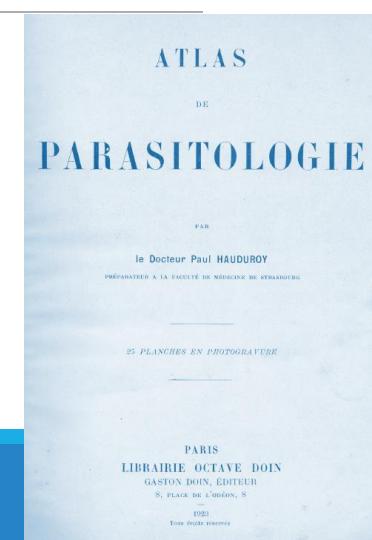


# Anquilstomideos

PROF. ALFONSO J. RODRÍGUEZ-MORALES

PARASITOLOGÍA GRUPOS 4 Y 5

SEMESTRE I-2015



# Phylum

## Classes

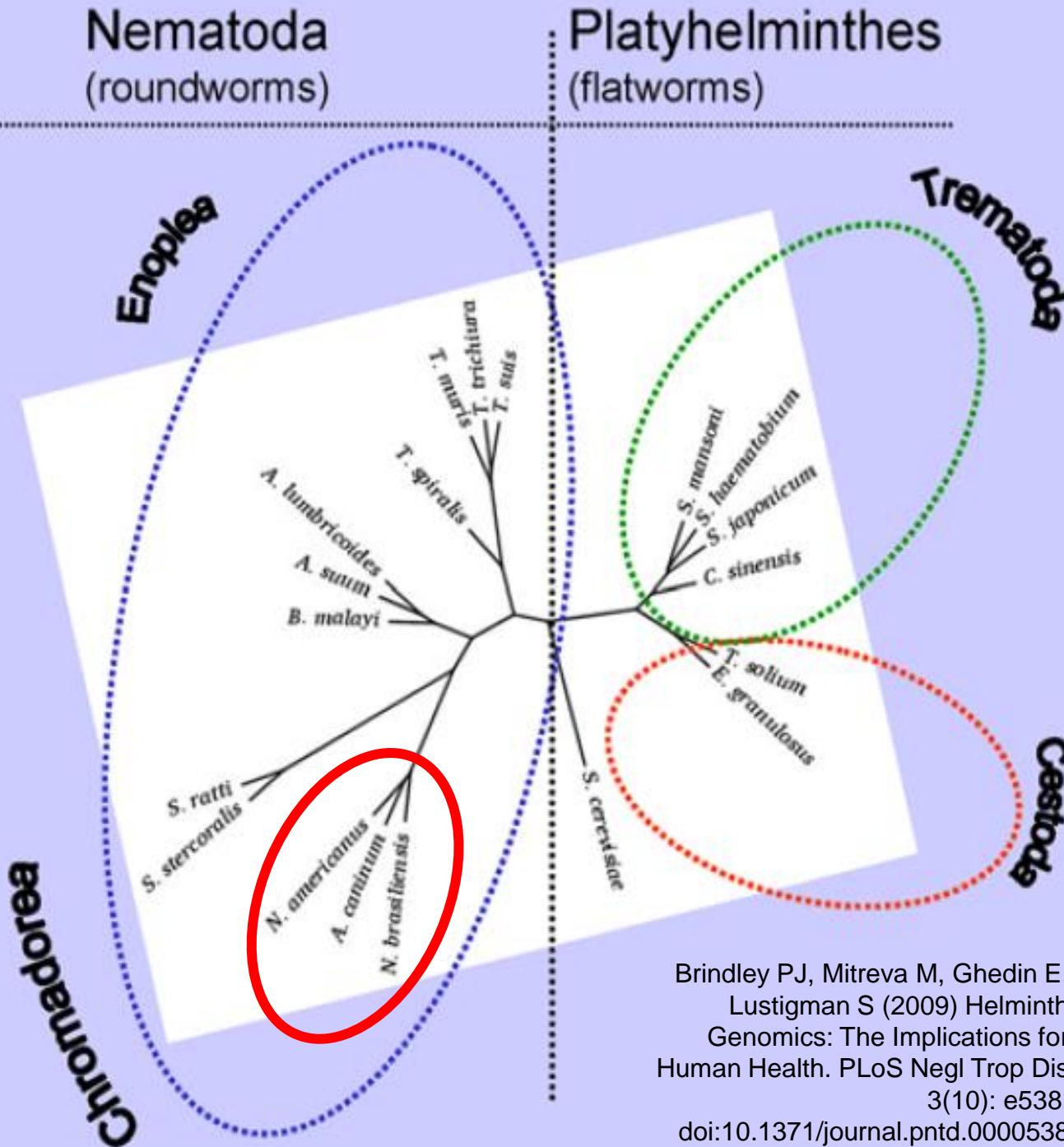


Figure 2. Phylogeny of the major taxa of human helminths—nematodes and platyhelminths—as established by maximum likelihood (ML) analysis of 18S ribosomal RNA from 18 helminth species.

Brindley PJ, Mitreva M, Ghedin E, Lustigman S (2009) Helminth Genomics: The Implications for Human Health. PLoS Negl Trop Dis 3(10): e538. doi:10.1371/journal.pntd.0000538

## Introducción a las Geohelmintiasis

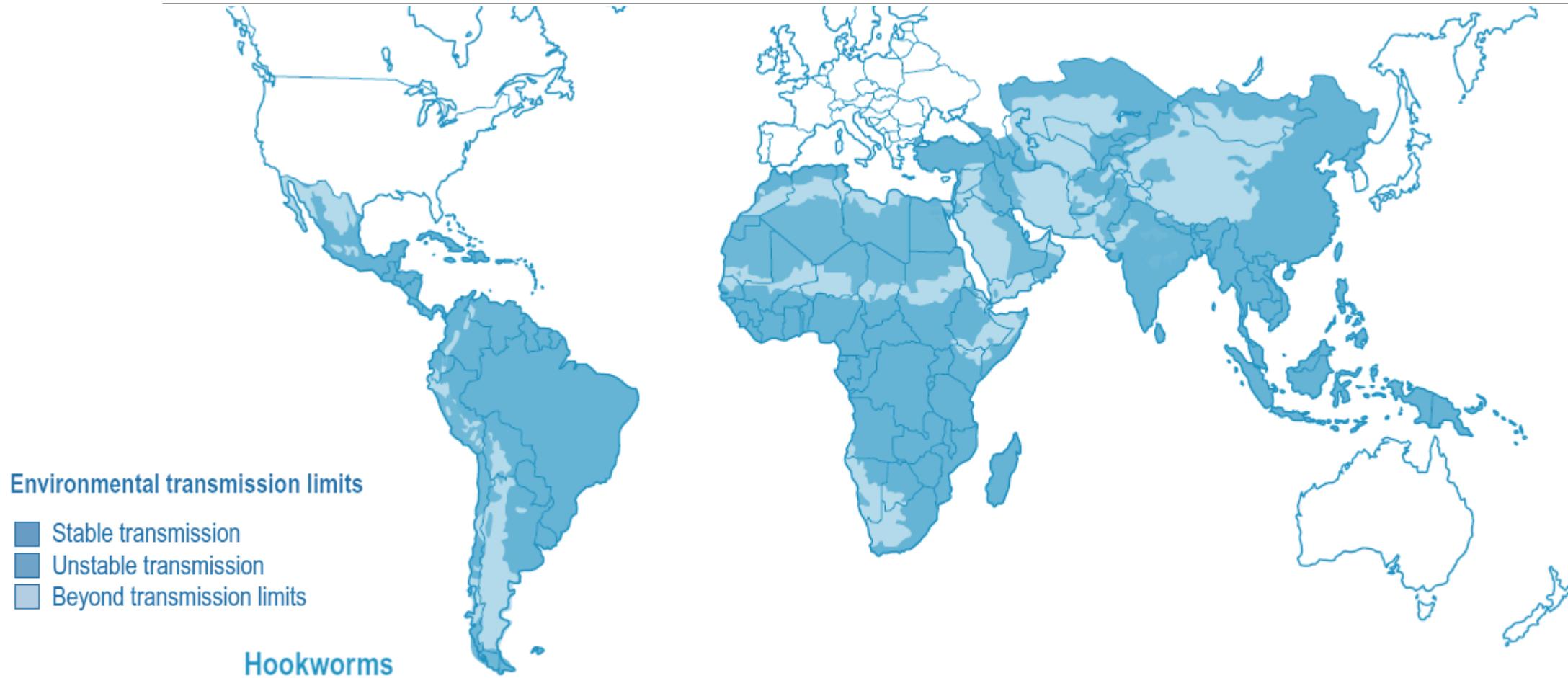
### Helmintiasis como NTDs (Enfermedades Desatendidas u Olvidadas)

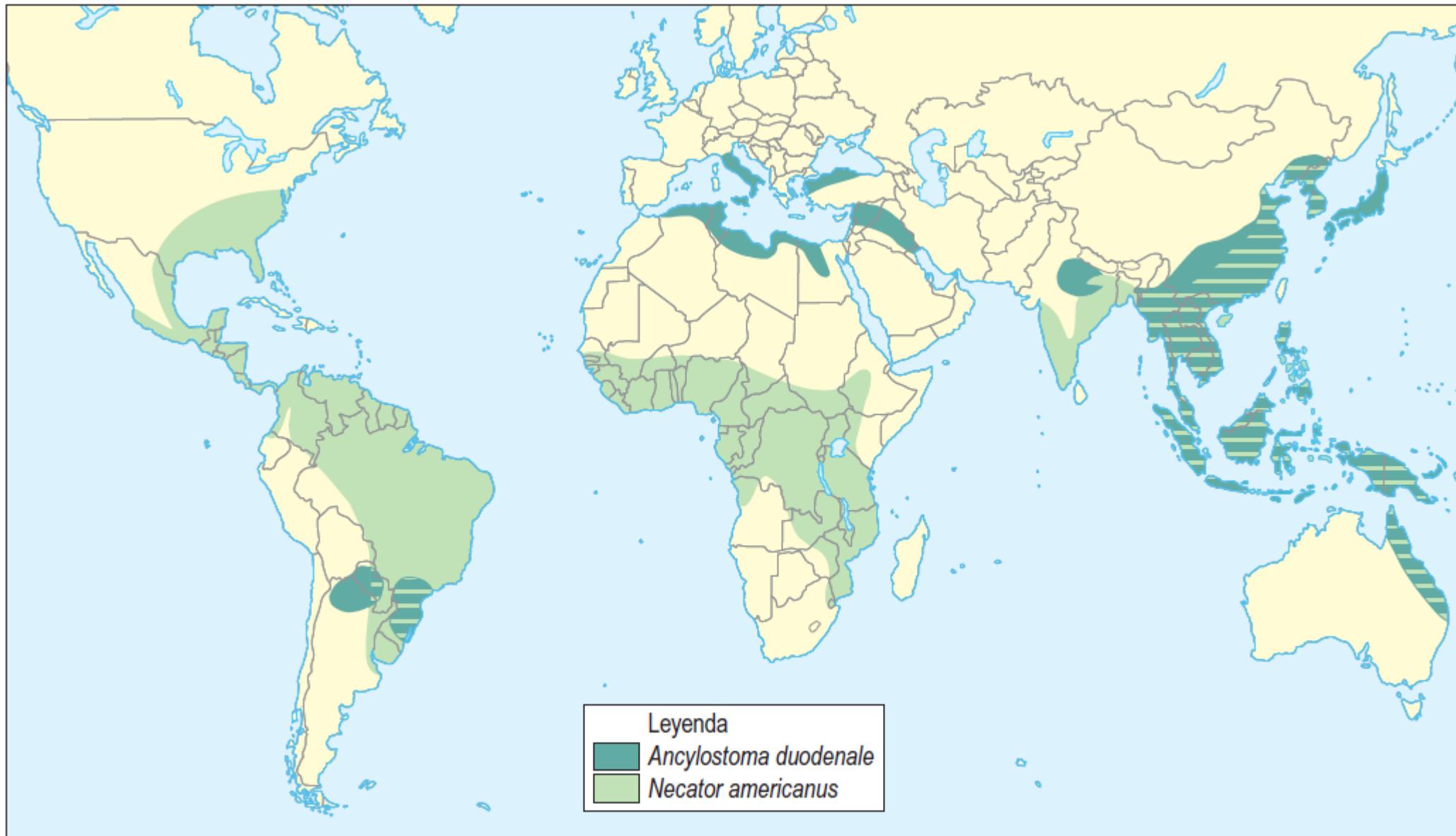
- Enfermedades Olvidadas, Desatendidas, de la Pobreza (*neglected tropical diseases*)
  - 13 infecciones bacterianas y parasitarias:
    1. [Ascariasis](#)
    2. [Anquilostomiasis](#)
    3. [Trichuriasis](#)
    4. [Filariasis linfática](#)
    5. [Oncocercosis](#)
    6. [Dracunculiasis](#)
    7. **Esquistosomiasis**
    8. [Enfermedad de Chagas](#)
    9. [Tripanosomiasis Africana Humana](#)
    10. [Leishmaniasis](#)
    11. [Ulcera de Buruli](#)
    12. [Lepra \(Enf. de Hansen\)](#)
    13. [Tracoma](#)



# Importancia mundial

---

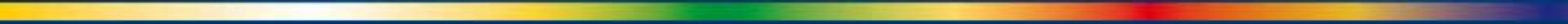




419. Distribución de la anquilostomiasis

# ENTEROPARASITOSIS

## Prevalencia Mundial



<i>Ascaris lumbricoides</i>	<i>1,300 millardos</i>
<i>Trichuris trichiura</i>	<i>1,049 millardos</i>
<i>Anquilostomideos</i>	<i>1 millardo</i>
<i>Complejo E. histolytica/dispar</i>	<i>500 millones</i>
<i>Enterobius vermicularis</i>	<i>400 millones</i>
<i>Schistosoma mansoni</i>	<i>200 millones</i>
<i>Giardia lamblia</i>	<i>200 millones</i>
<i>Strongyloides stercoralis</i>	<i>100 millones</i>
<i>Taenia sp</i>	<i>70 millones</i>

# ¿Nuevos efectos de las protozoosis?

Rodríguez-Morales AJ, Barbella RA, Case C, Arria M, Ravelo M, Perez H, Urdaneta O, Gervasio G, Rubio N, Maldonado A, Aguilera Y, Viloria A, Blanco JJ, Colina M, Hernández E, Araujo E, Cabaniel G, Benítez J, Rifakis P. **Intestinal parasitic infections among pregnant women in Venezuela.** *Infect Dis Obstet Gynecol.* 2006;2006:23125.

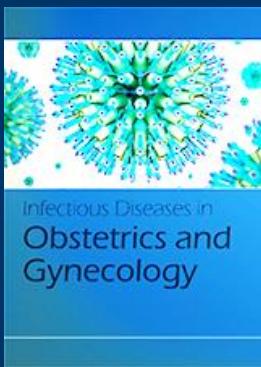


TABLE 1: Parasite positivity in stool specimens examined from pregnant women studied.

	Number	(%)	Helminths		
Protozoans					
Nonpathogenic					
<i>Entamoeba coli</i>	44	5.7	<i>Ascaris lumbricoides</i>	437	57.0
<i>Endolimax nana</i>	30	3.9	<i>Trichuris trichiura</i>	276	36.0
Pathogenic			<i>Necator americanus</i>	62	8.1
<i>Giardia lamblia</i>	108	14.1	<i>Enterobius vermicularis</i>	48	6.3
<i>Entamoeba histolytica/dispar</i>	92	12.0	<i>Strongyloides stercoralis</i>	25	3.3
<i>Cryptosporidium spp</i>	2	0.3			

TABLE 2: Relative risk for anemia at pregnancy according to the presence of intestinal parasitosis.

Variable (risk for anemia)	Anemia	Normal			$\chi^2_{\text{Yates}}$	P
		Hb	RR			
Intestinal parasitosis at pregnancy						
Present	594	173	2.56	194.24	< .0001	
Absent	82	189	—	—	—	
Helminth infection at pregnancy						
Present	322	61	1.56	94.63	< .0001	
Absent	354	301	—	—	—	
Protozoan infection at pregnancy						
Present	179	23	1.49	59.65	< .0001	
Absent	497	339	—	—	—	

# Helmintiasis

## Epidemiología

**Table 1**

Prevalence of intestinal helminths and protozoa in individuals from North Central Venezuela (May 2007 to December 2008)

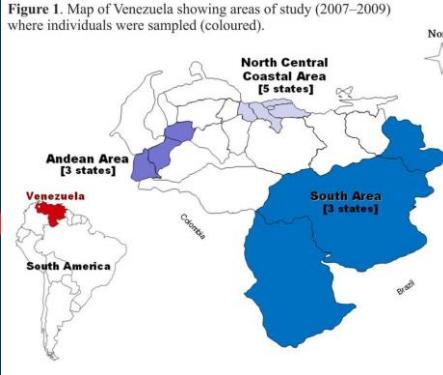
Parasite	n <sup>a</sup>	% (95% CI)
Helminths	209 845	4.49 (4.47–4.51)
<i>Ascaris lumbricoides</i>	174 257	3.73 (3.71–3.74)
<i>Trichuris trichiura</i>	53 031	1.13 (1.12–1.14)
<i>Enterobius vermicularis</i>	18 177	0.39 (0.38–0.40)
<i>Strongyloides stercoralis</i>	15 743	0.34 (0.33–0.35)
<b>Hookworms</b>	<b>7 817</b>	<b>0.17 (0.16–0.18)</b>
<i>Hymenolepis nana</i>	2 979	0.06 (0.05–0.07)
Protozoa	2 675 384	57.22 (57.18–57.27)
<i>Blastocystis hominis</i>	2 176 703	46.56 (46.51–46.60)
<i>Giardia duodenalis</i>	358 538	7.67 (7.64–7.69)
<i>Iodamoeba bütschlii</i>	150 032	3.21 (3.19–3.23)
<i>Dientamoeba fragilis</i>	76 086	1.63 (1.62–1.64)
<i>Entamoeba histolytica/dispar</i>	42 396	0.91 (0.90–0.92)
<i>Trichomonas hominis</i>	8 416	0.18 (0.17–0.19)
<i>Chilomastix mesnili</i>	4 675	0.10 (0.09–0.11)

<sup>a</sup> n = number of positives in the population.



# Helmintiasis

## Epidemiología



**Epidemiology of intestinal parasitosis in eleven states of Venezuela:  
partial results of an ongoing national survey  
(N=7.120.744)**

Parasite	Prevalence (%)	95%CI	Parasite	Prevalence (%)	95%CI
<i>B. hominis</i>	45.632	45.596-45.669	<i>T. trichiura</i>	1.569	1.560-1.578
<i>E. nana</i>	12.573	12.548-12.597	<i>Hookworms</i>	0.664	0.658-0.670
<i>E. coli</i>	11.745	11.722-11.769	<i>S. stercoralis</i>	0.381	0.376-0.385
<i>G. intestinalis</i>	7.426	7.406-7.445	<i>E. vermicularis</i>	0.264	0.260-0.268
<i>A. lumbricoides</i>	3.974	3.959-3.988	<i>H. nana</i>	0.257	0.253-0.261
<i>I. bütschlii</i>	3.211	3.198-3.224	<i>C. mesnili</i>	0.246	0.242-0.249
<i>E. histolytica</i>	1.632	1.623-1.642	<i>T. hominis</i>	0.118	0.116-0.121

# Helmintiasis

## Epidemiología en Colombia

**Tabla 1.** Prevalencia de parásitos intestinales en población general del corregimiento de Loma Arena Santa Catalina. 2004

Espece parasitaria	Nº	%
<i>Entamoeba coli</i>	210	60
<i>Entamoeba histolytica/dispar</i>	191	54
<i>Endolimax nana</i>	125	36
<i>Blastocystis hominis</i>	103	29
<i>Iodamoeba butschlii</i>	72	21
<i>Giardia duodenalis</i>	61	17
<i>Trichomonas hominis</i>	3	0,9
<i>Cyclospora sp</i>	2	0,6
<i>Ascaris lumbricoides</i>	196	56
<i>Trichuris trichiura</i>	185	53
<b>Uncinaria</b>	<b>21</b>	<b>6</b>
<i>Hymenolepis nana</i>	14	4
<i>Strongyloides stercoralis</i>	11	3
<i>Taenia sp</i>	3	0,9
<i>Enterobius vermicularis</i>	2	0,6

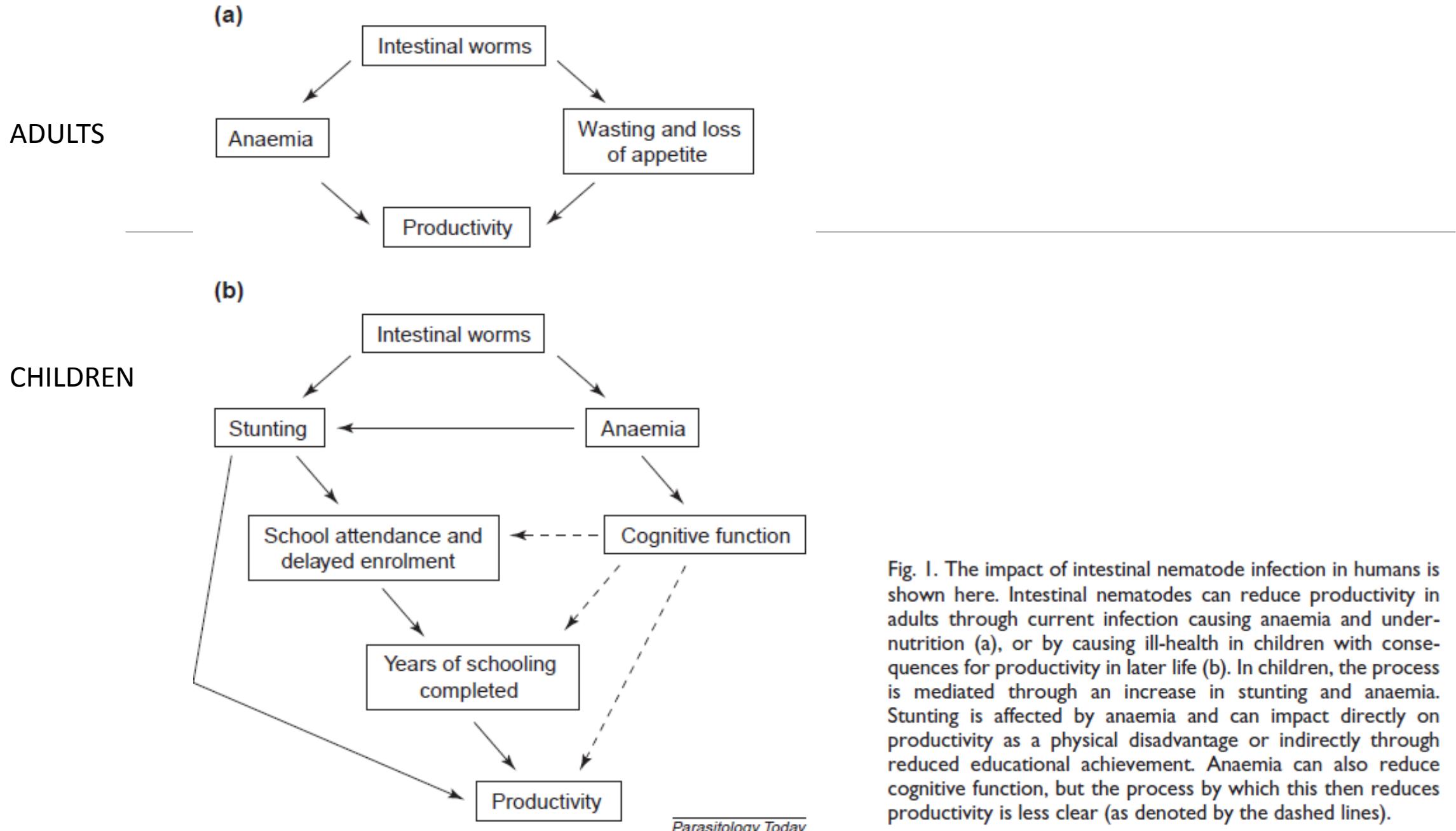
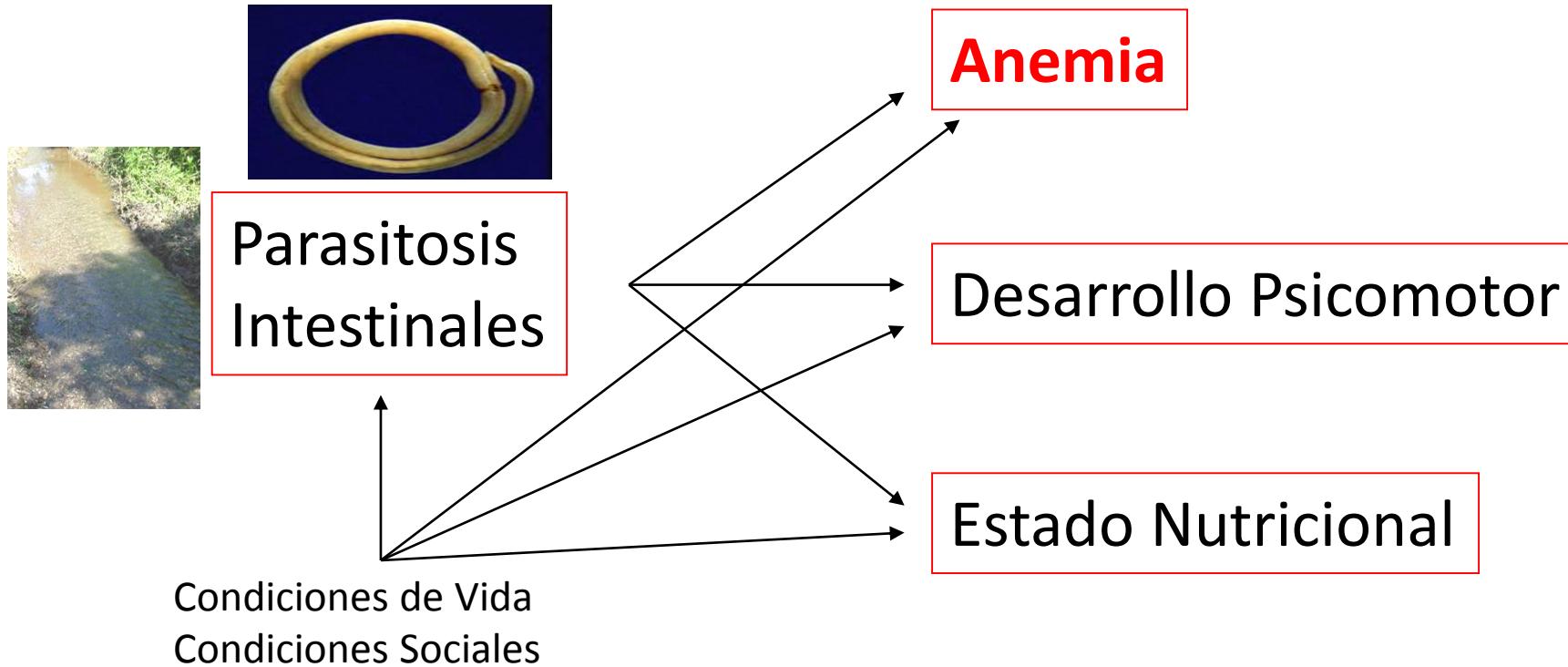


Fig. 1. The impact of intestinal nematode infection in humans is shown here. Intestinal nematodes can reduce productivity in adults through current infection causing anaemia and under-nutrition (a), or by causing ill-health in children with consequences for productivity in later life (b). In children, the process is mediated through an increase in stunting and anaemia. Stunting is affected by anaemia and can impact directly on productivity as a physical disadvantage or indirectly through reduced educational achievement. Anaemia can also reduce cognitive function, but the process by which this then reduces productivity is less clear (as denoted by the dashed lines).





### 403. Letrina pública en Gedi (Kenya)

Esta letrina pública, consistente en un simple agujero, fue construida en el siglo XIV en la ciudad afroárabe de Gedi, cerca de Malindi, en la costa swahili de Kenya. El valor de una medida básica de salud pública de este tipo fue aparente incluso para los médicos del Imperio romano, una época en que los baños públicos bien dotados y con agua corriente eran concurridos lugares de reunión y de debate. El uso de este tipo de letrina en África oriental representó una contribución significativa para la limitación de las helmintiasis descritas en este capítulo, así como también de las infecciones causadas por los virus, las bacterias y los protozoos patógenos adquiridos a través del tracto gastrointestinal (v. cap. 4).

# Cycles and transmission

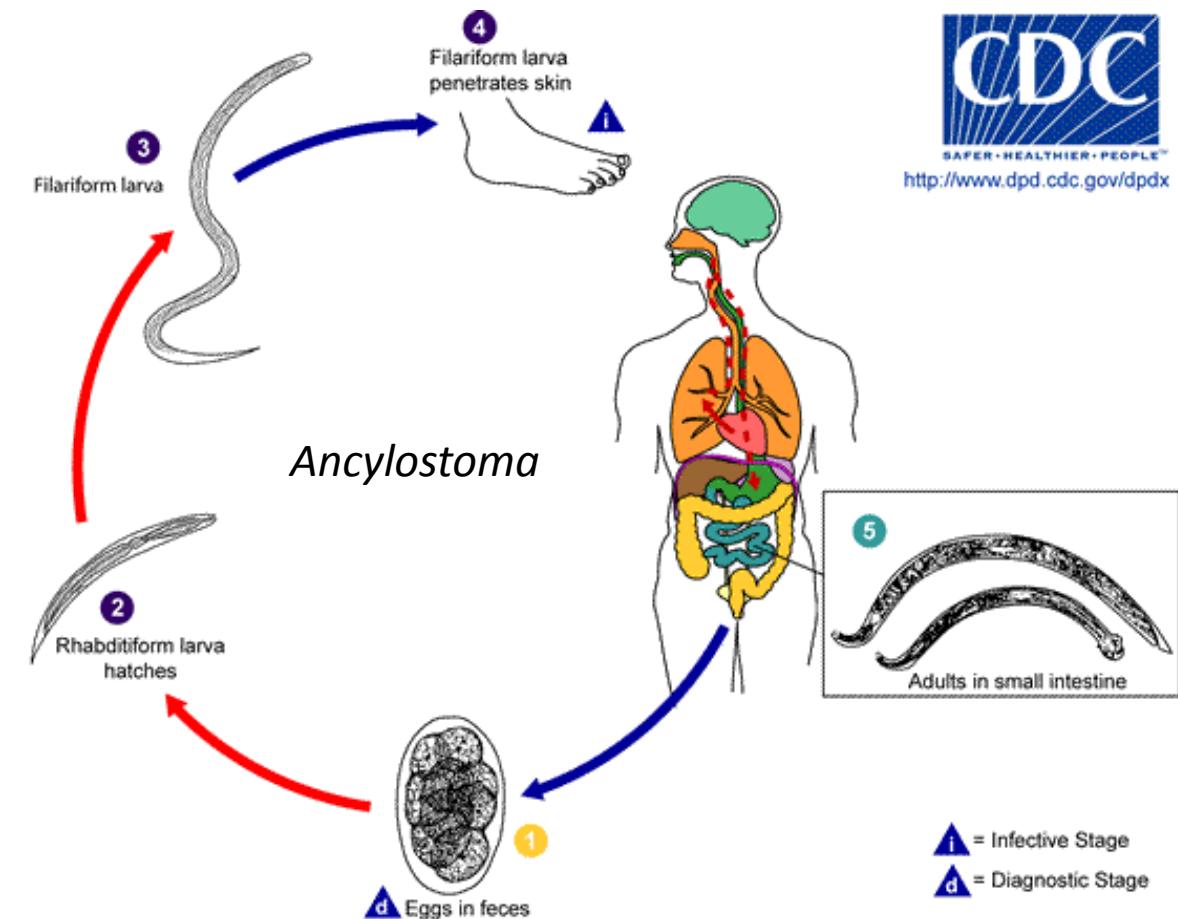
---

- ❖ Type 1: Direct (*Enterobius vermicularis*, *Trichuris trichiura*)
- ❖ Type 2: Modified Direct (*Ascaris lumbricoides*, *Toxocara spp.*)
- ❖ Type 3: Penetration of the Skin (*Ancylostoma*, *Necator*,  
*Strongyloides*, *Trichostrongylus*)

# Type 3: Penetration of the Skin (*Ancylostoma*, *Necator*, *Strongyloides*, *Trichostrongylus*)

In this group, eggs are passed in the stools to the soil, where they hatch into larvae, which undergo **further development** before they are ready to **penetrate the skin** and reach the circulation and lungs, which they penetrate to enter the respiratory tract; they move up to enter the oesophagus and reach the small intestine, where they become adult.

The hookworms, *Ancylostoma duodenale* and *Necator americanus*, and *Strongyloides stercoralis* belong to this group, but differ in that *S. stercoralis* larvae are passed in the stool and autoinfection can occur at the anal margin, or independent development takes place in the soil, where they can exist in the absence of any further cycle through humans.



# Phylum

## Classes

### Nematoda (roundworms)

### Platyhelminthes (flatworms)

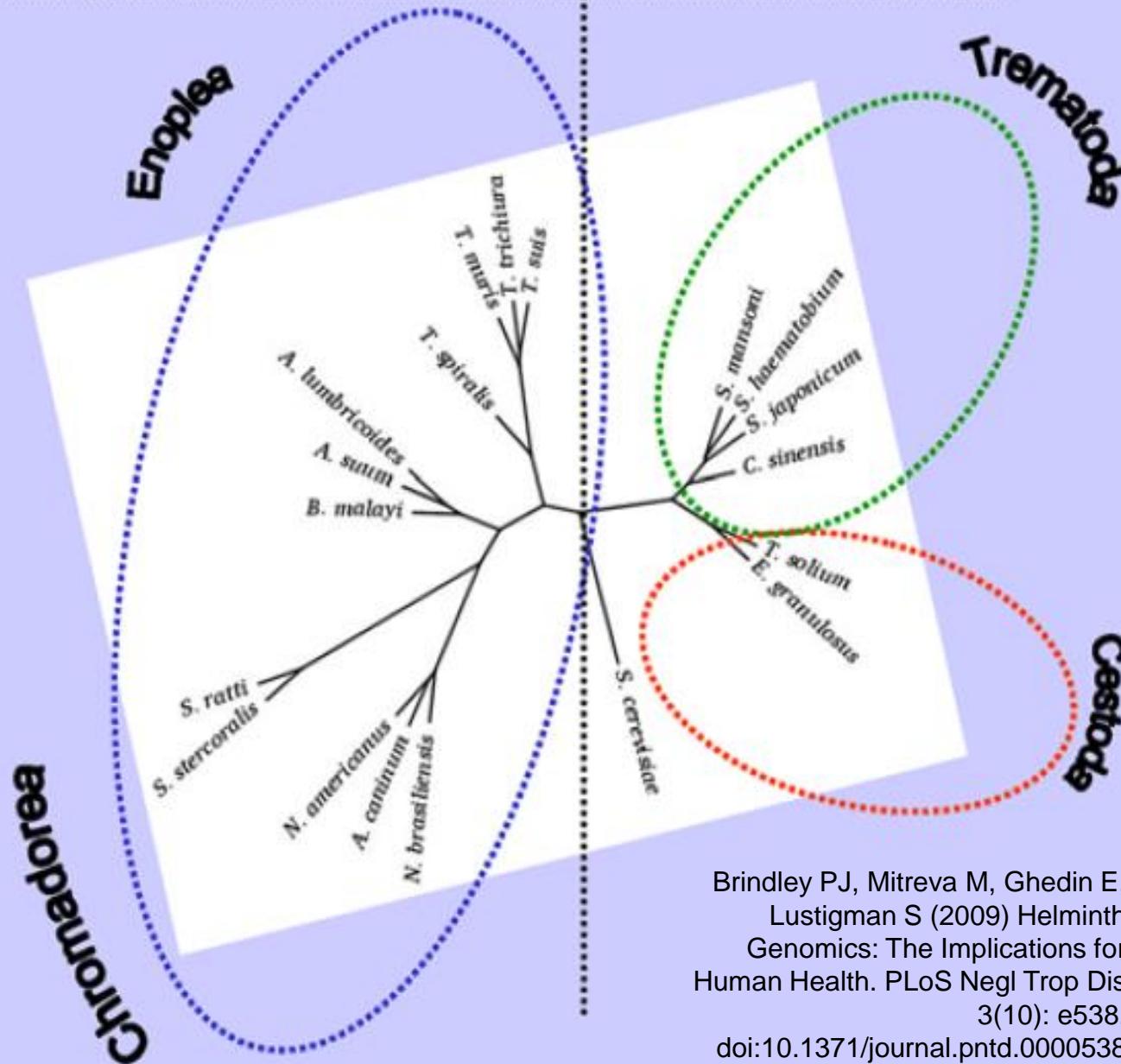


Figure 2. Phylogeny of the major taxa of human helminths—nematodes and platyhelminths—as established by maximum likelihood (ML) analysis of 18S ribosomal RNA from 18 helminth species.

Brindley PJ, Mitreva M, Ghedin E, Lustigman S (2009) Helminth Genomics: The Implications for Human Health. PLoS Negl Trop Dis 3(10): e538. doi:10.1371/journal.pntd.0000538

Tabla 11. Nematodos de importancia médica y su prevalencia<sup>1</sup>

Subclase	Orden (Suborden)	Superfamilia	Género y especie	Prevalencia probable en el ser humano
Adenophorea	Enoploga	Trichuroidea	<i>Trichinella spiralis</i> <i>Trichinella papuae</i> <i>Trichinella zimbabwiensis</i> <i>Trichuris trichiura</i> <i>Capillaria hepatica</i> <i>Capillaria philippinensis</i>	49 millones Miles ? 500 millones Infrecuente Miles
Secernentea	Rhabditida Strongylida	Rhabditoidea Ancylostomoidea	<i>Strongyloides stercoralis</i> <i>Strongyloides fulleborni</i> <i>Pelodera strongyloides</i> Género <i>Rhabditis</i> <i>Ancylostoma duodenale</i> } <i>Necator americanus</i> } <i>Ancylostoma caninum</i> <i>Ancylostoma braziliense</i> <i>Ancylostoma ceylanicum</i> <i>Ternidens deminutus</i> <i>Oesophagostomum bifurcum</i> <i>Syngamus laryngeus</i>	70 millones Miles Infrecuente Infrecuente 700-900 millones Miles Miles Infrecuente Miles Miles >250.000 Infrecuente
		Trichostrongyoidea Metastrongyoidea	Genero <i>Trichostrongylus</i> <i>Metastrongylus elongatus</i> <i>Parastrengylus cantonensis</i> <i>Parastrengylus costaricensis</i>	10 millones Infrecuente Miles Miles
	Oxyurida Ascaridida	Oxyuroidea Ascaridoidea	<i>Enterobius vermicularis</i> <i>Ascaris lumbricoides</i> <i>Toxocara canis</i> <i>Toxocara cati</i> <i>Lagochilascaris minor</i> <i>Baylisascaris procyonis</i> Género <i>Anisakis</i> <i>Pseudoterranova decipiens</i>	400 millones 800-1.000 millones Miles Miles Infrecuente Infrecuente Infrecuente Miles
	Spirurida (Spirurina)	Spiruroidea Gnathostomoidea Thelazoidea Filarioidea	<i>Gongylonema pulchrum</i> <i>Gnathostoma spinigerum</i> <i>Thelazia callipaeda</i> <i>Wuchereria bancrofti</i> <i>Brugia malayi</i> } <i>Brugia timori</i> } <i>Loa loa</i> <i>Onchocerca volvulus</i> <i>Mansonella perstans</i> <i>Mansonella streptocerca</i> <i>Mansonella ozzardi</i> Género <i>Dirofilaria</i> <i>Dracunculus medinensis</i>	120 millones <sup>2</sup> 6 millones 33 millones <17 millones <sup>3</sup> 65 millones 2 millones 15 millones Infrecuente <3 millones <sup>4</sup>
	Spirurida (Camallanina)	Dracunculoidea		

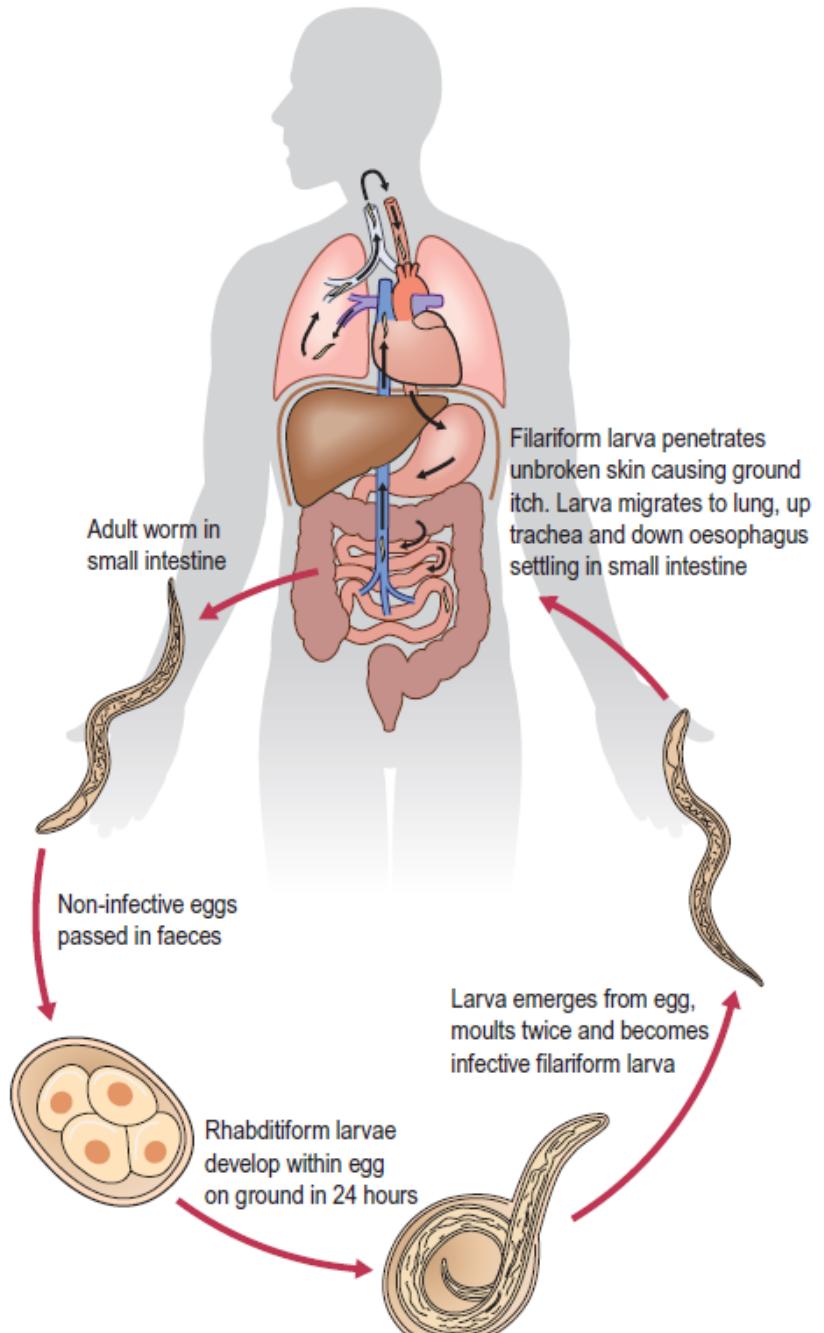
Ancylostomatoidea	<i>Strongyloides fulleborni</i>	Miles
	<i>Pelodera strongyloides</i>	Infrecuente
	Género <i>Rhabditis</i>	Infrecuente
	<i>Ancylostoma duodenale</i> }	700-900 millones
	<i>Necator americanus</i> }	
	<i>Ancylostoma caninum</i>	Miles
	<i>Ancylostoma braziliense</i>	Miles
	<i>Ancylostoma ceylanicum</i>	Infrecuente
	<i>Ternidens diminutus</i>	Miles
	<i>Oesophagostomum bifurcum</i>	>250.000
	<i>Syngamus laryngeus</i>	Infrecuente

## Ciclo Anquilostomideos

Puinare, Anzoátegui, Venezuela, 2011  
A. J. Rodriguez-Morales



Rio de Janeiro, Brasil, 2004  
A. J. Rodriguez-Morales

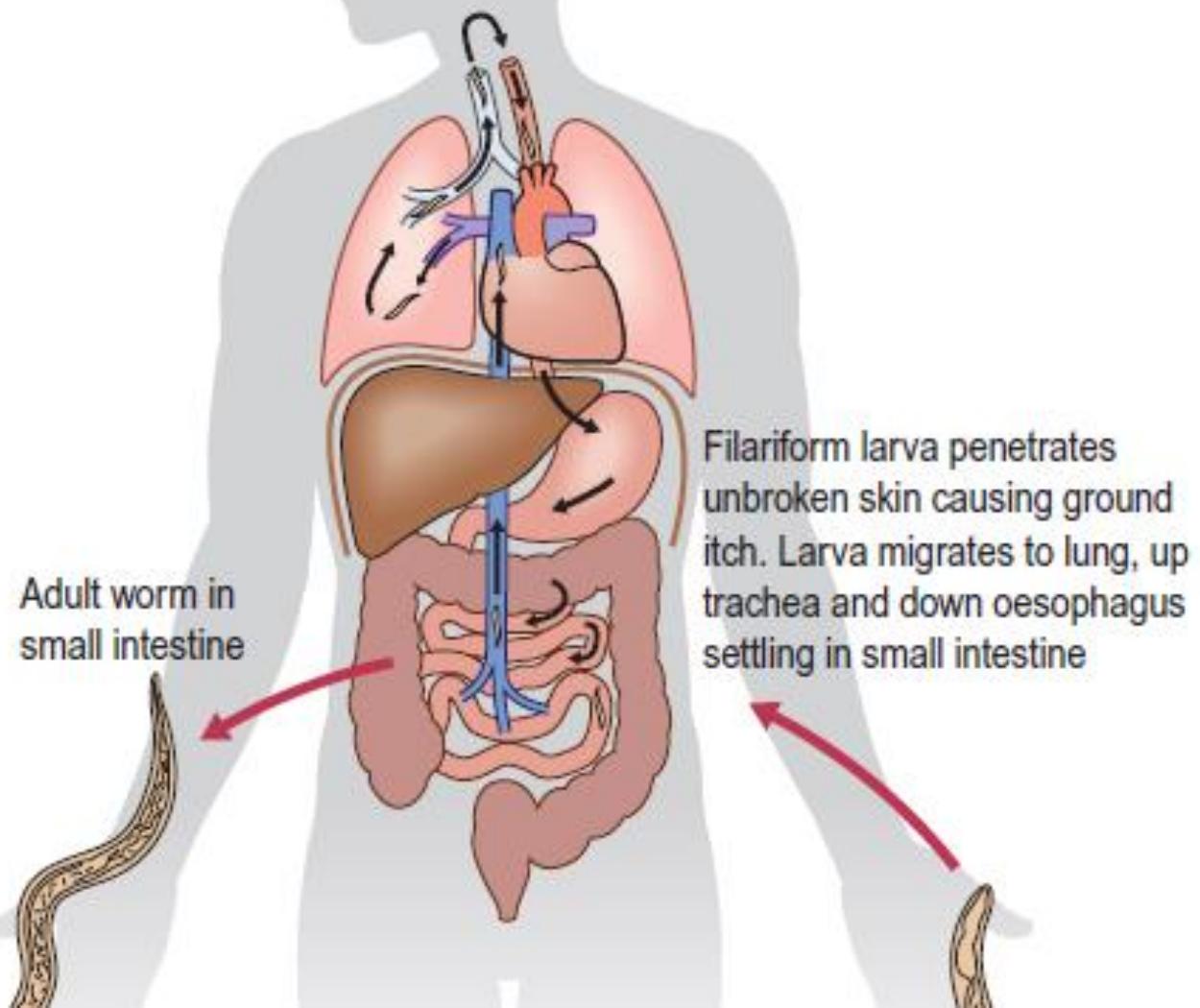


**Figure 55.13** Life cycle of hookworm. (Courtesy of Tropical Resources Unit.)



Guigue, Carabobo, Venezuela, 2005  
A. J. Rodriguez-Morales

## Ciclo Anquilostomideos

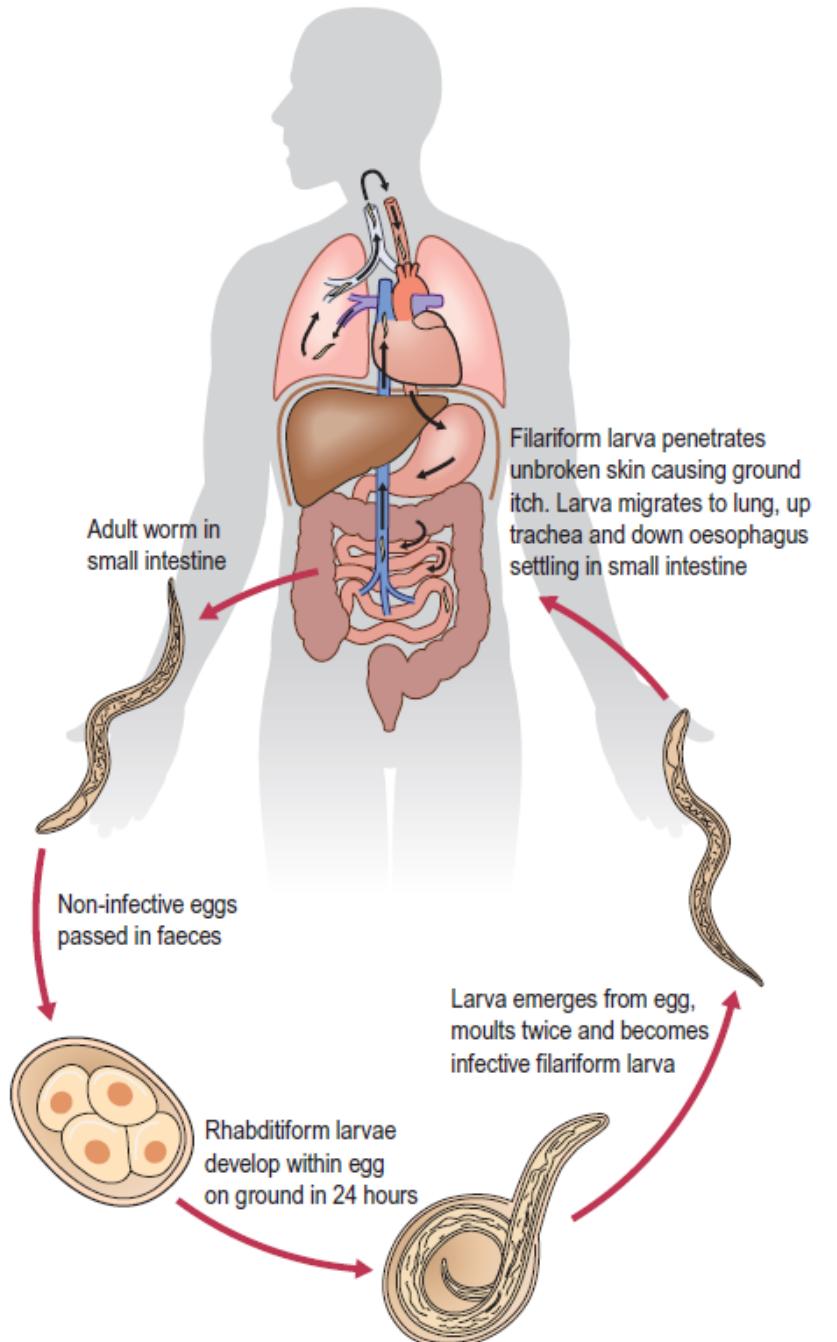


## Ciclo Anquilostomideos

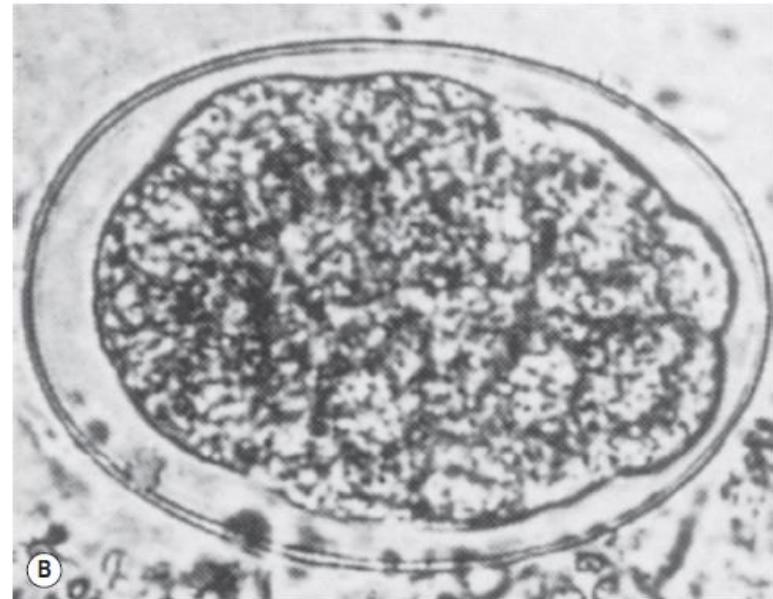
Puinare, Anzoátegui, Venezuela, 2011  
A. J. Rodriguez-Morales



Rio de Janeiro, Brasil, 2004  
A. J. Rodriguez-Morales



**Figure 55.13** Life cycle of hookworm. (Courtesy of Tropical Resources Unit.)



**Figure 55.12** Hookworm eggs. (A) Immature egg showing developing larva. (B) Mature egg. ((A) Courtesy of J. S. Tatz. (B) Courtesy of Tropical Resources Unit.)

## Ciclo Anquilostomideos

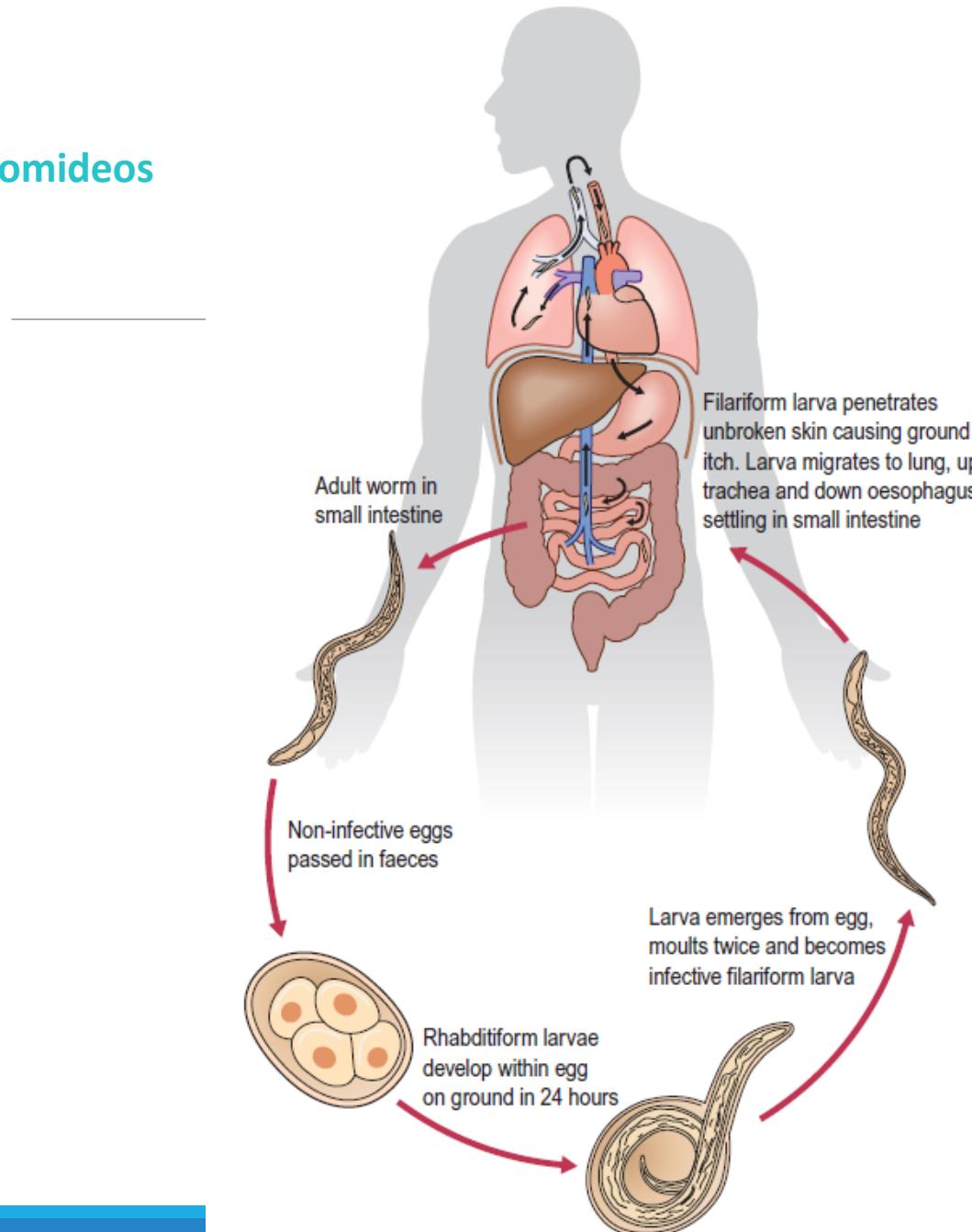


Figure 55.13 Life cycle of hookworm. (Courtesy of Tropical Resources Unit.)

### Pathology

Hookworm causes pathology at three stages of infection (the first two caused by larval hookworms usually seen only in expatriates who receive a primary infection):

1. Vesiculation and pustulation at the site of entry (ground itch). This is usually mild or absent in the tropics except in expatriates
2. Asthma and bronchitis during migration through the lungs with small haemorrhages into the alveoli and eosinophilic and leucocytic infiltration
3. Established infection, seen in the local residents of endemic areas, leading to hookworm anaemia and hookworm disease.

# The life cycles of *A. duodenale* and *N. americanus* are similar, except that:

---

- *A. duodenale* live on average 1–3 years and *N. americanus* live 3–10 years
- *A. duodenale* can infect by ingestion as well as via the skin, whereas ***N. americanus* infects only through the skin**
- Migrating larvae of *N. americanus* grow and develop in the lungs, whereas those of *A. duodenale* do not.
- ***A. duodenale*** possesses the ability to remain within the host as a larval stage for many months before finally developing to an adult, thus bridging seasons which are inappropriate for transmission.



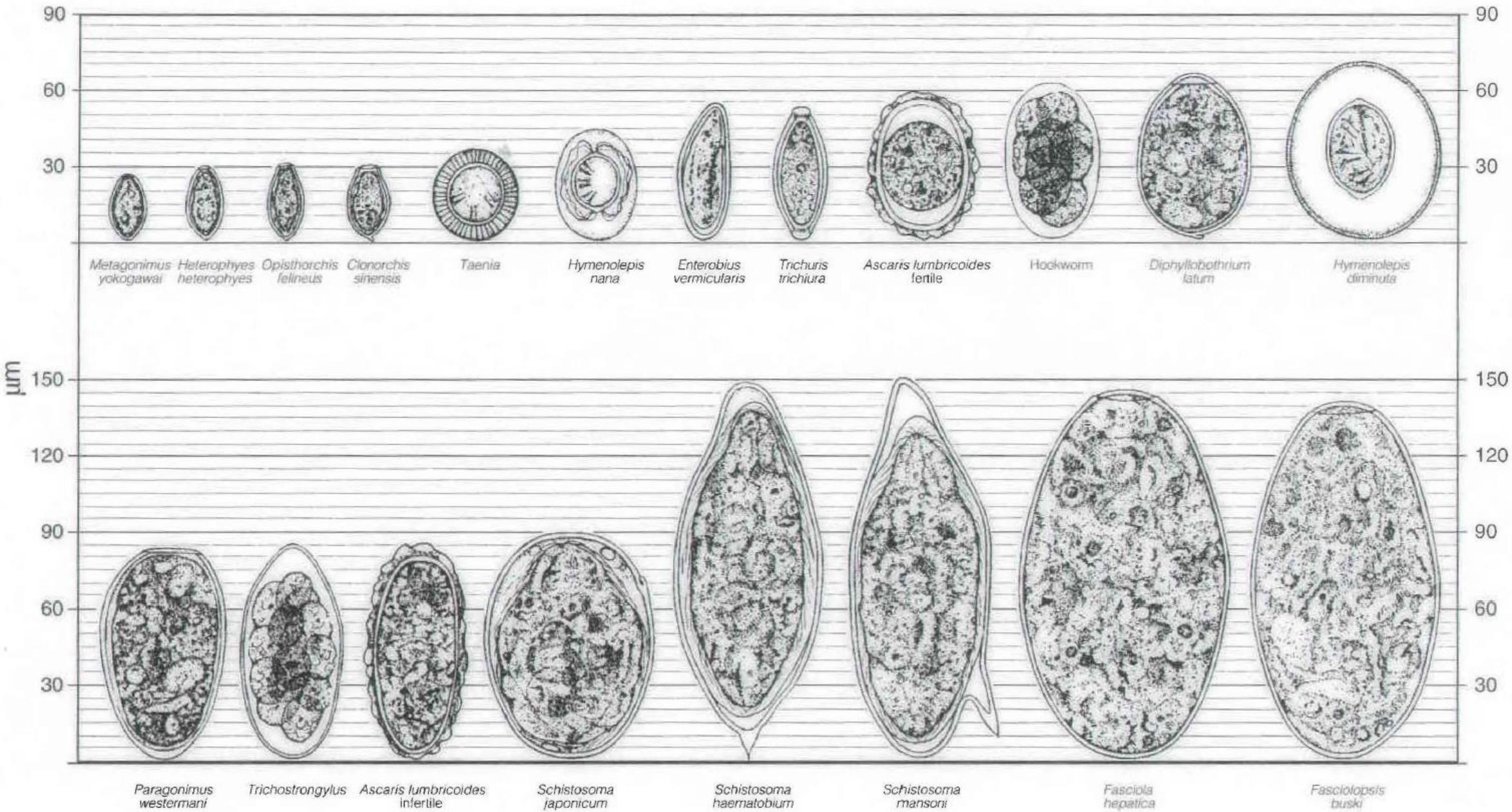
Los huevos de *anguilostoma* presentes en las heces presentan una típica forma de tonel con una fina cubierta hialina; miden 60-75 µm por 36-40 µm. Por lo general, se encuentran en la fase de cuatro o de ocho células en las heces frescas o en una fase más avanzada de división en las que han permanecido a la temperatura ambiente durante algún tiempo, incluso durante pocas horas.



En las preparaciones de Kato-Katz, los huevos de *anguilostoma* aparecen a menudo casi redondos y es difícil ver el ovum en división. En los climas cálidos la glicerina puede acentuar la transparencia de los huevos y hacerlos invisibles a los 30-60 minutos de la preparación.



## Tamaño relativo de los huevos de helmintos\*

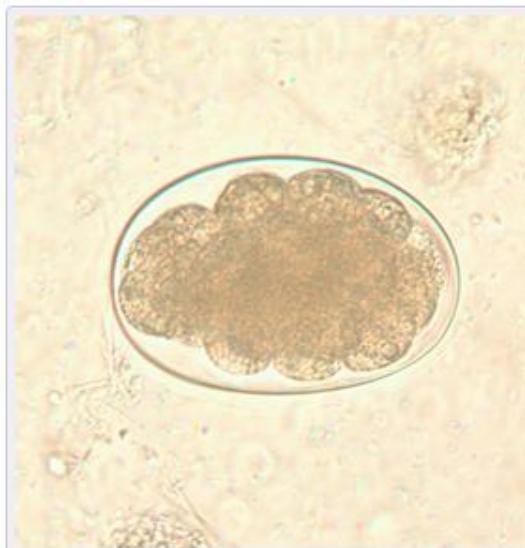


## Hookworm eggs.

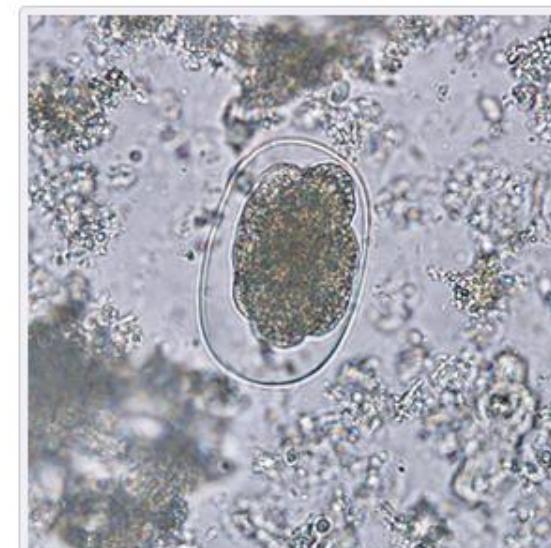
The eggs of *Ancylostoma* and *Necator* cannot be differentiated microscopically. The eggs are thin-shelled, colorless and measure 60-75 µm by 35-40 µm.



**Figure A:** Hookworm egg in an unstained wet mount, taken at 400x magnification.



**Figure B:** Hookworm egg in an unstained wet mount, taken at 400x magnification.



**Figure C:** Hookworm egg in an unstained wet mount.



**Figure D:** Hookworm egg in an unstained wet mount.



**Figure E:** Hookworm egg in a wet mount.



**Figure F:** Hookworm egg in a wet mount under UV fluorescence microscopy; image taken at 200x magnification.

TABLE  
55.2

### Classification of Intensity of Infection for STH Species Based on WHO Guidelines

	Light	Moderate	Heavy
<i>Trichuris trichiura</i>	1-999	1 000-9 999	≥10 000
<i>Ascaris lumbricoides</i>	1-4 999	5 000-49 999	≥50 000
Hookworm	1-1 999	2 000-3 999	≥4 000

Manson's Tropical Infectious Diseases (Twenty-third Edition)  
Editor: Jeremy Farrar ISBN: 978-0-7020-5101-2, 2014.

**▼ Hookworm rhabditiform larva.**

Rhabditiform (L1) larvae that hatch from eggs are 250-300  $\mu\text{m}$  long and approximately 15-20  $\mu\text{m}$  wide. They have a long buccal canal and an inconspicuous genital primordium. Rhabditiform larvae are usually not found in stool, but may be found there is a delay in processing the stool specimen. If larvae are seen in stool, they must be differentiated from the L1 larvae of *Strongyloides stercoralis*.



**Figure A:** Hookworm rhabditiform larva (wet preparation).



**Figure B:** Hookworm rhabditiform larva (wet preparation).

**▼ Hookworm filariform larva.**

Infective, third-stage (L3), filariform larvae are 500-600 µm long. They have a pointed tail and a striated sheath. These L3 are found in the environment and infect the human host by penetration of the skin.



**Figure A:** Filariform (L3) hookworm larva.



**Figure B:** Filariform (L3) hookworm larva.



**Figure C:** Filariform (L3) hookworm larva in a wet mount.



**Figure D:** Close-up of the posterior end of a filariform (L3) hookworm larva.

**▼ Adult hookworms.**

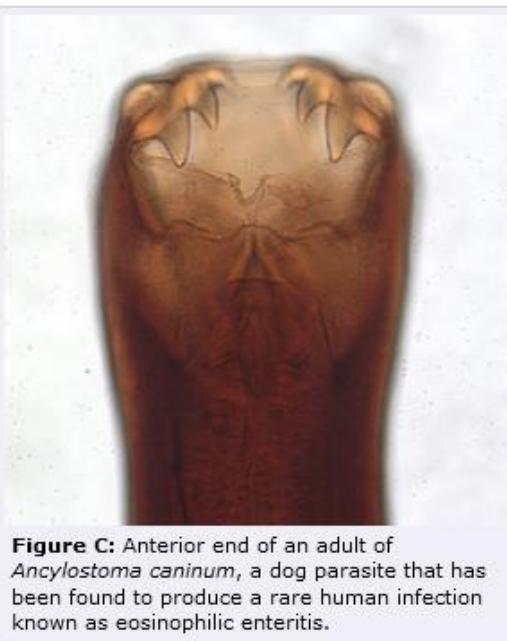
Adult hookworms reside in the small intestine of their hosts. Males measure approximately 8-12 mm long and are bursate, with two spicules that do not fuse at their distal ends. Females measure approximately 10-15 mm long. Adults of both sexes have a buccal capsule containing sharp teeth.



**Figure A:** Adult worm of *Ancylostoma duodenale*. Anterior end is depicted showing cutting teeth.



**Figure B:** Adult worm of *Necator americanus*. Anterior end showing mouth parts with cutting plates.



**Figure C:** Anterior end of an adult of *Ancylostoma caninum*, a dog parasite that has been found to produce a rare human infection known as eosinophilic enteritis.



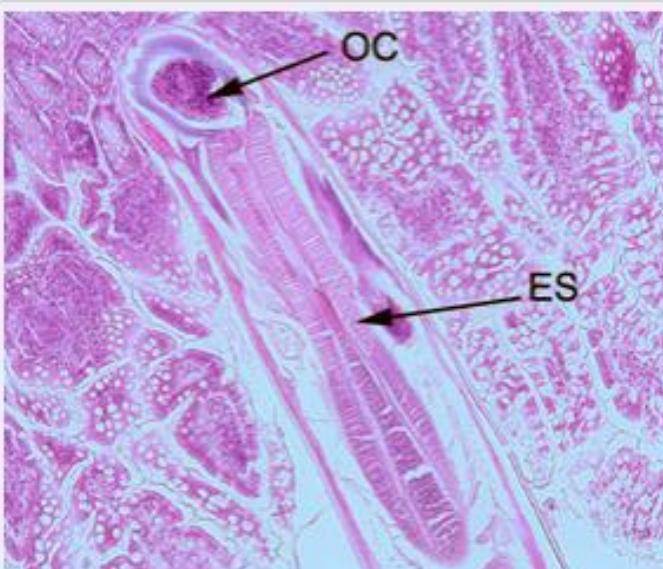
**Figure D:** Anterior end of an adult female *Ancylostoma* sp.



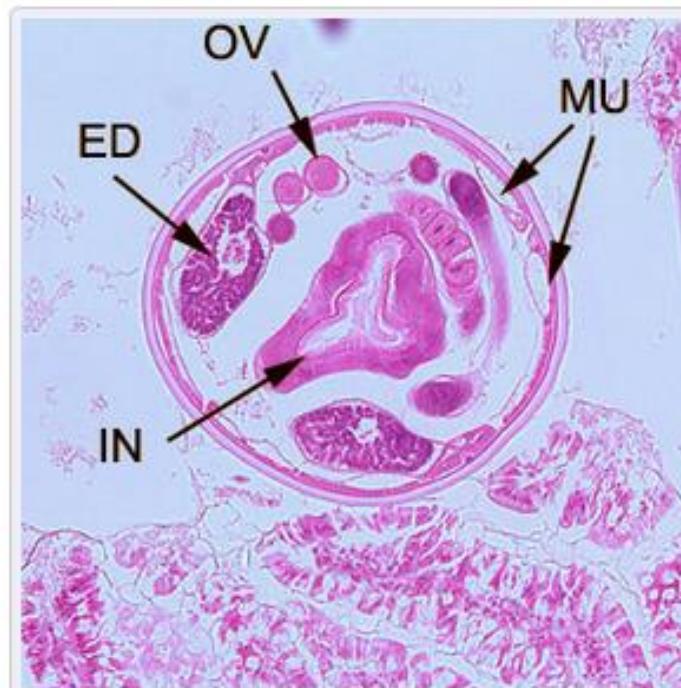
**Figure E:** Posterior end of the worm seen in **Figure D**.

▼ Hookworms in tissue, stained with hematoxylin and eosin (H&E).

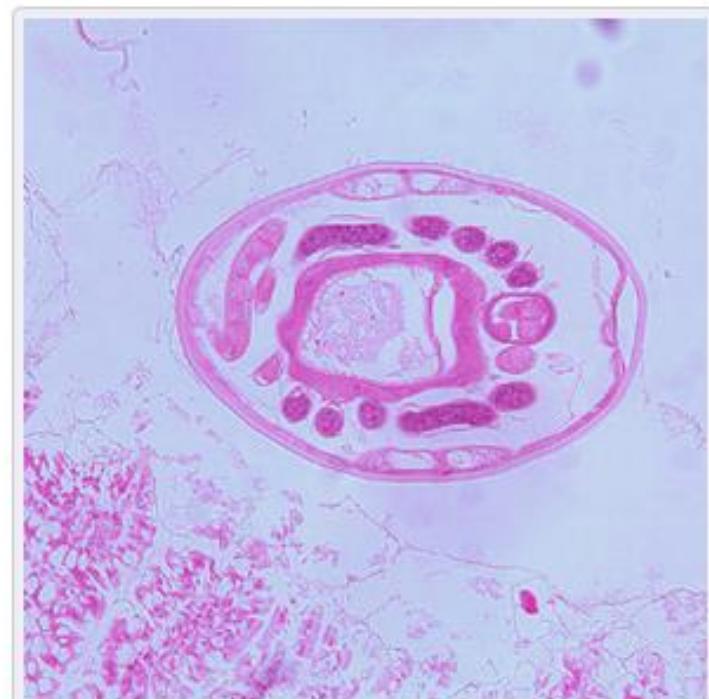
Adult hookworms in tissue, stained with hematoxylin and eosin (H&E).



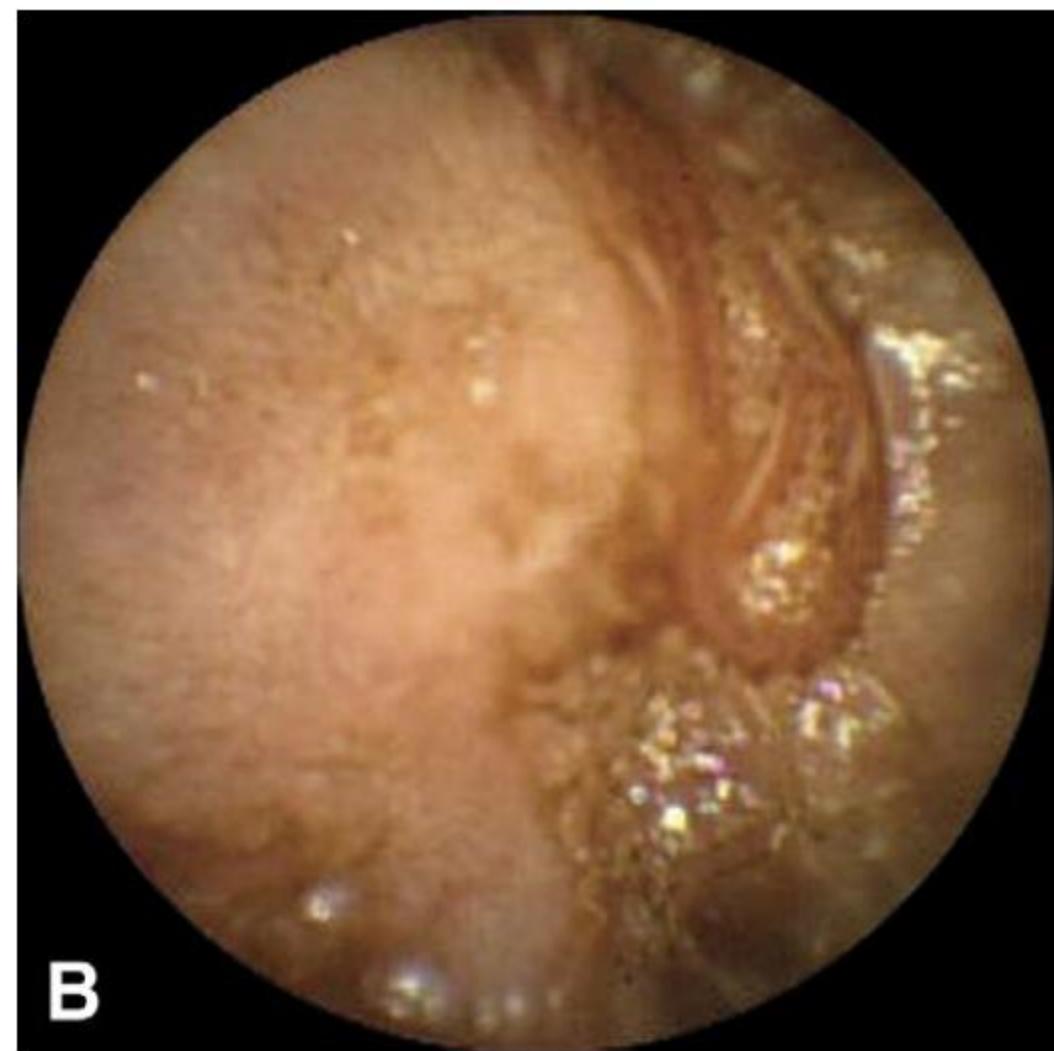
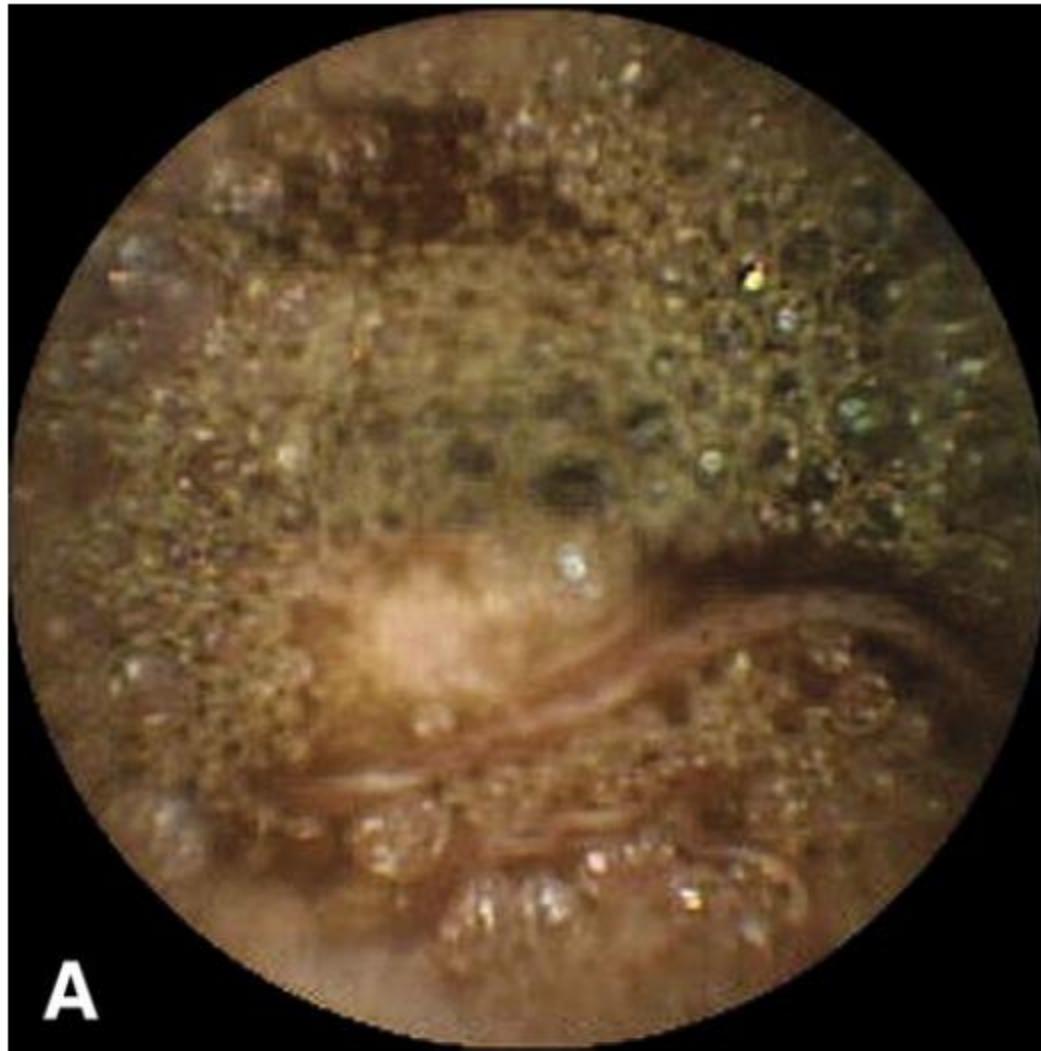
**Figure A:** Longitudinal section of an adult hookworm worm in a bowel biopsy, stained with H&E. Note the oral cavity (**OC**) and strong, muscled esophagus (**ES**).



**Figure B:** Cross-section of an adult hookworm from the same specimen in **Figure A**. Shown here are the platymyarian musculature (**MU**), intestine with brush border (**IN**), excretory ducts (**ED**), and coiled ovaries (**OV**).



**Figure C:** Another-cross section of the specimen in **Figures A and B**.





# Endoscopia en anquilostomiasis



Hookworm infestation diagnosed by capsule endoscopy (with video).

Chen TH, Chen TY, Shyu LY, Lin CK, Lin CC.

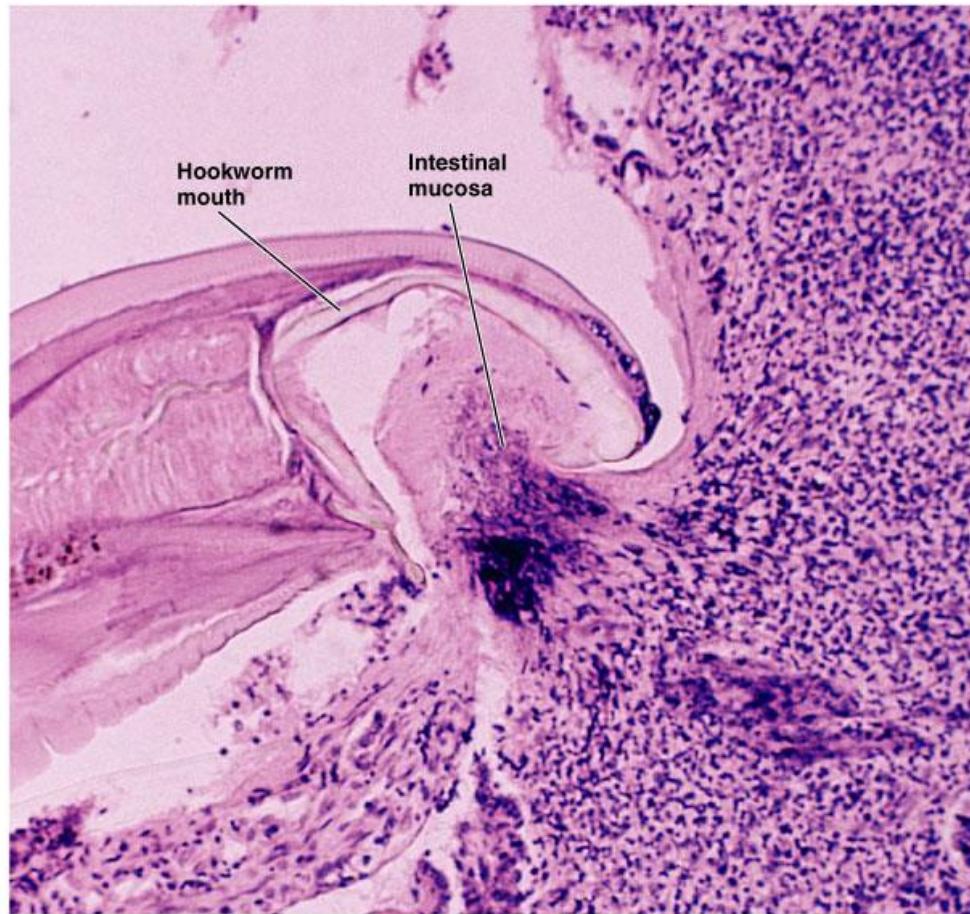
Gastrointest Endosc. 2006 Aug;64(2):277-8.

En caso de estar viendo un PDF, el video se encuentra en (hacer click):

<http://www.sciencedirect.com/science/MiamiMultiMediaURL/1-s2.0-S001651070600201X/1-s2.0-S001651070600201X-mmcl.mpg/273305/FULL/S001651070600201X/3720aafaf3b237a90623612f32b94336/mmc1.mpg>

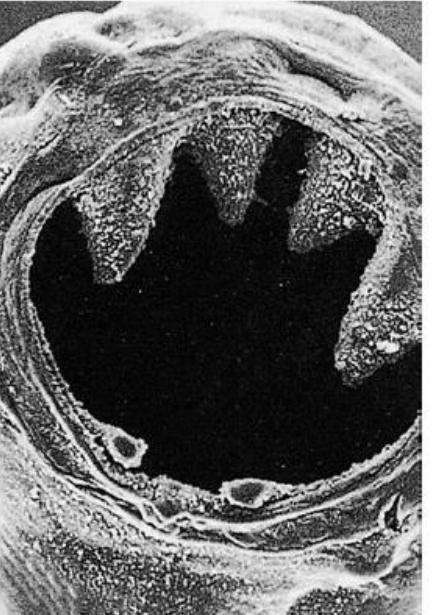
# Anemia en la anquilostomiasis

---

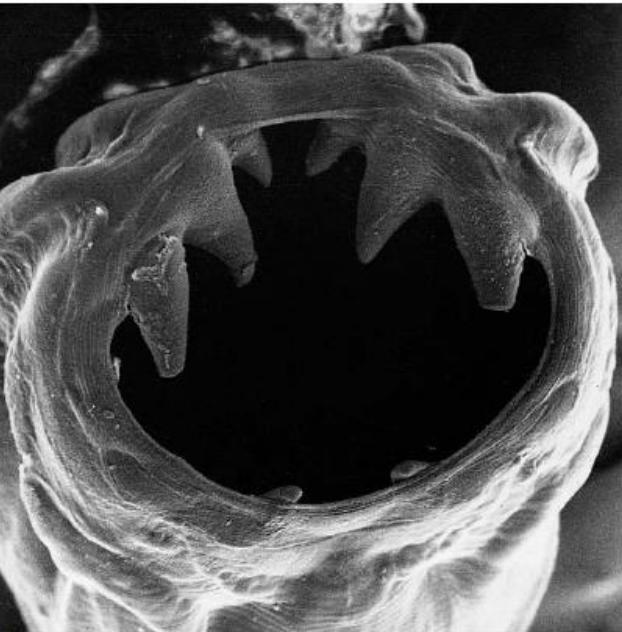


Copyright © 2004 Pearson Education, Inc., publishing as Benjamin Cummings.

**421-425. Identificación de los anquilostomas adultos**  
*Ancylostoma caninum* (421) ( $\times 280$ ). *Ancylostoma duodenale* (422) ( $\times 630$ ). *Ancylostoma ceylanicum* (423) ( $\times 670$ ). *Necator americanus* (424) ( $\times 470$ ). *Ancylostoma duodenale* (425) ( $\times 470$ ). Las diferentes especies se pueden distinguir por la morfología característica de la cápsula de la cabeza (421-424) y de la bolsa masculina (425), en imágenes de microscopía electrónica de barrido. La bolsa masculina se puede diferenciar por el número y por el patrón de los «radios».



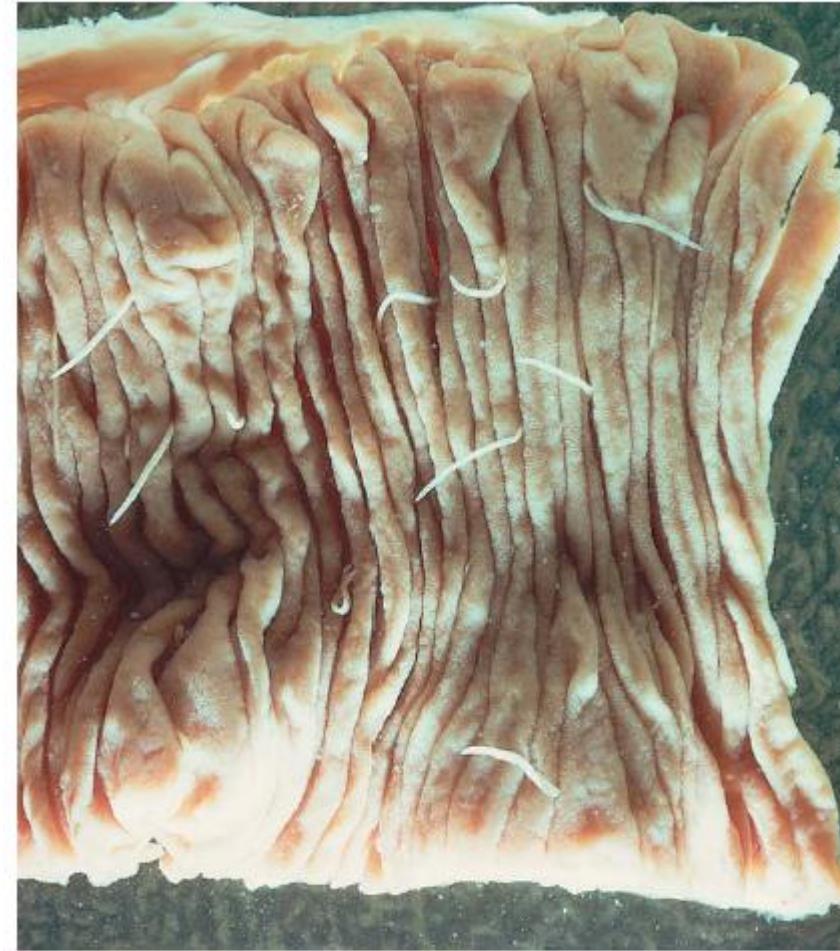
422



421



423



#### **430. Anquilostomas adultos *in situ***

Los gusanos tienen una longitud aproximada de 1 cm y su configuración es característicamente curvada. Se unen a las vellosidades del intestino delgado a través de sus cápsulas bucales. (*Tamaño natural*)

# Anemia

---

The classical anaemia of hookworm infection is a ***hypochromic anaemia***,

- the result of chronic blood loss,
- depletion of iron stores and
- deficiency of iron intake.

The attachment of hookworms' cutting organs to the intestinal mucosa and submucosa and the subsequent rupture of intestinal capillaries and arterioles causes blood loss.

Hookworms have been shown to produce **active suction impulses 120–200 times/min** and evidence indicates that the hookworm is indeed an habitual blood-sucker and needs serum.

# Anemia

---

The secretion of **factor Xa and VIIa/TF inhibitors**, and anti-platelet agents by the parasite helps to maintain continuous oozing of blood at the hookworm attachment site and the free flow of blood through the parasite alimentary canal.

The blood loss has been estimated as:

- **0.03 mL/day per worm in *N. americanus* and**
- **0.15 mL/day per worm in *A. duodenale* infections.**

Where body iron stores are low, there is a significant negative relationship between the intensity of infection and blood loss and haemoglobin concentration.

A significant negative correlation between plasma ferritin levels and hookworm burden, using the worm expulsion method, has been reported. Persistent anaemia among children can result in stunted growth and impaired cognitive ability. Hookworm anaemia is of the iron deficiency type and responds dramatically to iron supplementation and also to removal of the hookworm burden, but after a much longer period.



# Burden of anemia associated to helminthiases: partial results from an ongoing Venezuelan survey



J. Flores,<sup>1</sup> C. Navarro,<sup>1</sup> M. Montero,<sup>1</sup> R. Nino-Incani,<sup>2</sup> J. Cortez,<sup>2</sup> S. Jiménez,<sup>2</sup> M. Diaz,<sup>2</sup> D. Ortega,<sup>3</sup> M. Cachare,<sup>3</sup> L. Gómez,<sup>3</sup> A. Marin,<sup>3</sup> E. Sanz,<sup>3</sup> M. Gámez,<sup>3</sup> Y. Sandoval,<sup>3</sup> E. Villegas,<sup>4</sup> N. Briceño,<sup>4</sup> N. Carrillo,<sup>4</sup> E. Salazar-Labord,<sup>4</sup> V. González,<sup>4</sup> M. Escheverría-Ortega,<sup>4</sup> J. Mendoza,<sup>4</sup> C. Alíbano,<sup>4</sup> G. Hidalgo,<sup>4</sup> A.J. Rodríguez-Morales,<sup>4,5\*</sup>  
Research Direction, Center for Studies on Growth and Development of the Population (FUNDACREDESA), Ministry of Communities and Social Protection, Caracas, Venezuela  
Parasitology Department, Universidad de Carabobo, Valencia, Venezuela  
CAICET, Puerto Ayacucho, Venezuela  
Instituto Experimental José W. Torrealba, Universidad de Los Andes, Trujillo, Venezuela  
Department of Preventive and Social Medicine, Raziati Medical School, Universidad Central de Venezuela, Caracas, Venezuela  
\*Email: alfonso.rodriguez@fundacredesa.gob.ve

## Abstract

**Objective:** Helminthiases are known aetiological factors in tropical anemia; however the extent to which their presence might interact to further enhance the risk of anaemia is poorly understood. The aim of this study was to determine the prevalence of helminthiases-associated anemia in asymptomatic individuals from 11 states in the context of a national survey of growth and development (2007–2009).

**Methods:** In the context of a Venezuelan Study on Human Growth and Development (SENACREDH, 2007–2011), a cross-sectional, probabilistic study, of 4,779 asymptomatic children and adults (<60 y-old) was done. Sampling was random, adjusted for age, sex and location. Results represented population weighted estimates (5,295,762 pop.), 2,935,070 male, 2,360,692 female. Study area was 71 municipalities in 11 states of North Central Coastal, South and Andean Venezuelan regions. Intestinal parasites were diagnosed in stool samples after being preserved in MIF media. Anemia was classified according WHO criteria after measure haemoglobin in blood samples.

**Results:** Hookworms (*Necator americanus/Ancylostoma duodenale*) and whipworm (*Trichuris trichiura*) were significantly associated with anemia. Whipworm prevalence was 1.35% (71,540) (95%CI 1.34–1.36%). Hookworms was 0.57% (30,153) (95%CI 0.56–0.58%). Anemia prevalence was 12.92% (684,054) (95%CI 12.88–12.95%), being significantly higher in those with hookworm infection (26.9%, 95%CI 26.42–27.42%) ( $p<0.001$ ) ( $OR=2.5$ , 95%CI 2.4–2.6). Similarly was found for whipworm (16.4%, 95%CI 16.36–16.43%) ( $p<0.001$ ) ( $OR=1.3$ , 95%CI 1.2–1.4).

**Conclusions:** Anemia is one of the most widespread and common health conditions afflicting individuals living in the tropics. The consequences of anemia are particularly severe for children and pregnant women. For these reasons multiple level preventive interventions at national scope should consider intestinal parasite surveys such as this study shows.

**Key words:** anemia, intestinal parasites, Venezuela.

## Introduction and Purpose

Anemia is one of the major public health problem in tropical countries, where this condition occurs at its highest prevalence. Especially there, anemia causes are multifactorial. Anemia is responsible for significant morbidity and mortality, and would be related to other secondary conditions and complications. Understanding causes of anemia and potential mechanisms are crucial to our ability to intervene to reduce this burden.(1)

One of the significant causes of anemia in tropical countries is infectious diseases, such as malaria, (2) some bacterial infections, (3) HIV infection, (4) some other viral infections (e.g. parvovirus, influenza)(5,6) and intestinal parasites (particularly helminthiases), among others. (7,8)

Today, helminthiases are well-known aetiological factors in tropical anemia; (7,9) however the extent to which their presence might interact to further enhance the risk of anaemia is poorly understood. (10)

The aim of this study was to determine the prevalence of helminthiases-associated anemia in asymptomatic individuals from 11 states in the context of a national survey of growth and development (2007–2009).

## Methods

This report constitutes part of a national parasitological survey that is being doing in the context of a large national representative assessment, the Second National Study of Human Growth and Development of the Bolivarian Republic of Venezuela (*Segundo Estudio Nacional de Crecimiento y Desarrollo Humano*, SENACREDH, 2007–2009).

The SENACREDH is a cross-sectional, probabilistic study, which for this report included an analysis of 4,779 asymptomatic children and adults (<60 y-old) assessed. Sampling was random, adjusted for age, sex and location.

Results represented population weighted estimates (5,295,762 pop.), 2,935,070 male, 2,360,692 female.

Study area was 71 municipalities in 11 states of North Central Coastal, South and Andean Venezuelan regions (2007–2009) (Figure 1). Human Development Index for North Central Coastal area ranged in 2008 from 0.827 to 0.887, Andean from 0.731 to 0.812 and South from 0.778 to 0.807.

Intestinal parasites were diagnosed in stool samples after being preserved in MIF media. Anemia was classified according the World Health Organization (WHO) criteria after measure haemoglobin in blood samples.

## Results

Hookworms prevalence was 0.569% (30,153/5,265,609) (95%CI 0.563–0.576%).

Whipworm prevalence was 1.35% (71,540/5,265,609) (95%CI 1.341–1.361%).

Anemia prevalence was 12.92% (684,054) (95%CI 12.88–12.95%).

Hookworms (*Necator americanus/Ancylostoma duodenale*) and whipworm (*Trichuris trichiura*) were significantly associated with anemia.

Anemia was significantly higher in those with hookworm infection (26.91%, 95%CI 26.42–27.42%) compared to those free of infection (12.832%, 95%CI 12.803–12.861%) ( $p<0.001$ ) (Table 1) ( $OR=2.501$ , 95%CI 2.438–2.566) (Figure 2).

Similarly was found for whipworm, higher anemia prevalence with it (16.4%, 95%CI 16.36–16.43%) compared to those free of infection (12.869%, 95%CI 12.840–12.897%) ( $p<0.001$ ) (Table 2) ( $OR=1.3$ , 95%CI 1.2–1.4) (Figure 2).

Figure 1. Map of Venezuela showing areas of study (2007–2009) where individuals were sampled (coloured).

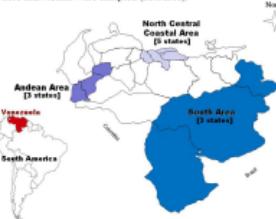
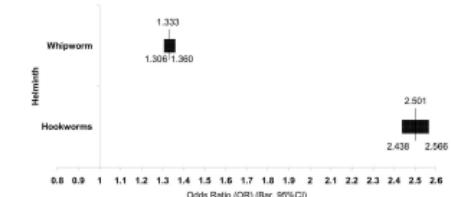


Figure 2. Odds ratio of helminth infections for anemia.



## Conclusions

Anemia is one of the most widespread and common health conditions afflicting individuals living in the tropics.(2;7;8;10;11) The consequences of anemia are particularly severe for children and pregnant women.(1;2;7) For these reasons national studies revealing its prevalence as well their associated factors, such as has been shown herein, helminthiases, should be periodically done.

In this national ongoing assessment context (SENACREDH), this population study partial report shows the importance of hookworm infections with double and half times chances of be found with anemia compared to those free of infection. However, anemia is a multifactorial problem and other factors in this study have been not specifically addressed.

Further multivariate analyses with complete national data are deserved and expected in the near future.

However the importance of the problem reflects the need for diffusion of results as well short- and long-term interventions.

For these reasons, multiple level preventive interventions at national scope should consider intestinal parasite surveys as this study shown. From a public health policy, successful interventions to reduce the burden of such neglected diseases will require greater attention to prioritization of iron-promoting actions, including long-term low dose iron supplementation (12) and deworming, among community participation and health education. (13) Additionally, especially in tropical countries, food fortification have proved to be efficacious and effective, and therefore should be considered as part of an integral strategy, to combat micronutrient deficiencies, including anemia.(14;15)

The World Health Organization recommends deworming of children aged 12–24 months in highly endemic areas, given the fact that different studies have shown results that support the implementation of deworming programs aimed at young children in highly endemic areas.(16)

Table 1. Relation between hookworm infection (*Necator americanus/Ancylostoma duodenale*) and anemia in three regions of Venezuela, SENACREDH (2007–2009).

Hookworm Infection ( <i>Necator americanus/Ancylostoma duodenale</i> )	Anemia		
	Positive	Negative	
		N	%
Positive	8,117	22,036	30,153
	26.919	73.081	100
	(26.417–27.422)	(75.578–73.583)	
Negative	675,937	4,589,672	5,265,609
	12.832	87,130	100
	(12,803–12,861)	(87,101–87,159)	
TOTAL	684,054	4,611,708	5,295,762
	12.917	87,083	100
	(12,888–12,946)	(87,054–87,112)	

$x^2=5.285$ ;  $P=0.021$ ;  $OR=2.501$ , 95%CI 2.438–2.566.

Table 2. Relation between whipworm (*Trichuris trichiura*) infection and anemia in three regions of Venezuela, SENACREDH (2007–2009).

Whipworm Infection ( <i>Trichuris trichiura</i> )	Anemia		
	Positive	Negative	
		N	%
Positive	11,766	59,774	30,153
	16,447	83,553	100
	(16,174–16,719)	(83,281–83,826)	
Negative	672,288	4,551,934	5,224,222
	12,869	87,131	100
	(12,840–12,897)	(87,103–87,160)	
TOTAL	684,054	4,611,708	5,295,762
	12,917	87,083	100
	(12,888–12,946)	(87,054–87,112)	

$x^2=803.239$ ;  $P<0.001$ ;  $OR=1.333$ , 95%CI 1.306–1.360.

## References

- Telentino K, Friedmann JP. An update on anemia in less developed countries. *Am J Trop Med Hyg* 2010;77:84–51.
- Rodríguez-Morales AJ, Salmerón F, Vergara M, Pascual C, Colino R, Alonso M. Anemia and helminth infections in children with Plasmodium vivax malaria. *J Trop Pediatr* 2006;52:49–51.
- Wang W, Li Y, Yang K, et al. Helminth infections in children with anemia: meta-analysis of randomized controlled trials. *Scand J Gastroenterol* 2010;45:661–676.
- Sullivan P. Associations of anemia, treatment for anemia, and survival in patients with human immunodeficiency virus infection. *J Infect Dis* 2002;185 Suppl 2:S138–S142.
- Jitschin R, Peters O, Pfanz A, Turszki P, Seeger H, Moskow S. Impact of paroxysmal nocturnal hemoglobinuria on paediatric patients with hematological and/or oncological disorders. *Clin Microbiol Infect* 2010.
- Hall A, Gooley M, Ayello C, et al. Clinical consequences of paediatric human immunodeficiency virus infection: a serial cross-sectional study. *J Pediatr* 2006;143:76–79.
- Smith JL, Brooker S. Impact of hookworm infection and deworming on anemia in non-pregnant populations: a systematic review. *Trop Med Health* 2007;77:88–99.
- Hall A, Harten S, de Souza J. The costs and cost-effectiveness of mass treatment for intestinal nematode worm infections using different treatment thresholds. *PLoS Negl Trop Dis* 2009;3:e503.
- Moayedi-Tehrani H, Noori-Shadman M, Farzad N, Naghavi Y, Once C. Weekly low-dose ivermectin supplementation effectively improves iron status in adolescent girls. *Biol Trace Elem Res* 2010;135:23–30.
- Sharon T, Villalpando S. The role of enriched foods in铁和铁的吸收。 *Br J Nutr* 2006;96:Suppl 1:S73–S77.
- Layne M, García-Casal MN, Moreno-Castilla H, et al. Impact of fortification of flours with iron to reduce the prevalence of anemia and iron deficiency among schoolchildren in Caracas, Venezuela: a follow-up. *Food Nutr Bull* 2002;23:384–389.
- Gyorkos TW, Málaga-García M, Casapia M, Jongee SA, Creed-Kanashio H. Stunting and helminth infections in early preschool-age children in a resource-poor community in the Amazon lowlands of Peru. *Trop Ed S Afr Trop Med Hyg* 2011;105:204–206.
- Talukder K, Friedmann JP. An update on anemia in less developed countries. *Am J Trop Med Hyg* 2010;77:84–51.
- Rodríguez-Morales AJ, Salmerón F, Vergara M, Pascual C, Colino R, Alonso M. Anemia and helminth infections in children with Plasmodium vivax malaria. *J Trop Pediatr* 2006;52:49–51.
- Wang W, Li Y, Yang K, et al. Helminth infections in children with anemia: meta-analysis of randomized controlled trials. *Scand J Gastroenterol* 2010;45:661–676.
- Sullivan P. Associations of anemia, treatment for anemia, and survival in patients with human immunodeficiency virus infection. *J Infect Dis* 2002;185 Suppl 2:S138–S142.
- Jitschin R, Peters O, Pfanz A, Turszki P, Seeger H, Moskow S. Impact of paroxysmal nocturnal hemoglobinuria on paediatric patients with hematological and/or oncological disorders. *Clin Microbiol Infect* 2010.
- Hall A, Gooley M, Ayello C, et al. Clinical consequences of paediatric human immunodeficiency virus infection: a serial cross-sectional study. *J Pediatr* 2006;143:76–79.
- Smith JL, Brooker S. Impact of hookworm infection and deworming on anemia in non-pregnant populations: a systematic review. *Trop Med Health* 2007;77:88–99.
- Hall A, Harten S, de Souza J. The costs and cost-effectiveness of mass treatment for intestinal nematode worm infections using different treatment thresholds. *PLoS Negl Trop Dis* 2009;3:e503.
- Moayedi-Tehrani H, Noori-Shadman M, Farzad N, Naghavi Y, Once C. Weekly low-dose ivermectin supplementation effectively improves iron status in adolescent girls. *Biol Trace Elem Res* 2010;135:23–30.
- Sharon T, Villalpando S. The role of enriched foods in 铁和铁的吸收。 *Br J Nutr* 2006;96:Suppl 1:S73–S77.
- Layne M, García-Casal MN, Moreno-Castilla H, et al. Impact of fortification of flours with iron to reduce the prevalence of anemia and iron deficiency among schoolchildren in Caracas, Venezuela: a follow-up. *Food Nutr Bull* 2002;23:384–389.
- Gyorkos TW, Málaga-García M, Casapia M, Jongee SA, Creed-Kanashio H. Stunting and helminth infections in early preschool-age children in a resource-poor community in the Amazon lowlands of Peru. *Trop Ed S Afr Trop Med Hyg* 2011;105:204–206.



Design by: José Antonio Moreno Ruiz



# Burden of anemia associated to helminthiases: partial results from an ongoing Venezuelan survey

[www.fundacredesa.gob.ve](http://www.fundacredesa.gob.ve)



**Table 1.** Relation between hookworms infection (*Necator americanus/Ancylostoma duodenale*) and anemia in three regions of Venezuela, SENACREDH (2007-2009).

Hookworms Infection ( <i>Necator americanus/</i> <i>Ancylostoma duodenale</i> )	Anemia			
	Positive	Positive		Negative
		N	%	
	Negative	26.919	(26.417-27.422)	73.081
<b>Total</b>	N	8,117		22,036
		675,937		5,265,609
<b>Total</b>	%	12.832		87.130
		(12.803-12.861)		(87.101-87.159)
<b>Total</b>	N	684,054		4,611,708
		12.917		87.083
		(12.888-12.946)		(87.054-87.112)

$\chi^2=5,285.891$ ; p<0.001; OR=2.501, 95%CI 2.438-2.566.

# Anemia

---

Light infections may cause anaemia where the iron intake is deficient and anaemia may also be caused in spite of the presence of an adequate iron intake, provided that the worm burden is heavy enough.

Light infections can have particular importance for pre-school **children** and **pregnant women**, who often have deficit iron stores.

Little is known about the anaemia which develops in light primary infections, but it may be of immunological origin, similar to that which develops in dogs infected with *A. caninum*.

A folate deficiency may be present, masked by the severe iron deficiency anaemia, and becomes overt only when this has been corrected.

In general, children and pregnant women because of their low underlying iron reserves are considered the two populations most vulnerable to hookworm anaemia.

# ¿Nuevos efectos de las protozoosis?

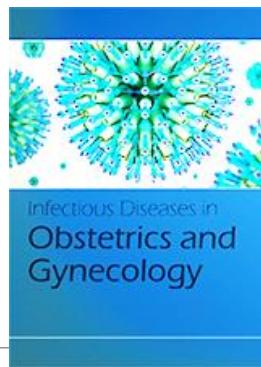


TABLE 1: Parasite positivity in stool specimens examined from pregnant women studied.

	Number	(%)	Helminths		
Protozoans					
Nonpathogenic					
<i>Entamoeba coli</i>	44	5.7	<i>Ascaris lumbricoides</i>	437	57.0
<i>Endolimax nana</i>	30	3.9	<i>Trichuris trichiura</i>	276	36.0
Pathogenic			<i>Necator americanus</i>	62	8.1
<i>Giardia lamblia</i>	108	14.1	<i>Enterobius vermicularis</i>	48	6.3
<i>Entamoeba histolytica/dispar</i>	92	12.0	<i>Strongyloides stercoralis</i>	25	3.3
<i>Cryptosporidium spp</i>	2	0.3			

TABLE 2: Relative risk for anemia at pregnancy according to the presence of intestinal parasitosis.

Variable (risk for anemia)	Anemia	Hb	RR	χ <sup>2</sup> Yates	P
Intestinal parasitosis at pregnancy					
Present	594	173	2.56	194.24	< .0001
Absent	82	189	—	—	—
Helminth infection at pregnancy					
Present	322	61	1.56	94.63	< .0001
Absent	354	301	—	—	—
Protozoan infection at pregnancy					
Present	179	23	1.49	59.65	< .0001
Absent	497	339	—	—	—

Table 1

Summary of the characteristics of natural infections caused by hookworms and hookworm-related species.

Species	Host	Infective stage	Route of infection	Passage of infection	Type of infection
<i>N. americanus</i>	Humans	L3 larvae	Skin penetration	Heart–lung–small intestine	Acute/chronic
<i>A. duodenale</i>	Humans	L3 larvae	Skin penetration/oral	Heart–lung–small intestine	Acute/chronic
<i>A. braziliense</i> <i>/A. caninum</i> <i>/U. stenocephala</i> <i>/A. tubaeforme</i>	Humans	L3 larvae	Skin penetration	Skin	Acute (cutaneous larva migrans)/ <i>A. caninum</i> can migrate to intestine and cause enteritis
<i>A. ceylanicum</i>	Humans	L3 larvae	Oral	Small intestine	Acute, on occasion, larvae may reach intestine and develop to adults
<i>A. braziliense</i>	Dogs/cats/foxes	L3 larvae	Skin penetration/oral	Lung–small intestine	Acute/may induce disease but with minimum blood loss
<i>A. caninum</i>	Dogs/cats/foxes	L3 larvae	Skin penetration/oral /transmammary and transplacental (only in dogs)	Lung–small intestine	Acute/cause blood loss and anemia
<i>U. stenocephala</i>	Dogs/cats/foxes	L3 larvae	Skin penetration/oral	Lung–mall intestine/straight to intestine in oral infections	Acute/may induce disease but with minimum blood loss
<i>A. tubaeforme</i>	Cats	L3 larvae	Skin penetration/oral /transmammary /transplacental	Lung–small intestine	Acute/cause blood loss and anemia
<i>A. ceylanicum</i>	Hamsters/dogs/cats	L3 larvae	Oral	Small intestine	Acute/cause blood loss and anemia
<i>N. brasiliensis</i>	Rats	L3 larvae	Skin penetration/oral	Lung–small intestine	Acute
<i>H. polygyrus</i>	Mice	L3 larvae	oral	Intestine	Acute/chronic

M.V. Periago, J.M.  
Bethony / Microbes and  
Infection 14 (2012)  
1451e1464

# Hiproteinemia

---

Loss of protein is a common feature of hookworm anaemia, which is a cause of protein-losing enteropathy and in heavy infections, may result in hypoproteinaemia leading to oedema, or even anasarca.

The protein loss, which is in excess of the red cell loss and is closely related to the hookworm burden, is caused by a limited capacity for albumin synthesis as well as loss caused by anaemia and other factors such as liver disease.



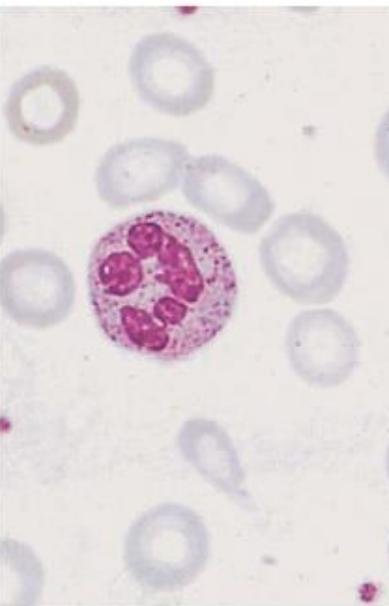
**431. Corte histológico de *Ancylostoma duodenale* adulto *in situ***  
El anquilostoma se alimenta succionando la sangre a partir de la mucosa intestinal. Se ha estimado que un único ejemplar de *Ancylostoma duodenale* puede extraer hasta 0,2 ml al día, mientras que *Necator americanus* extrae hasta 0,05 ml. ( $\times 20$ )



**432. Anemia por anquilostoma**  
La anemia intensa es la característica clínica clásica de la anquilostomiasis. Esta joven tailandesa presentaba una gran cantidad de *Necator americanus* y una hemoglobina de 22 g/l.



**433. Cuadro clínico de la anquilostomiasis masiva**  
Este cuadro clínico se debe a la combinación de una elevada cantidad de anquilostomas y de un consumo diario insuficiente de hierro. Los pacientes suelen sufrir fatiga y disnea. Algunos también presentan edema y ascitis, como el joven de la imagen.



**434. Frotis de sangre correspondiente a un paciente con anemia por anquilostoma**  
La anemia típica debida a la anquilostomiasis intensa es de tipo ferropénico, con hematíes hipocrómicos y microcíticos, disminución de la concentración sérica de hierro y valores bajos de ferritina. ( $\times 1.300$ )

# Respuesta inmune

Parasite Immunol. 2014 Aug;36(8):358-66.  
Immunology of experimental and natural  
human hookworm infection.  
Gaze S, Bethony JM, Periago MV.

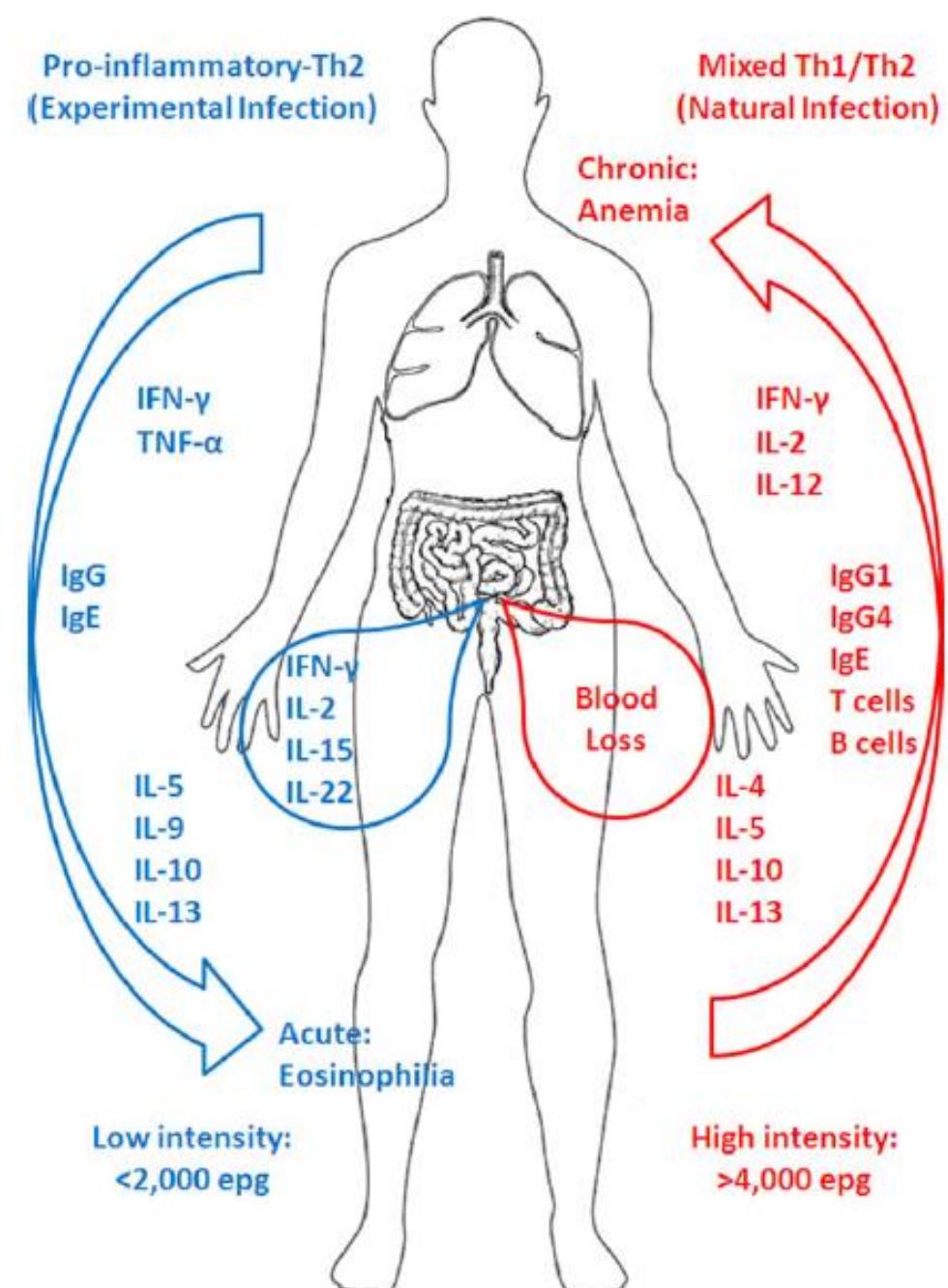
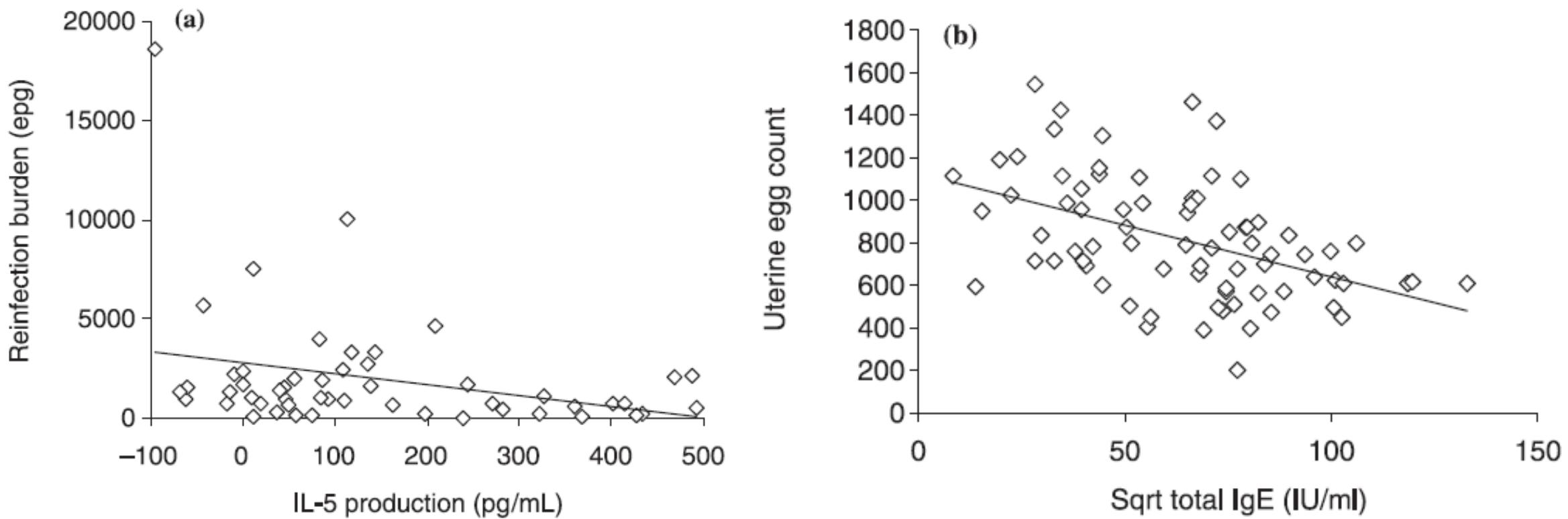


Figure 1 Diagram summarizing the major characteristics of human natural and experimental hookworm infection.

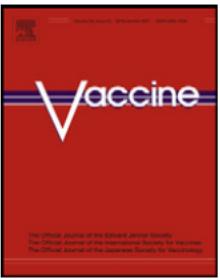
## Immunoepidemiological evidence for protective immunity in human *N. americanus* infection



**Figure 1** Immunoepidemiological evidence for protective immunity in human *N. americanus* infection. (a) Hookworm reinfection 33 months after chemotherapy and IL-5 production in response to adult ES antigen; (b) female worm fecundity and total IgE levels, in Papua New Guinea.



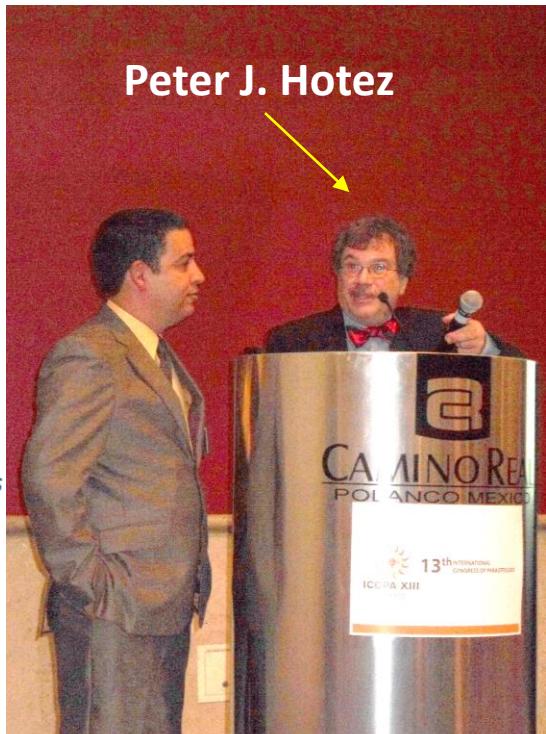
Contents lists available at SciVerse ScienceDirect

**Vaccine**journal homepage: [www.elsevier.com/locate/vaccine](http://www.elsevier.com/locate/vaccine)

Review

**The Human Hookworm Vaccine**

Peter J. Hotez<sup>a,b,c,d,\*</sup>, David Diemert<sup>a,b,e,1</sup>, Kristina M. Bacon<sup>f</sup>, Coreen Beaumier<sup>a,b,c,d</sup>, Jeffrey M. Bethony<sup>a,b,e</sup>, Maria Elena Bottazzi<sup>a,b,c,d</sup>, Simon Brooker<sup>g</sup>, Artur Roberto Couto<sup>h</sup>, Marcos da Silva Freire<sup>h</sup>, Akira Homma<sup>h</sup>, Bruce Y. Lee<sup>f</sup>, Alex Loukas<sup>i</sup>, Marva Loblock<sup>a,b</sup>, Carlos Medicis Morel<sup>h</sup>, Rodrigo Correa Oliveira<sup>j</sup>, Philip K. Russell<sup>a,b</sup>

<sup>a</sup> Sabin Vaccine Institute Product Development Partnership, Houston, TX, United States<sup>b</sup> Sabin Vaccine Institute Product Development Partnership, Washington, DC, United States<sup>c</sup> Sabin Vaccine Institute and Texas Children's Hospital Center for Vaccine Development, National School of Tropical Medicine, Baylor College of Medicine, Houston, TX, United States<sup>d</sup> Department of Pediatrics and Molecular Virology and Microbiology, National School of Tropical Medicine, Baylor College of Medicine, Houston, TX, United States<sup>e</sup> Department of Microbiology, Immunology, and Tropical Medicine, George Washington University School of Medicine and Health Sciences, Washington, DC, United States<sup>f</sup> Public Health Computational and Operations Research (PHICOR), University of Pittsburgh School of Medicine, Pittsburgh, PA, United States<sup>g</sup> Faculty of Infectious and Tropical Disease, London School of Hygiene and Tropical Medicine, UK<sup>h</sup> Oswaldo Cruz Foundation (FIOCRUZ), Rio de Janeiro, Brazil<sup>i</sup> Queensland Tropical Health Alliance, James Cook University, Cairns, Australia<sup>j</sup> Oswaldo Cruz Foundation (FIOCRUZ) – René Rachou Research Centre, Belo Horizonte, Brazil**Naftale Katz**



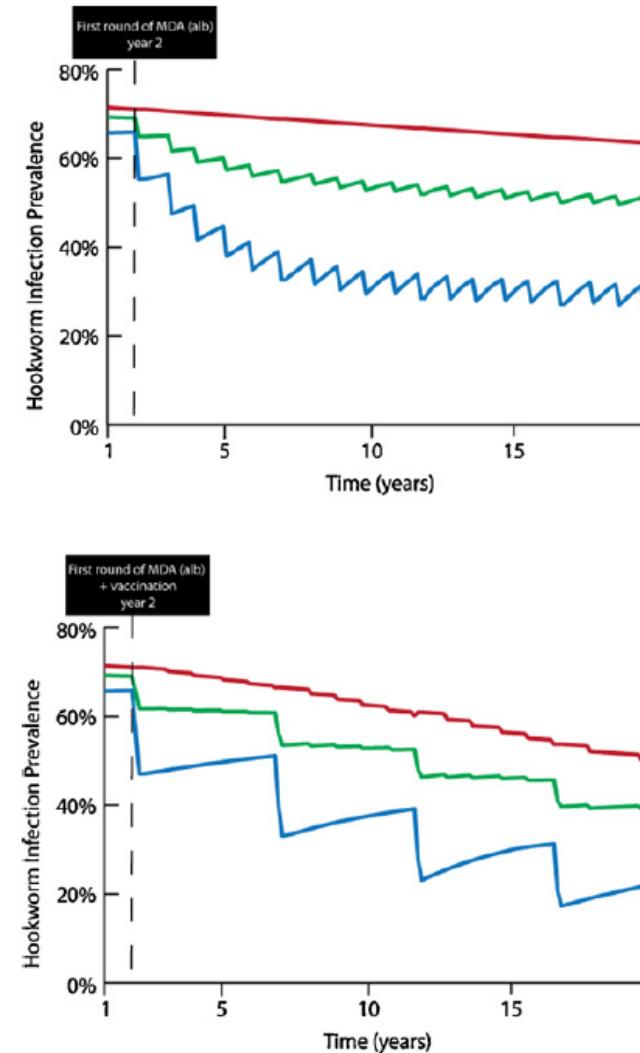
Contents lists available at SciVerse ScienceDirect

# Vaccine

journal homepage: [www.elsevier.com/locate/vaccine](http://www.elsevier.com/locate/vaccine)

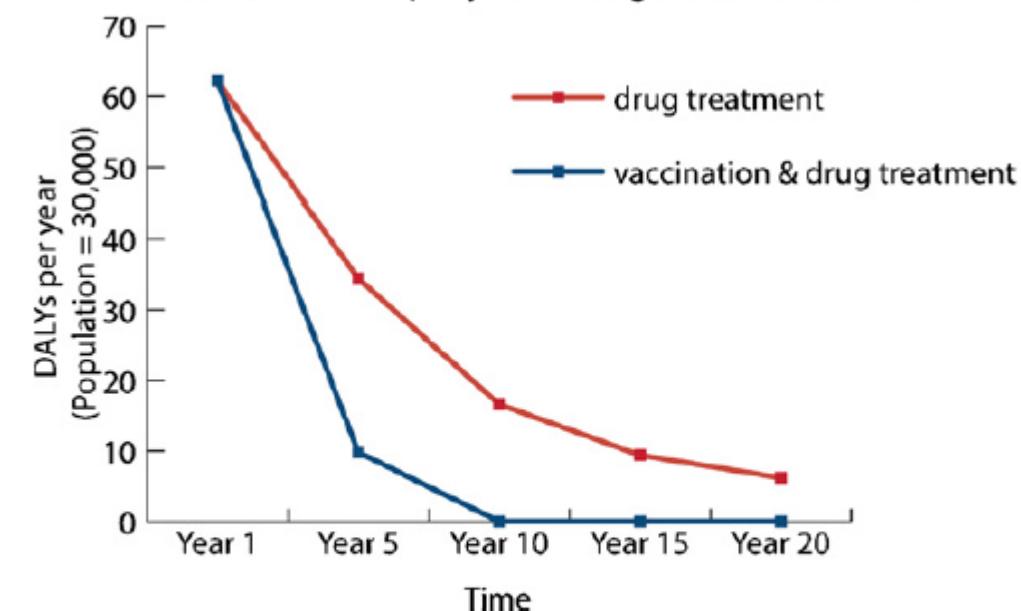
Review

## The Human Hookworm Vaccine



**Fig. 1.** Benefit of adding an effective Human Hookworm Vaccine to Mass Drug Administration (MDA) in order to achieve hookworm elimination, using an economic dynamic transmission compartment model with compartments representing human and free-living hookworm populations. In this scenario, albendazole is administered annually to 75% of children ages 1–14 and the MDA+vaccination (2 doses) is administered to the same group once every 5 years (assuming a 5-year duration of vaccine protection). Albendazole cure rate = 78.4%; vaccine efficacy = 70%; mean baseline worm burden = 30 (adults), 15 (children). Top: MDA alone. Bottom: MDA + vaccination.

### Adding Vaccination to Drug Treatment Decreases DALY Burden Much More Rapidly than Drug Treatment Alone



**Fig. 2.** Benefit of an effective Human Hookworm Vaccine in reducing disease burden, as measured by disability adjusted life years (DALYs), relative to MDA alone. Only disability resulting from anemia is included in this analysis. Albendazole cure rate = 78.4%; vaccine efficacy = 70%; mean baseline worm burden = 30 (adults), 15 (children).

# Diagnóstico

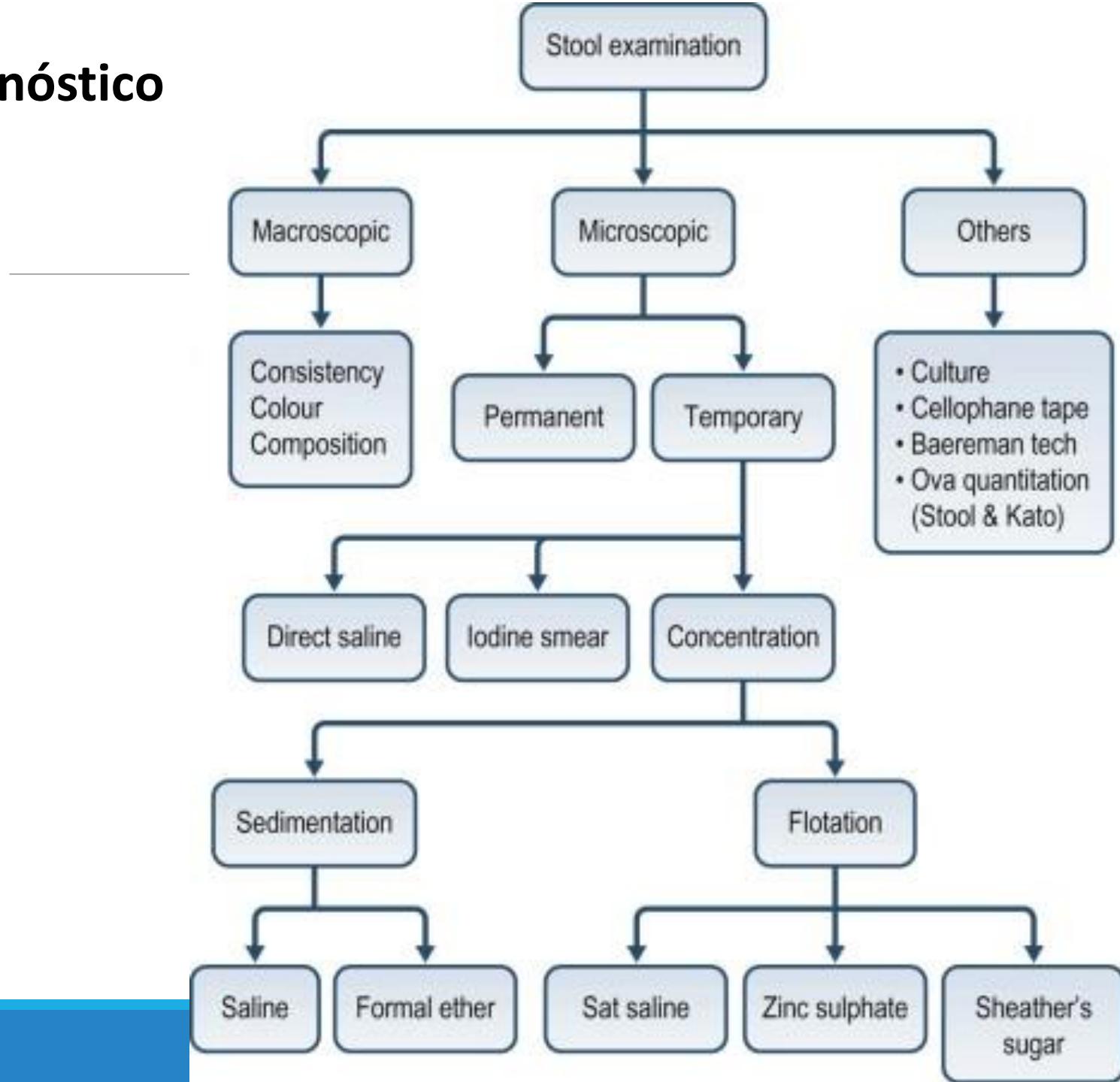
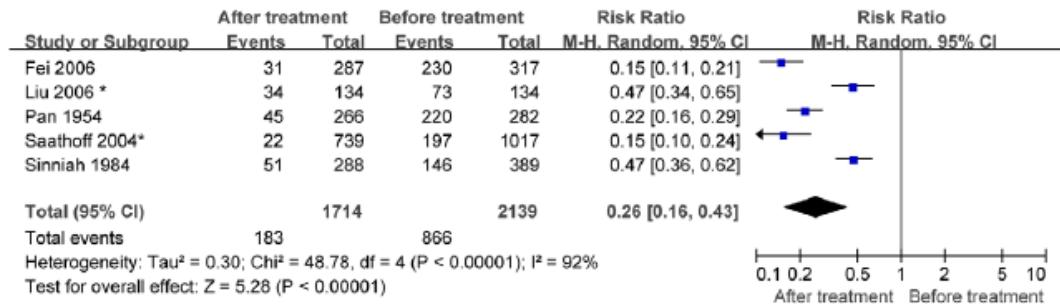


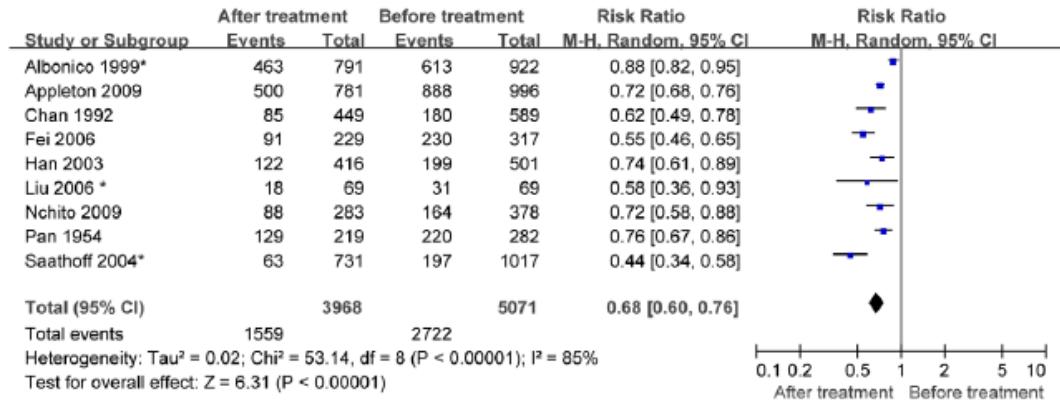
TABLE  
55.1**Recommended Treatments for Soil-Transmitted Helminths. Note All Treatment are Administered Orally**

Infection	Drugs	Dose	Duration
<b>ENTEROBIUS</b>			
Drugs of choice	Albendazole Mebendazole Pyrantel pamoate	400 mg 100 mg 10 mg/kg	Single dose <sup>a</sup> Single dose <sup>a</sup> Single dose <sup>a</sup>
<b>TRICHURIS</b>			
Drugs of choice	Albendazole Mebendazole	400 mg 500 mg	Single dose <sup>b</sup> Single dose <sup>b</sup>
Alternatives	Nitazoxanide	500 mg or 200 mg for children 4–11 years or 100 mg for children 1–3 years	Daily for 3 days
<b>ASCARIS</b>			
Drugs of choice	Albendazole	400 mg or 200 mg for children 2–5 years	Single dose
	Mebendazole Levamisole Pyrantel pamoate	500 mg 2.5 mg/kg 10 mg/kg	Single dose Single dose Single dose
Alternatives	Nitazoxanide	500 mg or 200 mg for children 4–11 years or 100 mg for children 1–3 years	Daily for 3 days
<b>TOXOCARA</b>			
Drugs of choice	Albendazole Mebendazole	400 mg 500 mg	Twice daily for 5 days Twice daily for 5 days
<b>LAGOCHILASCARIASIS</b>			
Drugs of choice	Albendazole Ivermectin	400 mg 300 µg/kg	Daily for 30 days Weekly for 10 weeks
<b>HOOKWORM</b>			
Drugs of choice	Albendazole Mebendazole	400 mg 500 mg	Single dose Single dose <sup>b</sup>
Alternatives	Pyrantel pamoate Levamisole	10 mg/kg 150 mg or 2.5 mg/kg	Daily for 3 days Single dose

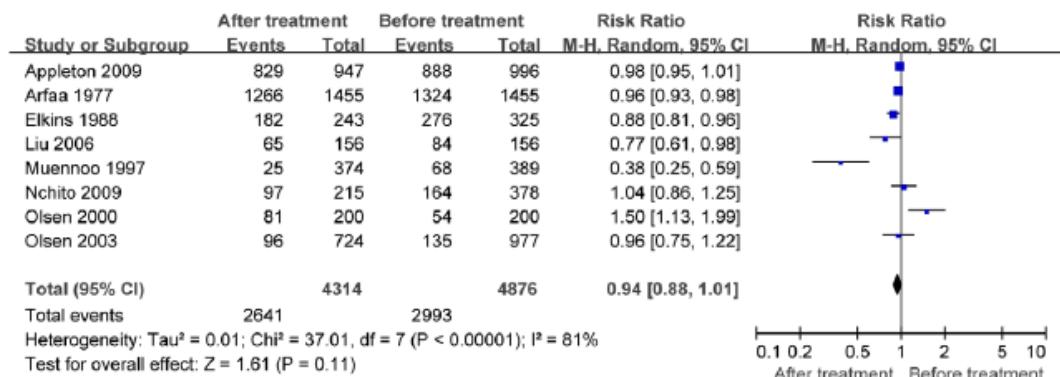
### A. lumbricoides 3 months after treatment



### A. lumbricoides 6 months after treatment



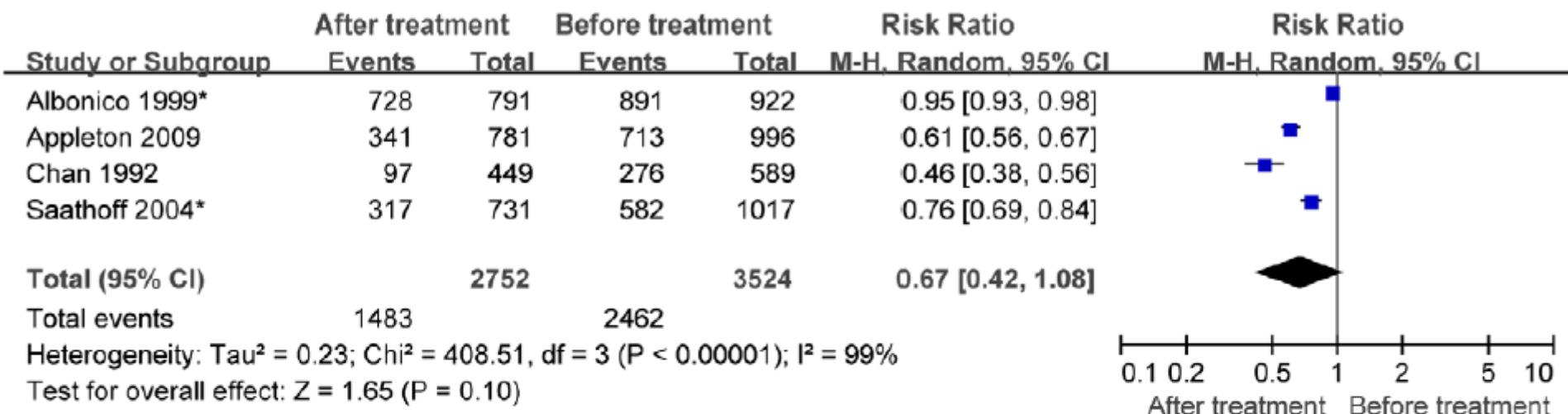
### A. lumbricoides 12 months after treatment



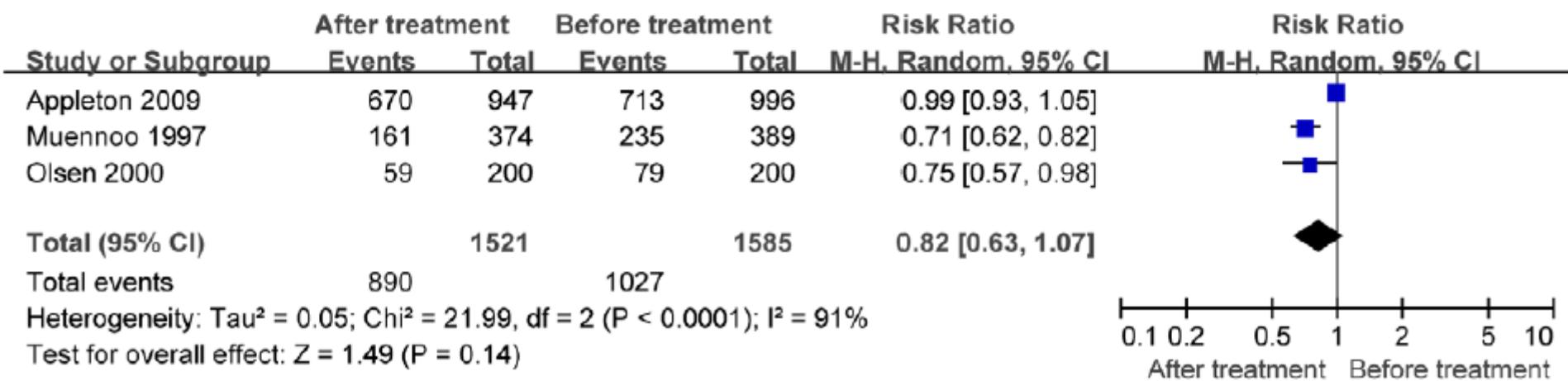
**Figure 2. Forest plot of prevalence of *Ascaris lumbricoides* 3, 6, and 12 months posttreatment.** A random relative risk (RR) value of less than 1 indicates a lower infection rate after treatment compared to the initial level. Diamonds represent the pooled estimate across studies. See Table S1 for full references. \*The infection rate 3 or 6 months after the last round of treatment was abstracted (Table S3).  
doi:10.1371/journal.pntd.0001621.g002

Jia T-W, Melville S, Utzinger J, King CH, Zhou X-N (2012) Soil-Transmitted Helminth Reinfection after Drug Treatment: A Systematic Review and Meta-Analysis. PLoS Negl Trop Dis 6(5): e1621. doi:10.1371/journal.pntd.0001621

## *T. trichiura* 6 months after treatment



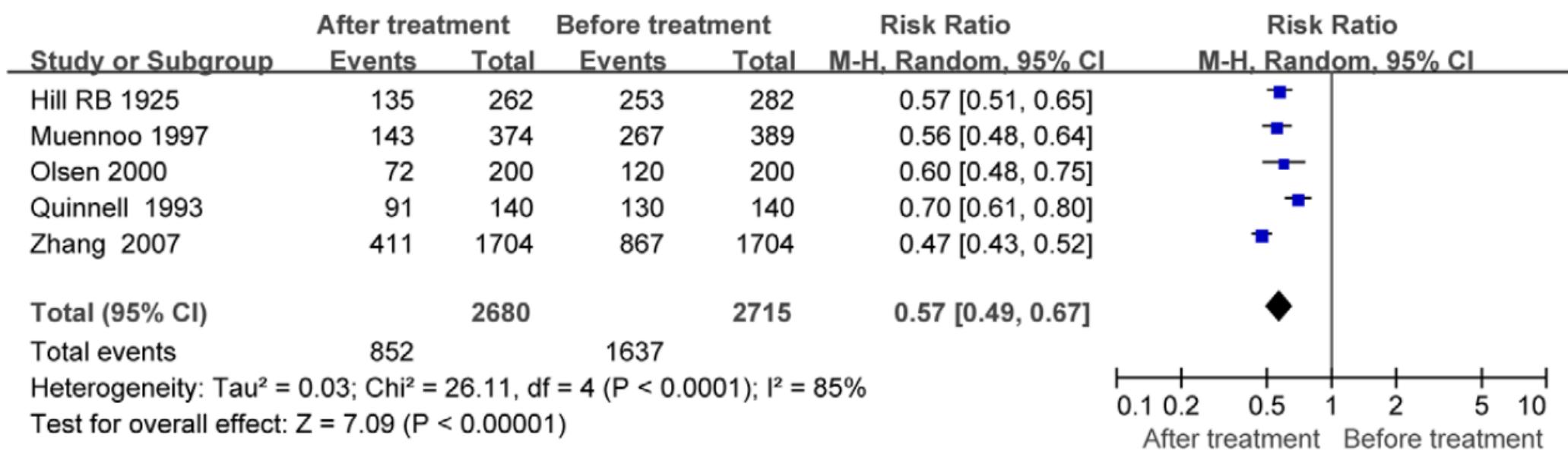
## *T. trichiura* 12 months after treatment



Jia T-W, Melville S, Utzinger J, King CH, Zhou X-N (2012) Soil-Transmitted Helminth Reinfection after Drug Treatment: A Systematic Review and Meta-Analysis. PLoS Negl Trop Dis 6(5): e1621.

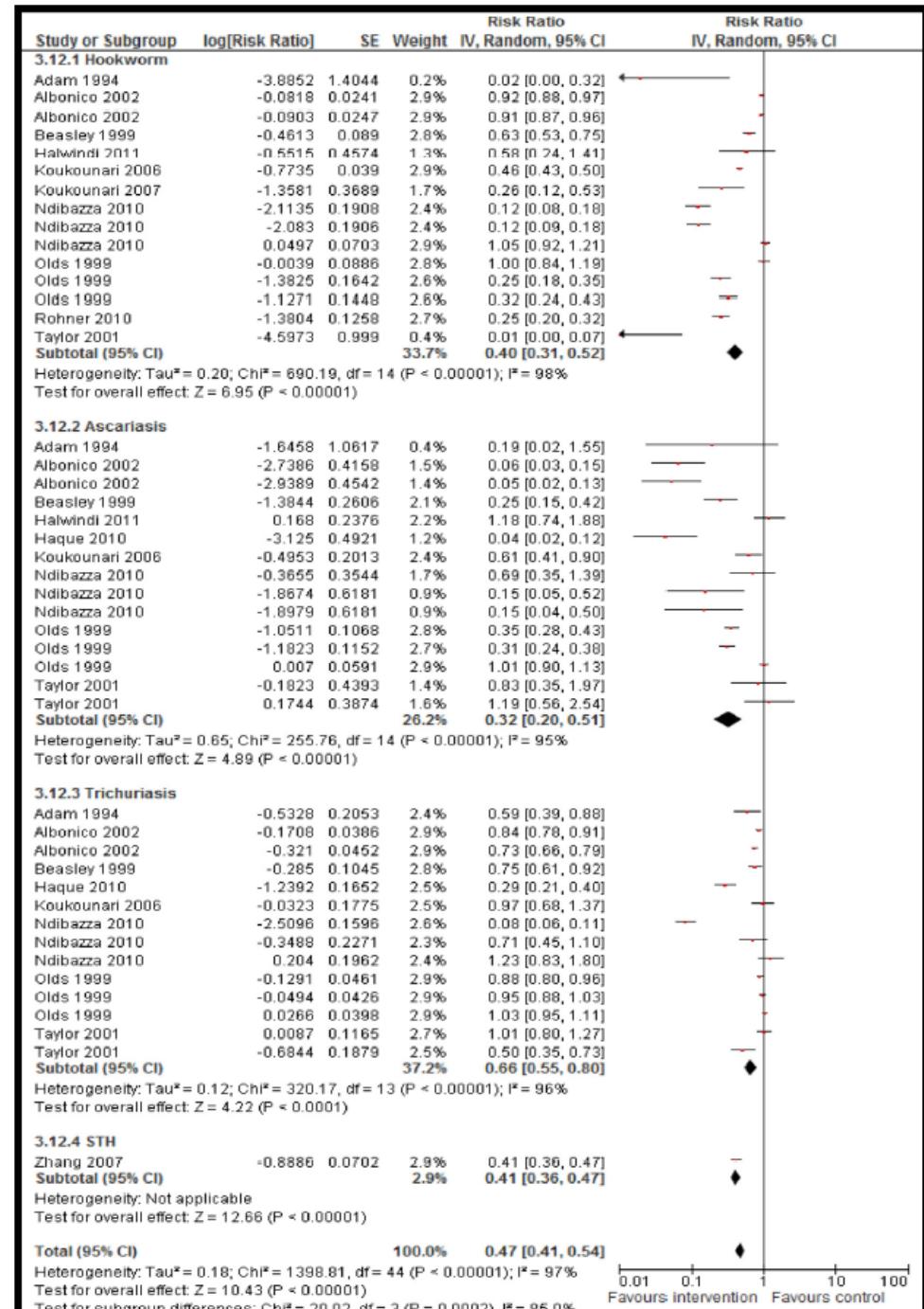
doi:10.1371/journal.pntd.0001621

### Hookworm 12 months after treatment



**Figure 3. Forest plot of prevalence of *Trichuris trichiura* or hookworm after treatment.** A random relative risk (RR) value of less than 1 indicates a lower infection rate after treatment compared to the initial level. Diamonds represent the pooled estimate across studies. See Table S1 for full references. \*The infection rate 6 months after the last round of treatment was abstracted (Table S3).

doi:10.1371/journal.pntd.0001621.g003

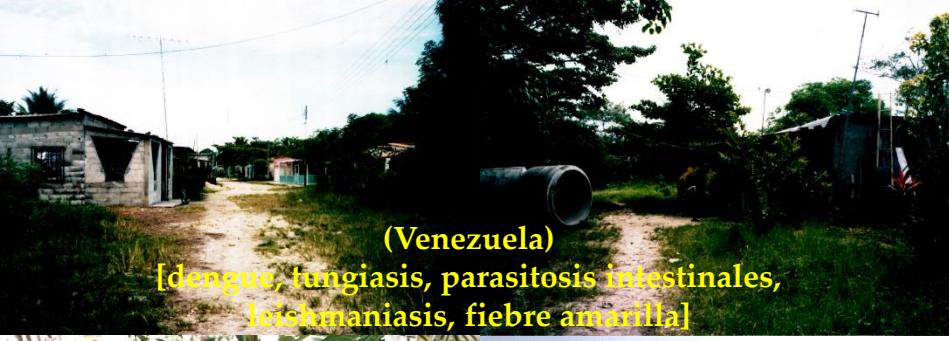


Infect Dis Poverty. 2014 Jul 31;3:23. doi: 10.1186/2049-9957-3-23. eCollection 2014.

Community-based interventions for the prevention and control of helminthic neglected tropical diseases.

Salam RA1, Maredia H2, Das JK1, Lassi ZS1, Bhutta ZA3.

Figure 2 Forest plot for the impact of CBIs on STH prevalence.





# Prevención y Control

Figure 1.1 A Model of the Determinants of Health

Ambientes de Riesgo (ej. Agricultura y Ganadería en zonas endémicas de parasitosis sistémicas o intestinales: Chagas, Fasciola, Equinococosis, Cisticercosis)

Menor capacidad de prevención, Higiene y sanidad  
Oportunidades de Empleo

Calidad de la Dieta  
Nutrición  
Inmunidad

Susceptibilidad  
Genética  
+ Endemicidad

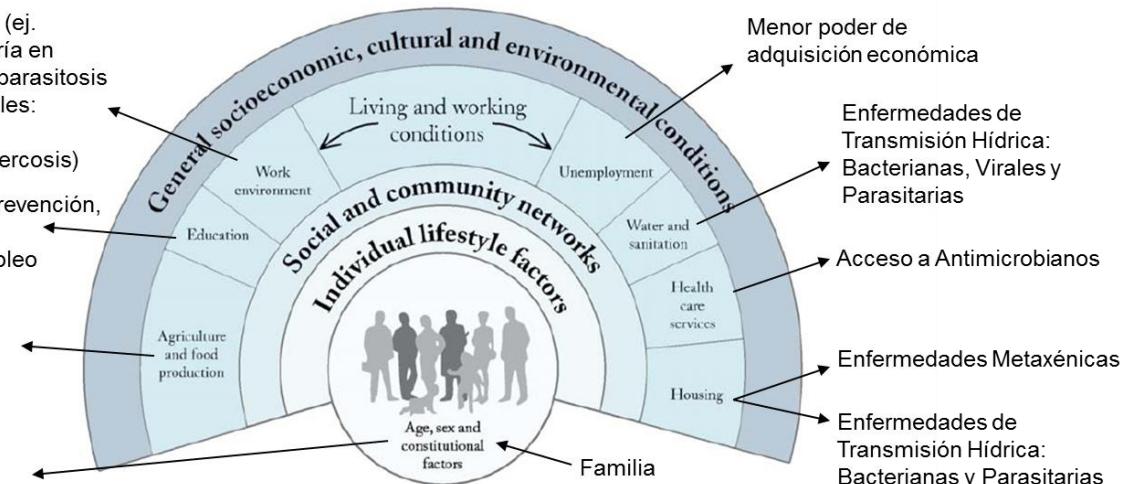


Figure shows one influential model of the determinants of health that illustrates how various health-influencing factors are embedded within broader aspects of society.

Source: Dahlgren, G. and Whitehead, M. (1991). Policies and Strategies to Promote Social Equity in Health. Stockholm: Institute for Futures Studies.

# Conclusiones

---

- ❖ Patología de gran importancia, la cual a pesar de su frecuencia, no es objeto de vigilancia epidemiológica en Colombia y en otros países
- ❖ Alta frecuencia en población infantil, especialmente rural y asociado con pobreza y condiciones medioambientales
- ❖ Fácil tratamiento, de importancia prevención y educación, tratamiento colectivo más que individual
- ❖ Clínicamente, pensar en los diagnósticos diferenciales, pero también en presentaciones atípicas que pueden complicarse, e incluso ser fatales
- ❖ Poliparasitismo
- ❖ Relación con desnutrición y alteraciones del crecimiento
- ❖ Necesidad de incrementar la investigación epidemiológica en la región y el país



Sucre, Venezuela, 2003

