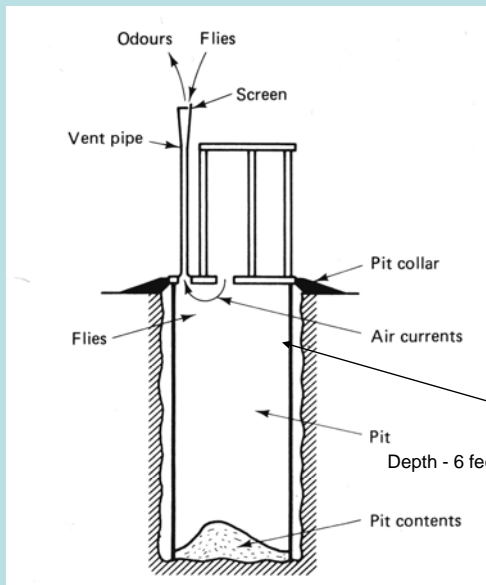




John D. Rockefeller  
Oil Baron *par excellent*

JDR established a sanitary commission (1909-1915) headed by Charles Wardell Stiles to look into the matter of "southern laziness".

## The Pit Privy



Distribution and installation began in the 1920's following The Rockefeller Sanitary Commission Report to Congress

Height to which hookworm larvae can crawl = 4 feet.

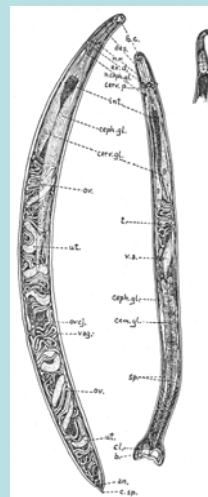
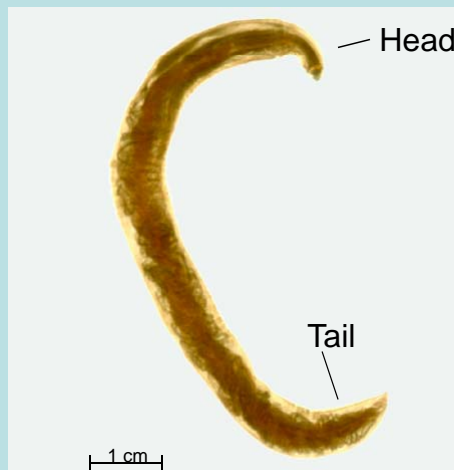


Colorado Out House

\* The camper's best friend

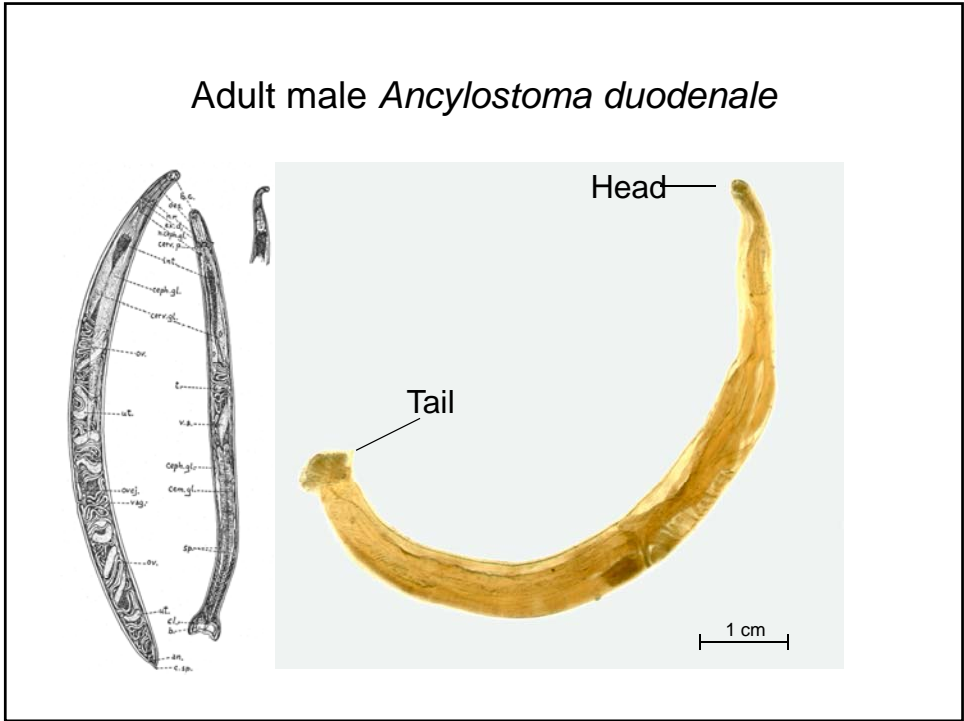
Circa 2006

Adult female *Ancylostoma duodenale*

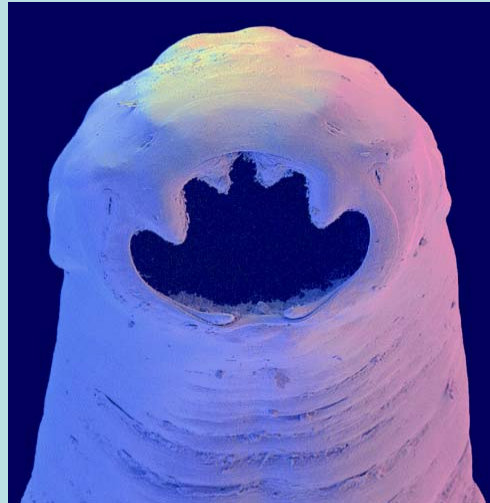


Looss' original elegant drawings

Adult male *Ancylostoma duodenale*



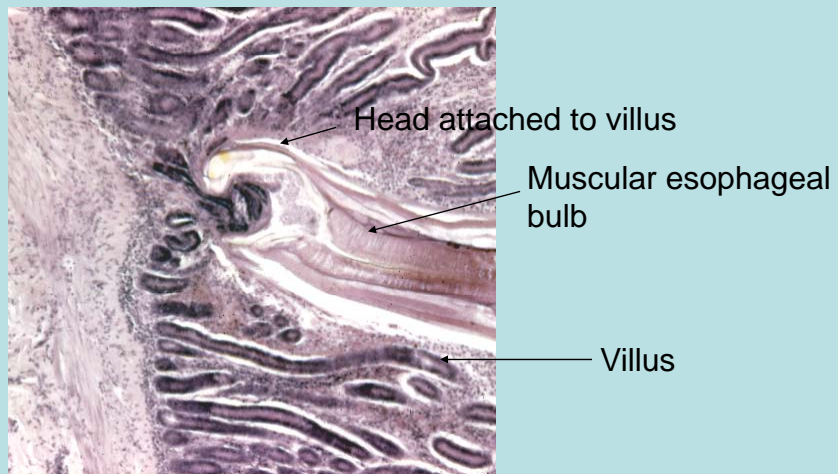
Adult *Ancylostoma duodenale*

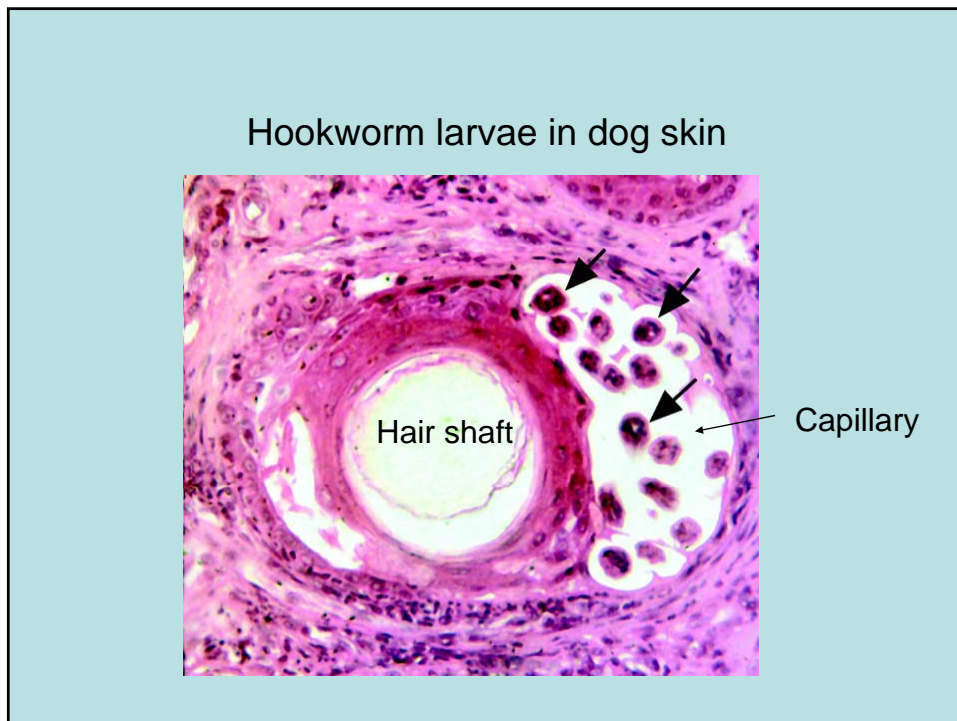
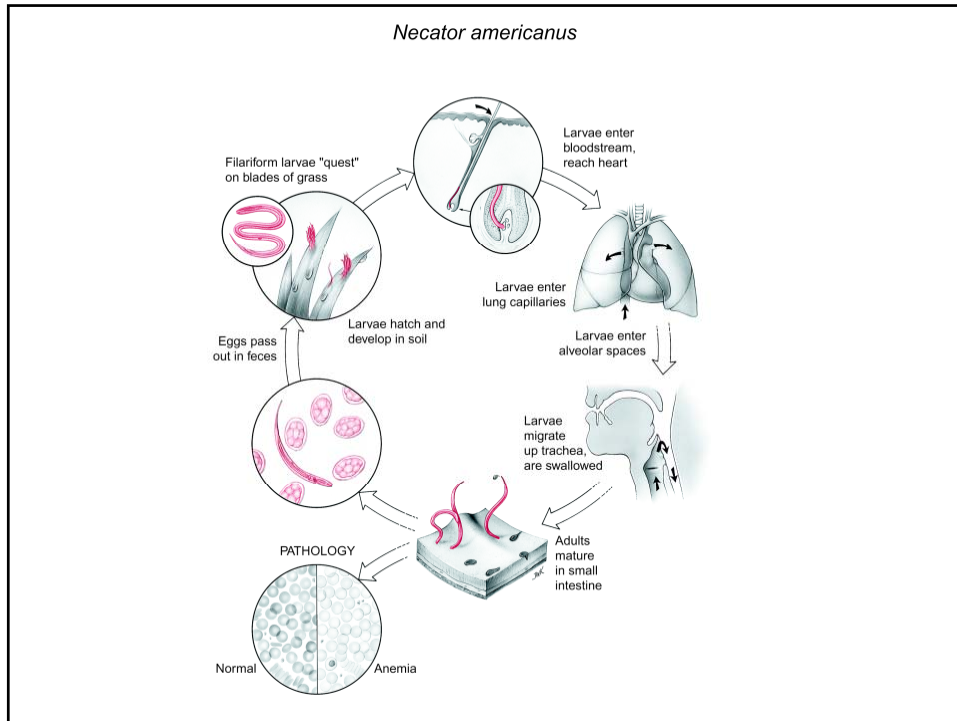


Adult *Necator americanus*



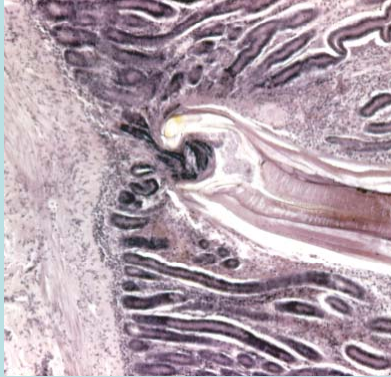
Histological section of adult hookworm attached to villus of small intestine





## Pathogenesis:

Adult worms suck blood and feed on villus tissue.



In order to do all this, the worm has evolved a set of powerful anti-coagulants\*even more effective than those of the medical leech. The cDNAs for these HW peptides have been cloned and may offer some interesting practical applications for medical use.

\* Cappello, M. et al. 1995. PNAS USA. 92: 6152-56

**Term:** Para-pharmacology

**Definition:** The science of taking advantage of parasite-specific products to better humankind

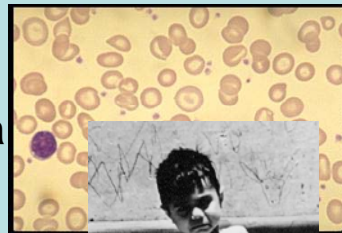
**Rationale:** The current pharmacopia of anti-parasitic drugs is running out. Lets turn their swords into our plowshares

Hookworm adult as seen on endoscopy

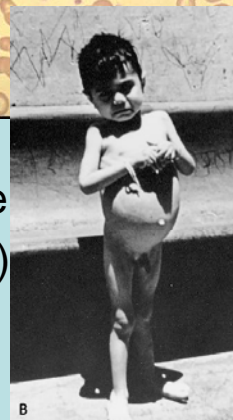


## Clinical Disease:

1. Iron-deficiency anemia

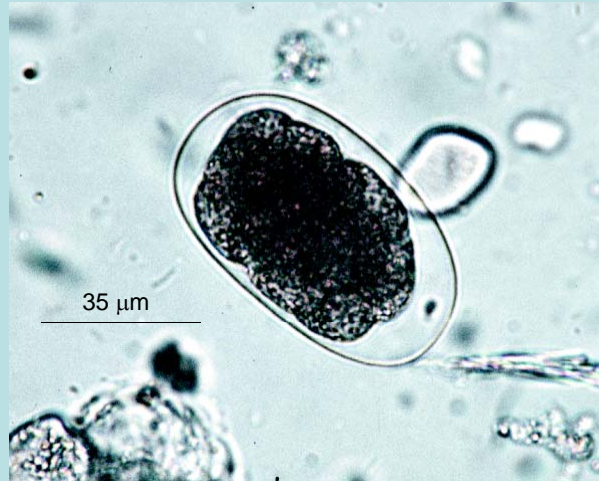


2. Failure-to-thrive syndrome  
(idiopathic endocrinopathy)

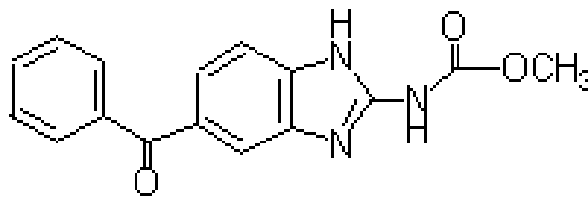


## Diagnosis:

Microscopic examination of feces for eggs



## Drug of choice:



Mebendazole

Mode of Action:

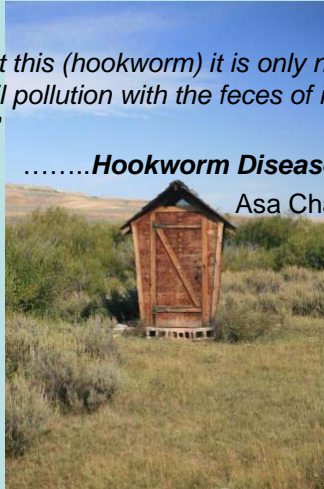
De-polymerizes invertebrate microtubules, only

## Prevention and Control

*"To prevent this (hookworm) it is only necessary to prevent soil pollution with the feces of infested individuals"*

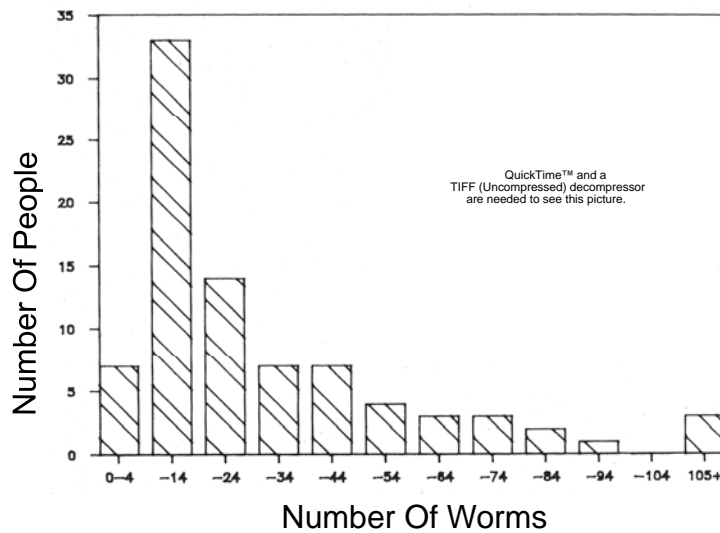
.....**Hookworm Disease**

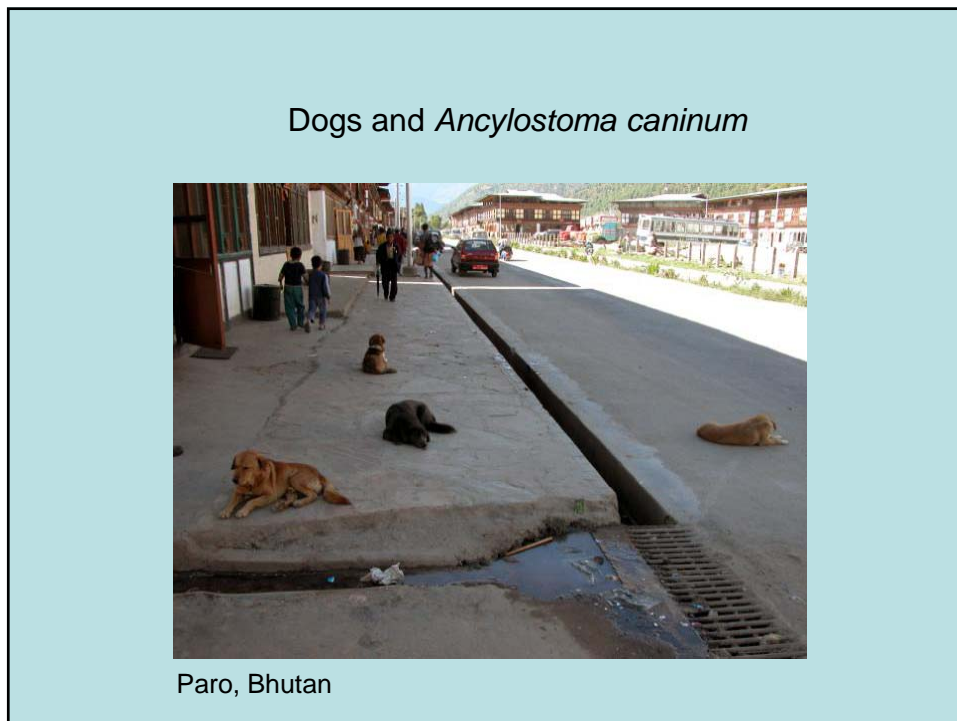
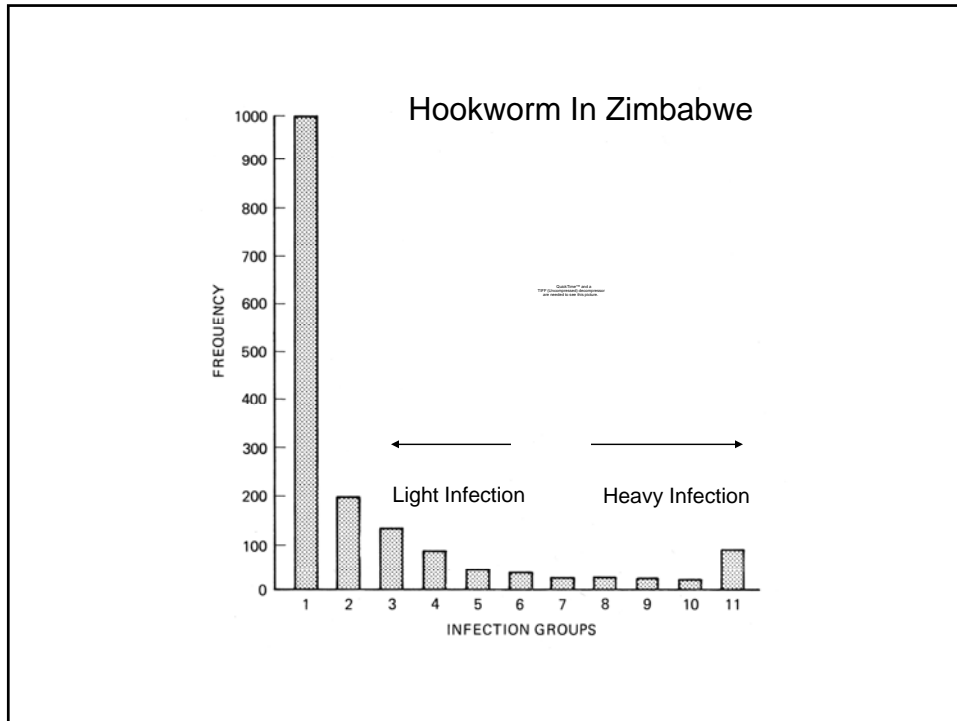
Asa Chandler, 1929



Greatest single invention of the 20th century!

## *Ancylostoma In India*





Infectious larva of *Ancylostoma sp.*



photo: E. Grave

“Creeping eruption” on the foot of a patient who stepped on an infective larva of *A. braziliense*



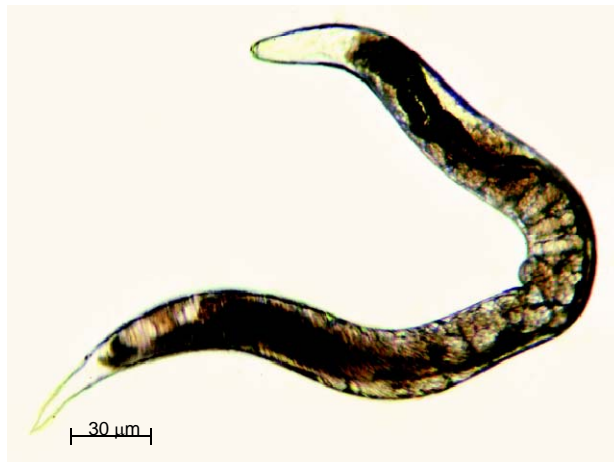
Photo: G. Zalar

# Helminths

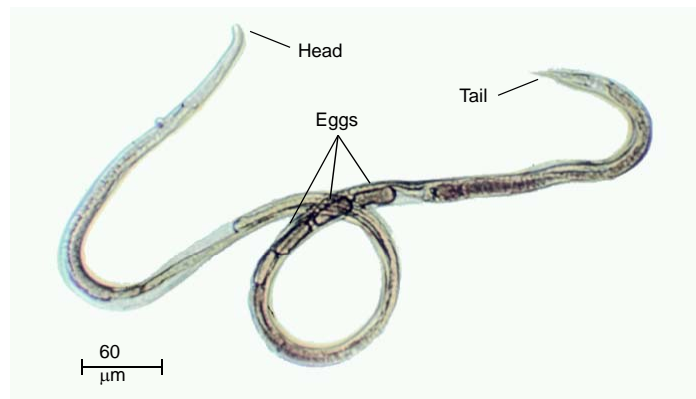
## Nematoda:

*Strongyloides stercoralis*

Free-living female *Strongyloides stercoralis*



## Parasitic female *Strongyloides stercoralis*



Am J Trop Med Hyg. 1982 Mar;31(2):313-9.

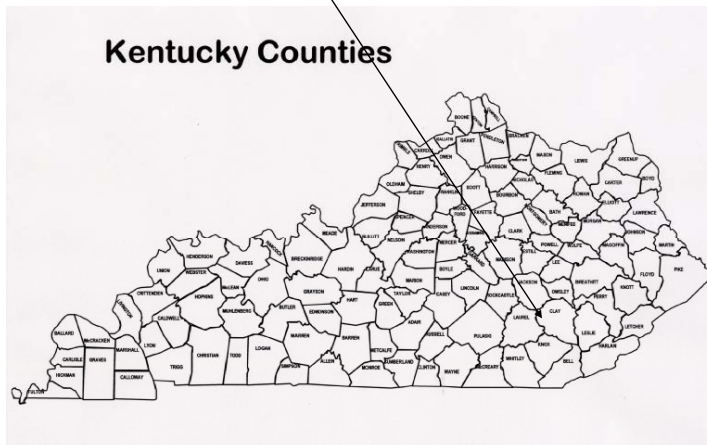
[Related Articles, Links](#)

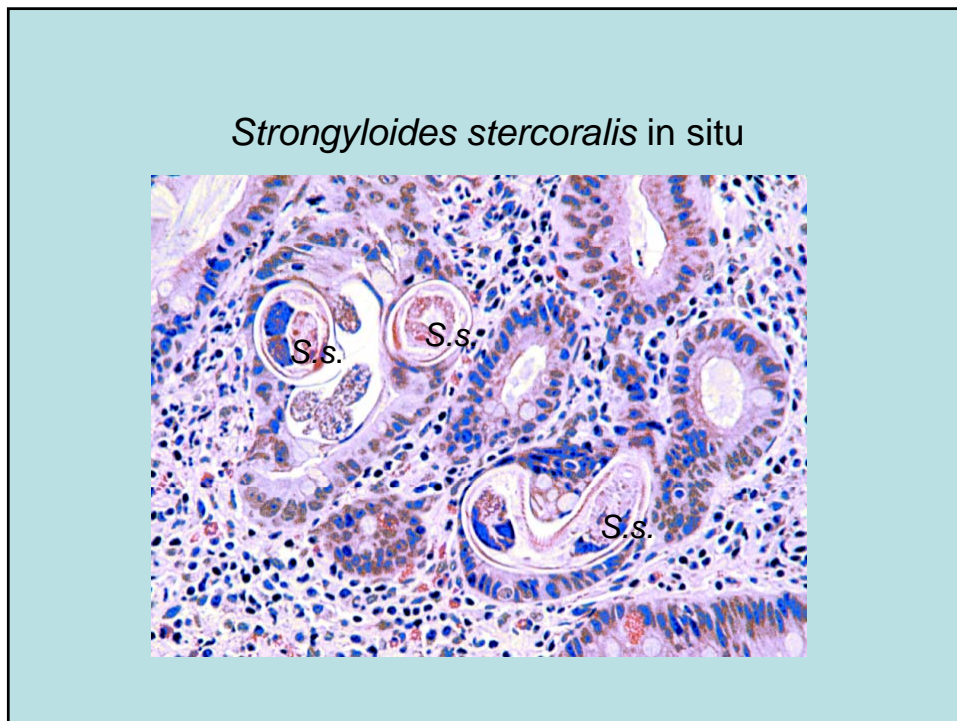
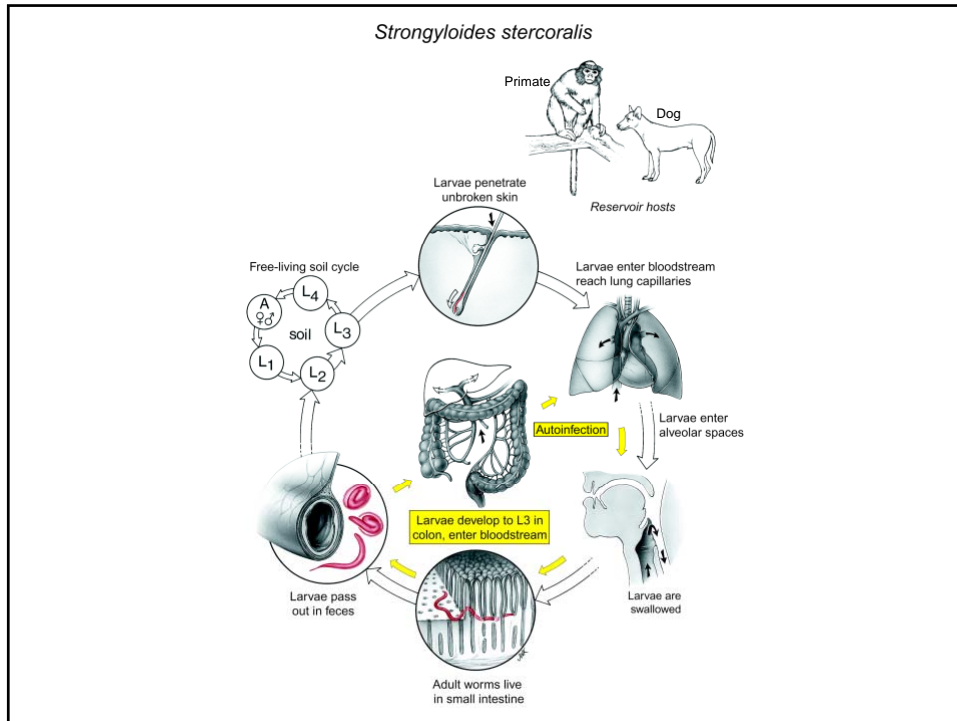
### Epidemiologic features of *Strongyloides stercoralis* infection in an endemic area of the United States.

Walzer PD, Milder JE, Banwell JG, Kilgore G, Klein M, Parker R.

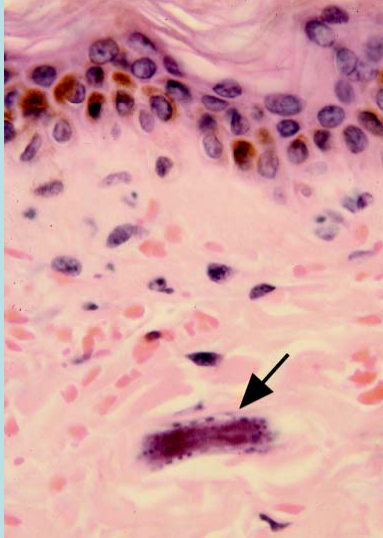
The epidemiologic features of *Strongyloides stercoralis* infection in Kentucky were studied by an analysis of clinical cases at the University of Kentucky Medical Center (UKMC); by an analysis of parasitologic records of the Kentucky Bureau for Health Services (KBHS); and by a prospective stool survey of school children in Clay County, located in southeastern Kentucky, an area of the state previously found to be highly endemic for intestinal parasites. *S. stercoralis* was the most common parasitic infection diagnosed at UKMC. The patients were predominantly white male adults who were over 50 years old, had an associated chronic or debilitating medical illness, were of low socioeconomic background, and resided in southeastern Kentucky. *S. stercoralis* was a common parasitic infection at KBHS and the patients showed a similar geographic distribution. Of 561 Clay County children surveyed, 23.7% harbored one or more intestinal parasite pathogens and 3.0% had *S. stercoralis*. Thus, *S. stercoralis* remains highly endemic in Kentucky and may cause disease even in geriatric patients.

### Kentucky Counties





Larva of *Strongyloides stercoralis* in skin



## Pathogenesis:

Worms invade epithelial cells, induce cell death

## Clinical Disease:

1. Diarrhea
2. Malabsorption syndrome
3. Secondary bacteremia/septicemia as larvae migrate throughout body and defecate microbes that they ingested in large intestine.
4. Death due to overwhelming bacterial septicemia.

## Diagnosis:

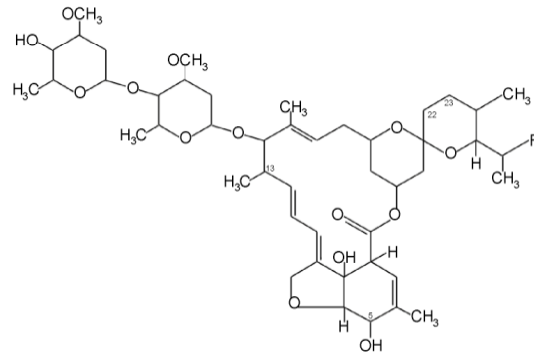
1. Microscopic examination of feces (x 6)
2. "String" test



Second stage larva

## Drug of choice:

Ivermectin\*



Mode of Action:

Blocks  $\text{Cl}^-$  ion channels, inhibits  $\gamma$ -aminobutyric acid receptor complex.

\* Alternate drug for all geohelminths

## Prevention and Control:

Sanitary disposal of human feces\*



Low Tech



High Tech



\*Dog is a common reservoir host. Cannot control spread of dog feces which may contain infective larvae.