Helminths

- Phylum Nematoda (Roundworms) - "Nematodes"

- Phylum Platyhelminthes (Flatworms)
  - Class Cestoidea (segmented flatworms) - "Cestodes"
  - Class Trematoda (non-segmented flatworms) - "Trematodes"

The Most Common Neglected Infections of Poor People

Disease	Number of Cases	Population at-risk
Ascariasis	807 million	4.2 billion
Trichuriasis	604 milion	3.2 billion
Hookworm	576 million	3.2 billion
Amebiasis	500 million	ND
Schistosomiasis	**200 million**	**0.6 billion**
Lymphatic Filariasis	120 million	1.0 billion
Trachoma	84 million	0.5 billion
Onchocerciasis	18 million	0.1 billion
Chagas Disease	16 million	0.1 billion
Leishmaniasis	12 million	0.4 billion
Leprosy	0.4 million	ND
Dracunculiasis	0.01 million	ND

“I’m Mad as Hell and I am not going to take it anymore!”

Network 1976, Paddy Chayevsky

Millennium Development Goals

"We will have time to reach the Millennium Development Goals – worldwide and in most, or even all, individual countries – but only if we break with business as usual.

We cannot win overnight. Success will require sustained action across the entire decade between now and the deadline. It takes time to train the teachers, nurses and engineers; to build the roads, schools and hospitals; to grow the small and large businesses able to create the jobs and income needed. So we must start now. And we must more than double global development assistance over the next few years. Nothing less will help to achieve the Goals."

United Nations Secretary-General
***Kofi A. Annan,* 2000**

http://www.un.org/millenniumgoals/

The 2000 Millennium Declaration

The Millennium Development Goals (MDGs)

1. Eradicate extreme poverty and hunger.
2. Achieve universal primary education.
3. Promote gender equality and empower women.
4. Reduce child mortality.
5. Improve maternal health.
6. Combat HIV/AIDS, malaria and other diseases.
7. Ensure environmental sustainability.
8. Develop a global partnership for development.

Helminths:
Trematoda - non-segmented flat worms

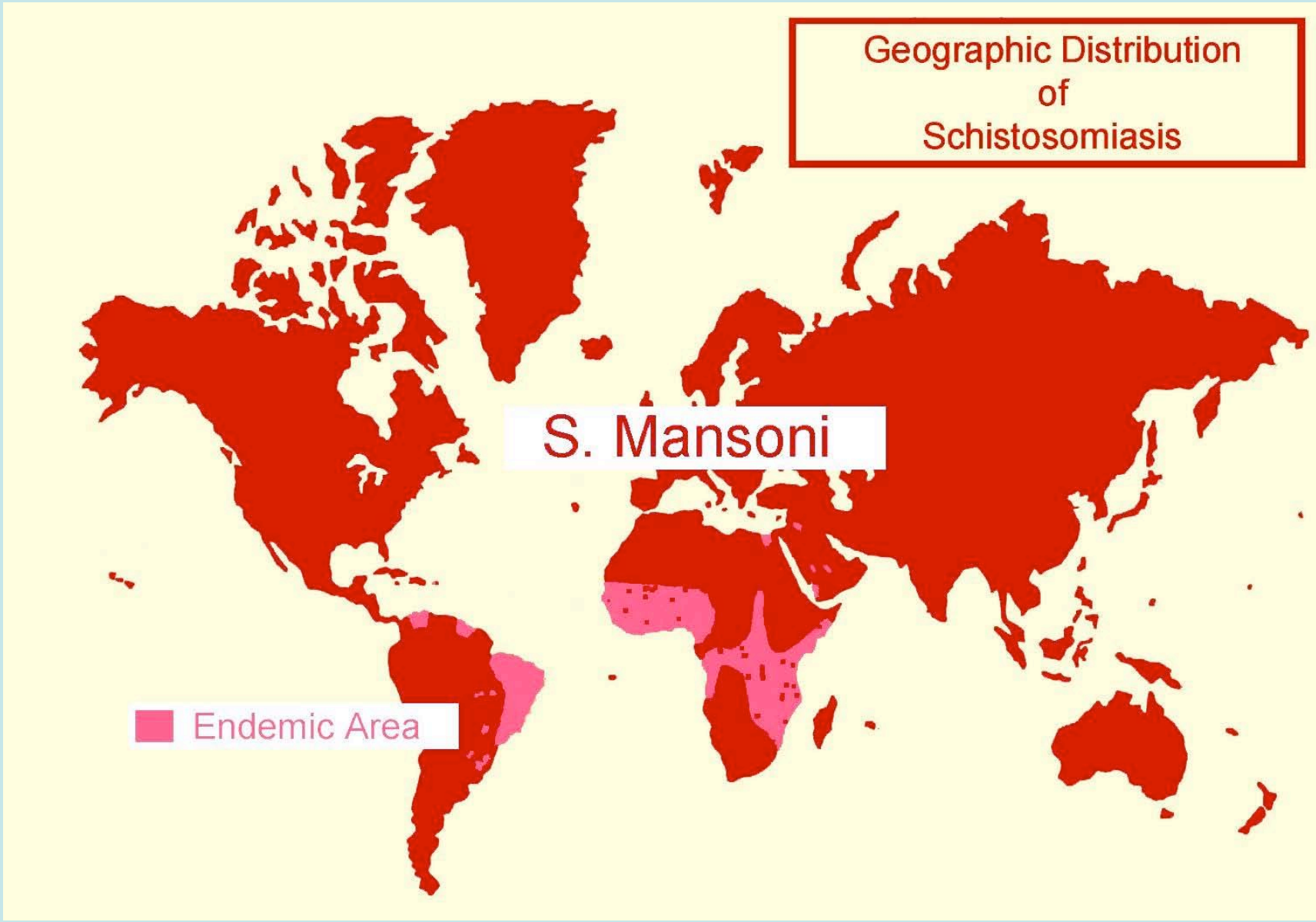
The schistosomes:

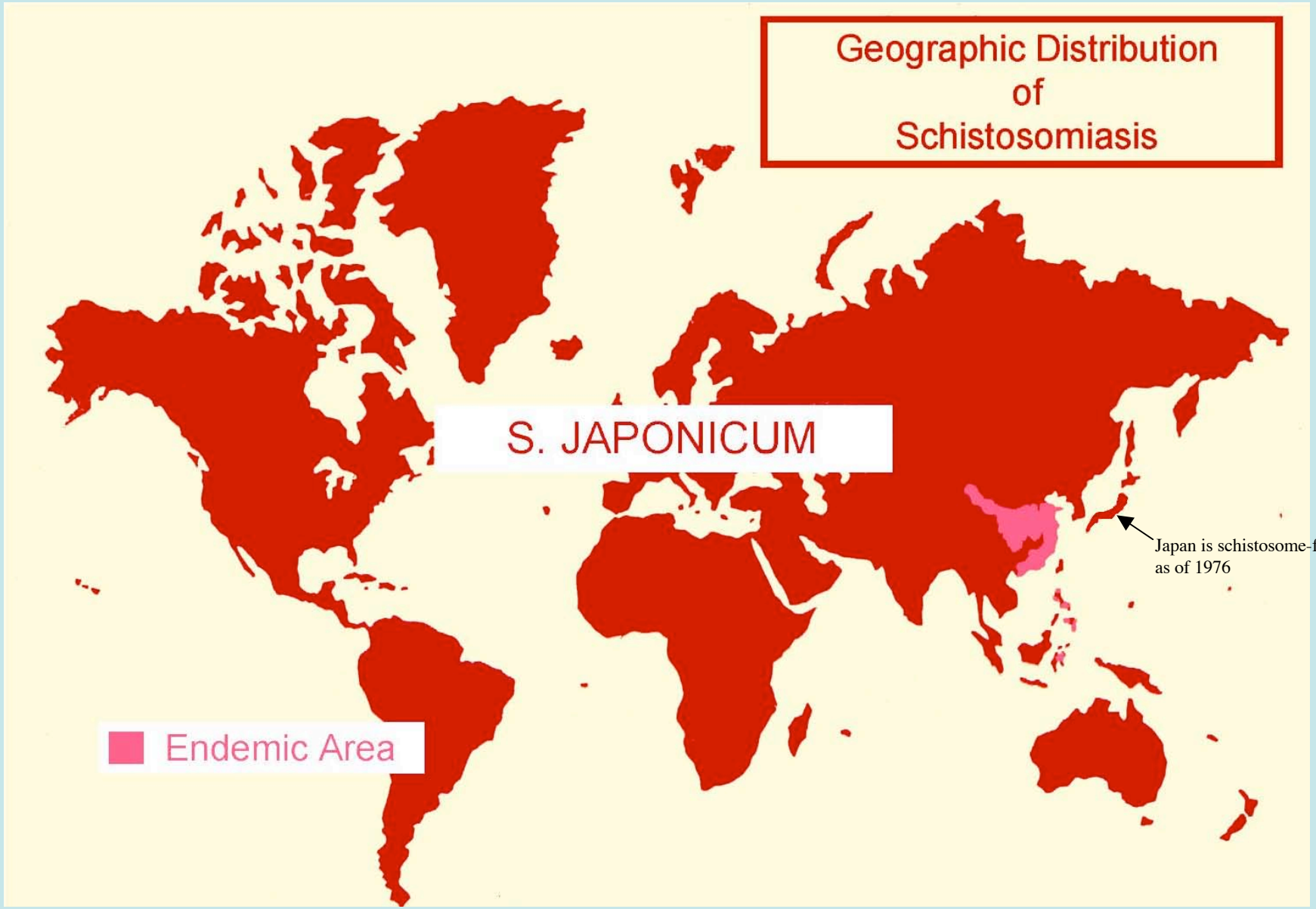
Schistosoma mansoni

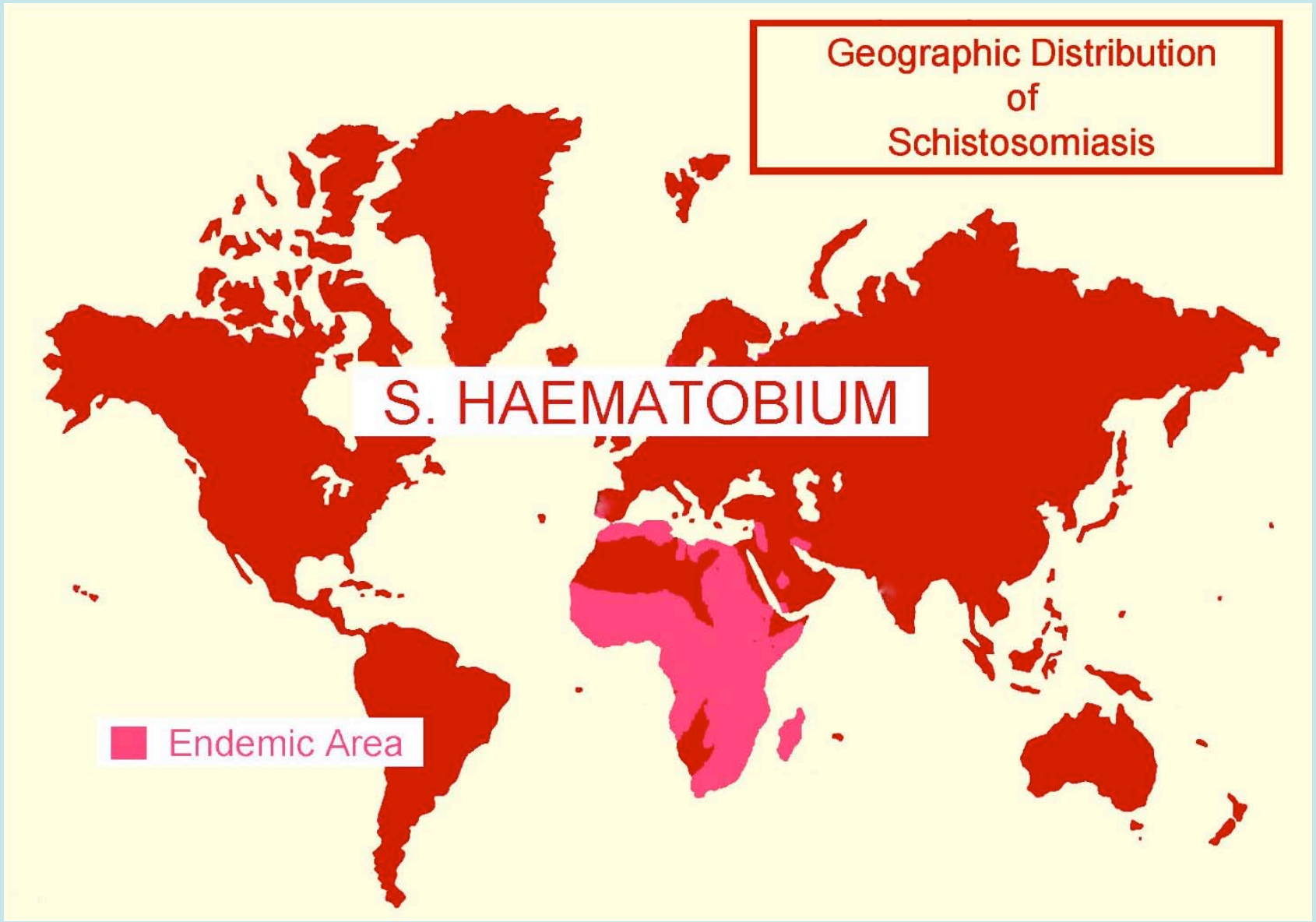
Schistosoma haematobium

Schistosoma japonicum

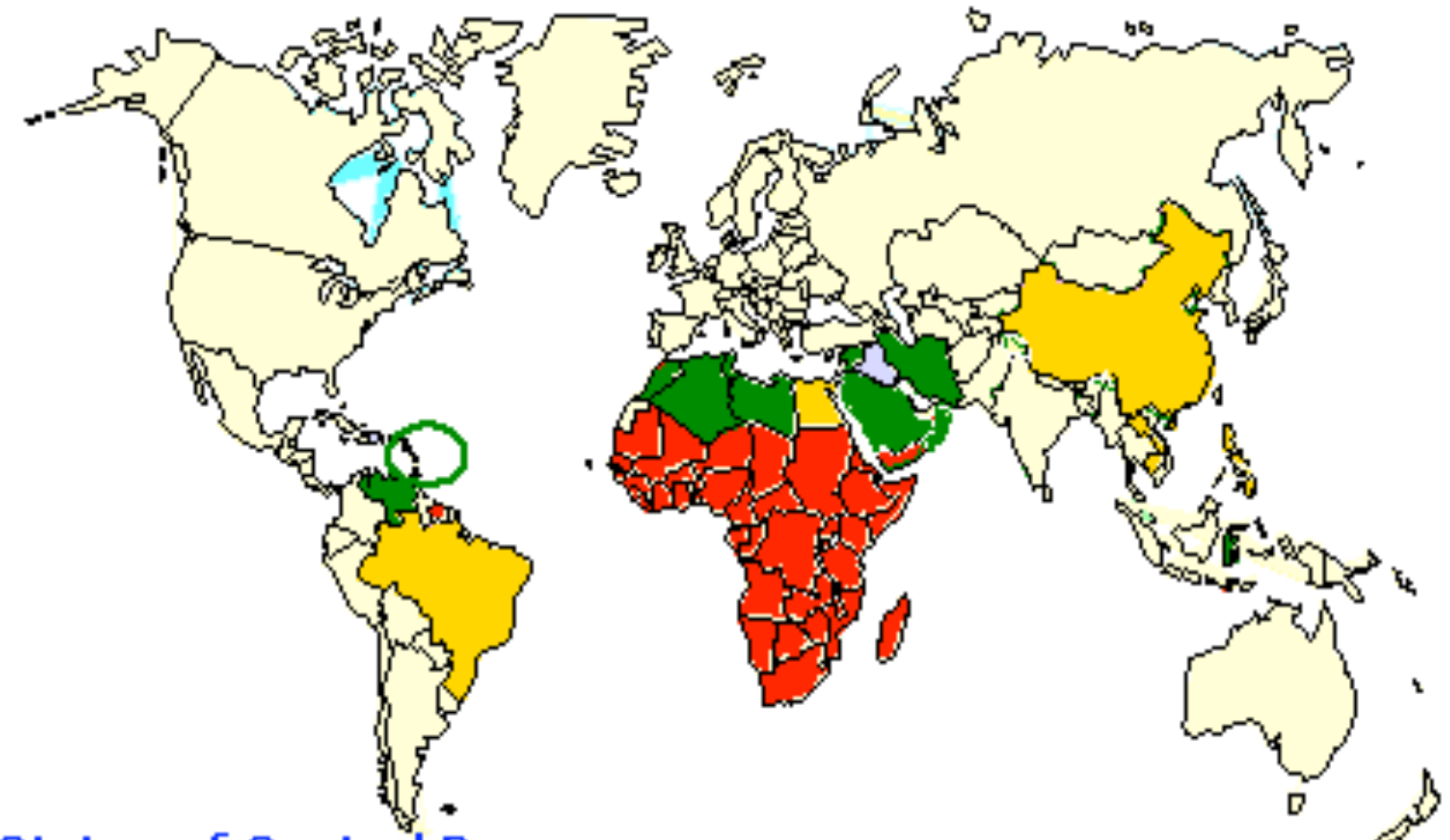
Schistosoma mekongi


Geographic Distribution
of
Schistosomiasis
S. Mansoni
Endemic Area


Geographic Distribution
of
Schistosomiasis
S. JAPONICUM
Japan is schistosome-free
as of 1976
Endemic Area


Geographic Distribution
of
Schistosomiasis
S. HAEMATOBIUM
Endemic Area

Global Distribution of Schistosomaisis



Status of Control Programs

- almost eradicated
- ongoing large-scale control programmes
- limited or no control

Source: WHO

"It's a *&^##@#*ing jungle out there!"

"Mr. Allnut, please! You must curtail your abuse of the English language!"

Simply by entering the water, these famous actors were at risk for acquiring Schistosomiasis.
Filming of "*The African Queen*" was done on location, Lake Victoria, Kenya.

Fishing and Bathing are High Risk in Endemic Zones

Science Times Tuesday, November 1, 2004

CASES WITHOUT BORDERS

At the Old Swimming Hole, a Vicious Cycle Thrives

By DONALD G. McNEIL Jr.

KWA'AL, Nigeria — The pond was about the size of a school swimming pool, except it was surrounded by dry mud pocked with hundreds of hoofprints.

A herd of goats was at one edge, drinking and defecating in the same spot. The sun was going down behind a thorn tree, backlighting 50 naked boys splashing one another in the warm dusk.

Where a colonialist romantic would have seen a landscape of native innocence, I saw a horror movie: there were worms in the brown water invisibly digging right through the boys' skin.

Kwa'al is a market village that exists only because the region's red dirt tracks meet a paved road here. Each morning, women walk in with sacks on their heads: potatoes, onions and cabbages that they pile by the road, hoping to earn $3 or so. It is rural and traditional; a nearby village is famous for the dogs it raises for meat.

Kwa'al is also a "schisto village." A third of its children have blood in their urine because of schistosomiasis, a parasitic disease transmitted by water snails. Also known as bilharzia, it is the second most common tropical disease in Africa, after malaria. Stuck to the mud wall of a building is a Health Ministry poster showing a silhouette of a squatting boy staring down, troubled, at the scarlet stream running out of him.

The blood is just a red flag for the real problem: children with heavy infestations of the worms, known as schistosomes, are stunted and do poorly in school.

An hour in Kwa'al is a mural of parasitology: a living schematic of how the life cycle of a human boy intersects the life cycle of a

For the boys, parasites in the water mean blood in the urine.

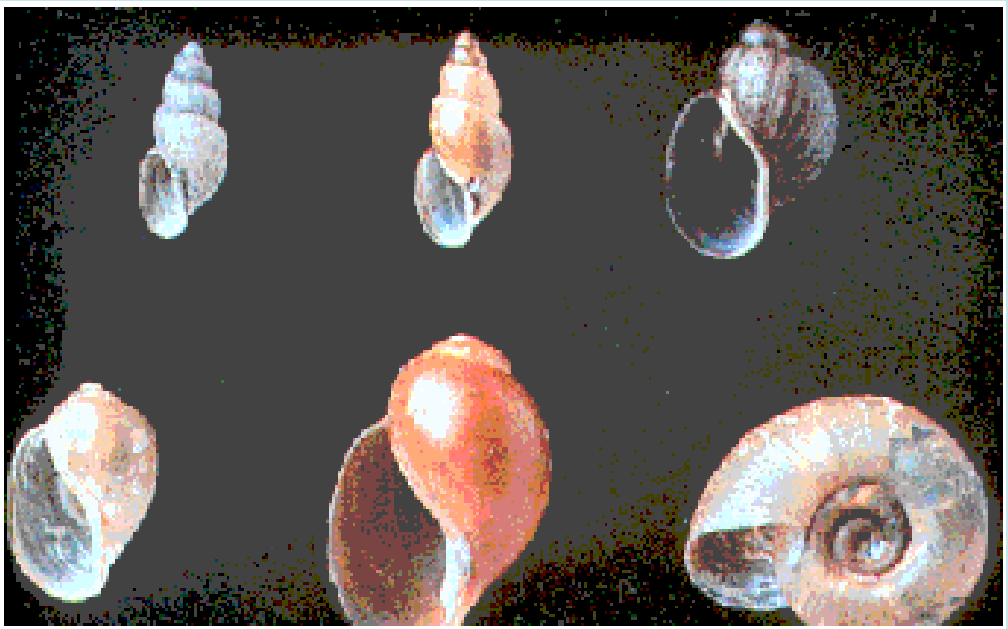
Photographs by Vanessa Vick for The New York Times

Children in Kwa'al, Nigeria, waited to be measured and then were given a dose of the deworming drug praziquantel according to their height. They are infected by swimming in contaminated water.

of his finger in.

"You can't keep a kid from urinating when he swims," he explained. "The eggs are in the urine. They infect the snails and develop into a form that invades human skin — a sharp head and a tail, sort of like a sperm. The head goes in, the tail snaps off, and it sets up shop in the human. Then, when it releases its eggs, they burrow their way

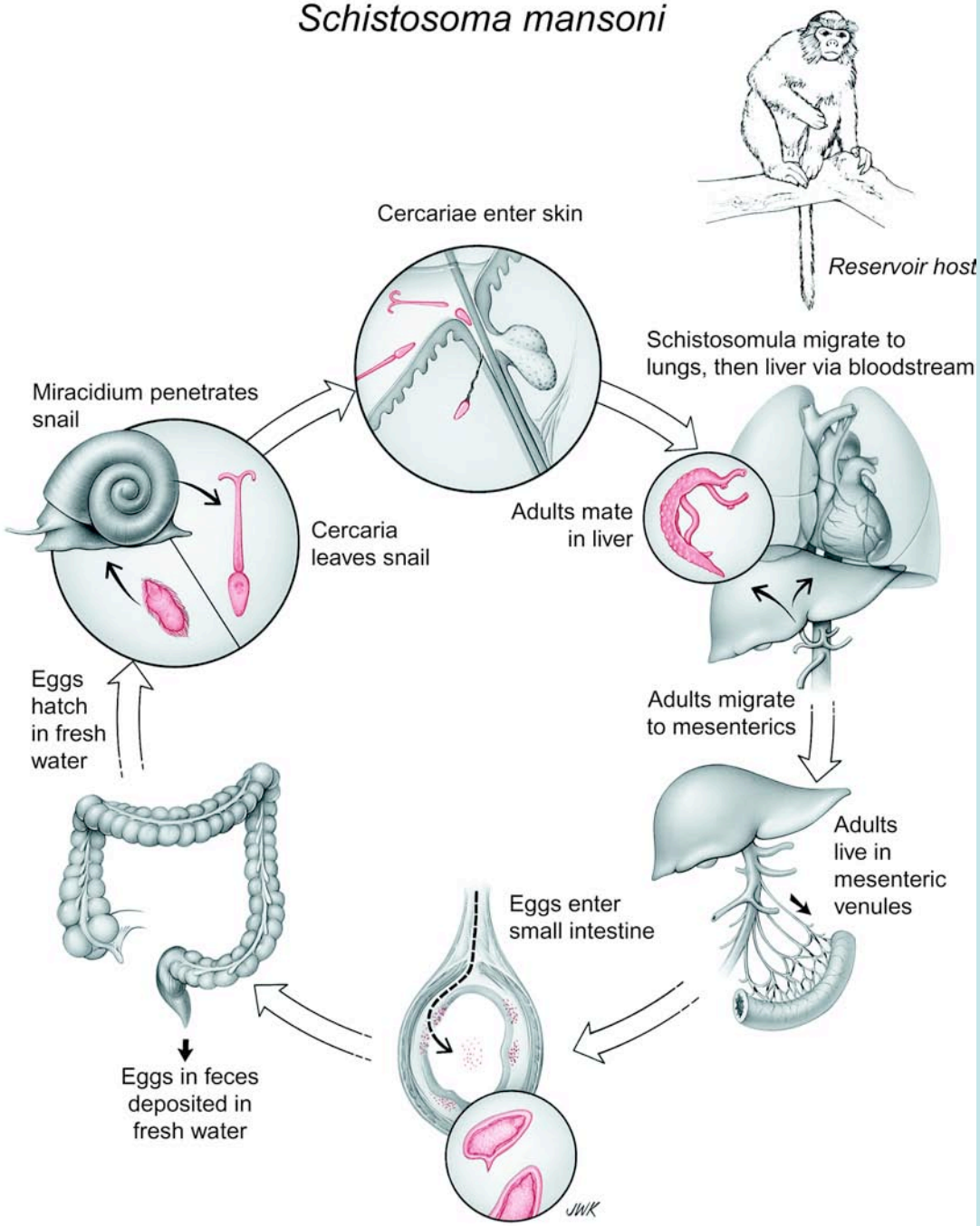
Aquatic freshwater snails are the intermediate hosts for all species of schistosomes



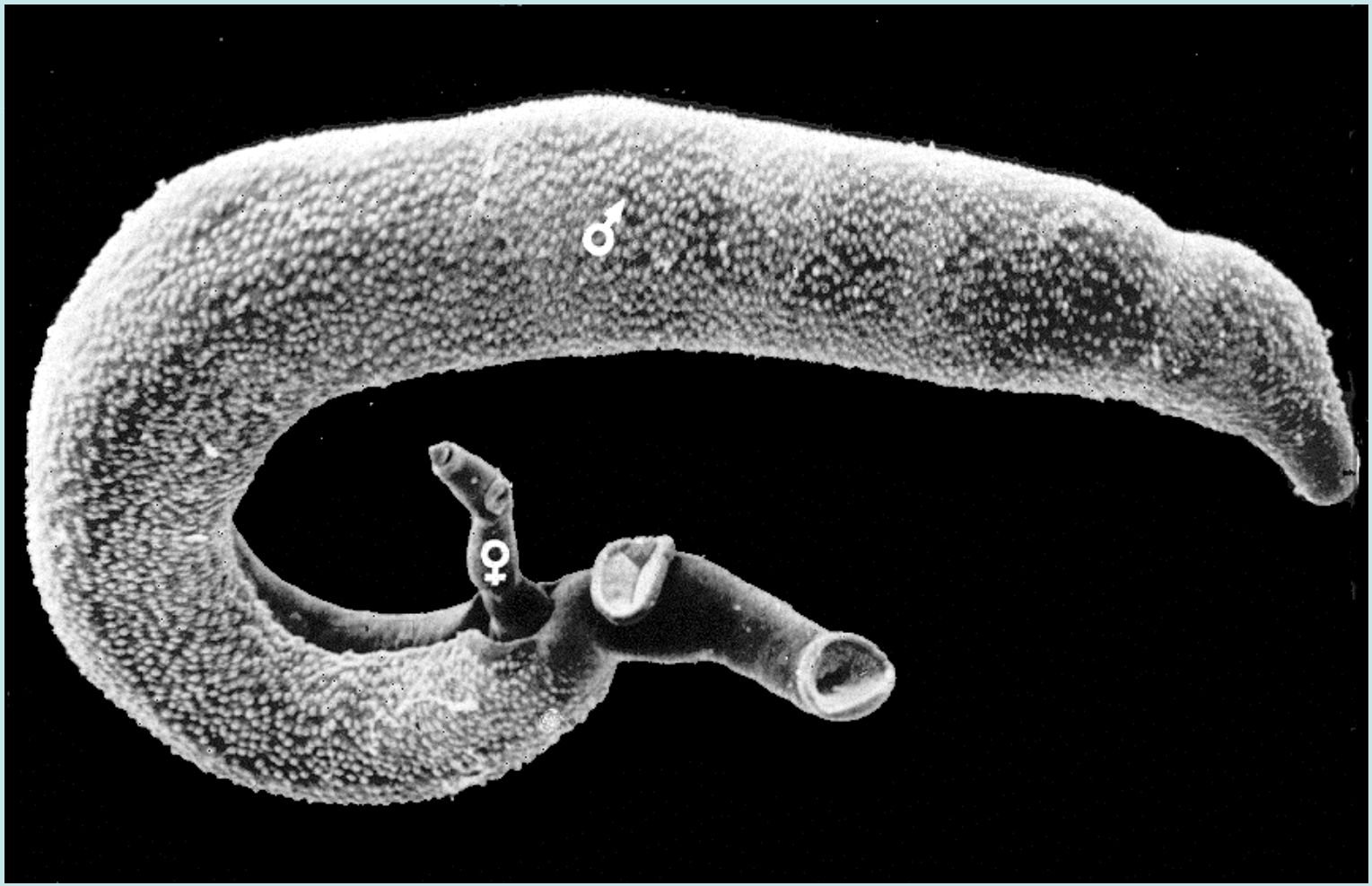
Schistosoma mansoni

Schistosoma japonicum

Schistosoma mansoni



Adult male and female *Schistosoma mansoni*



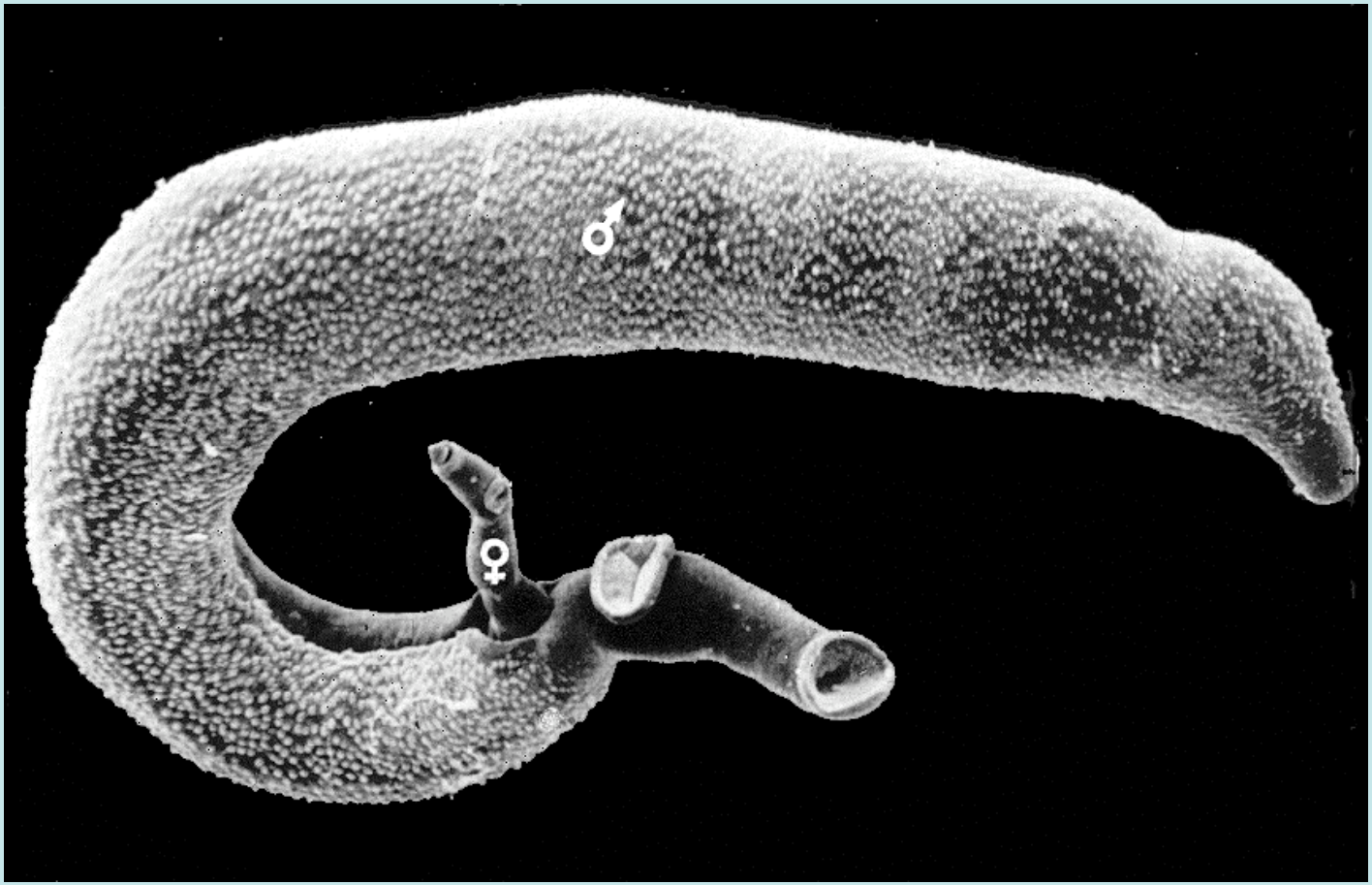
One Effective Evolutionary Strategy for Survival: Camouflage

□ ecora□d Crab

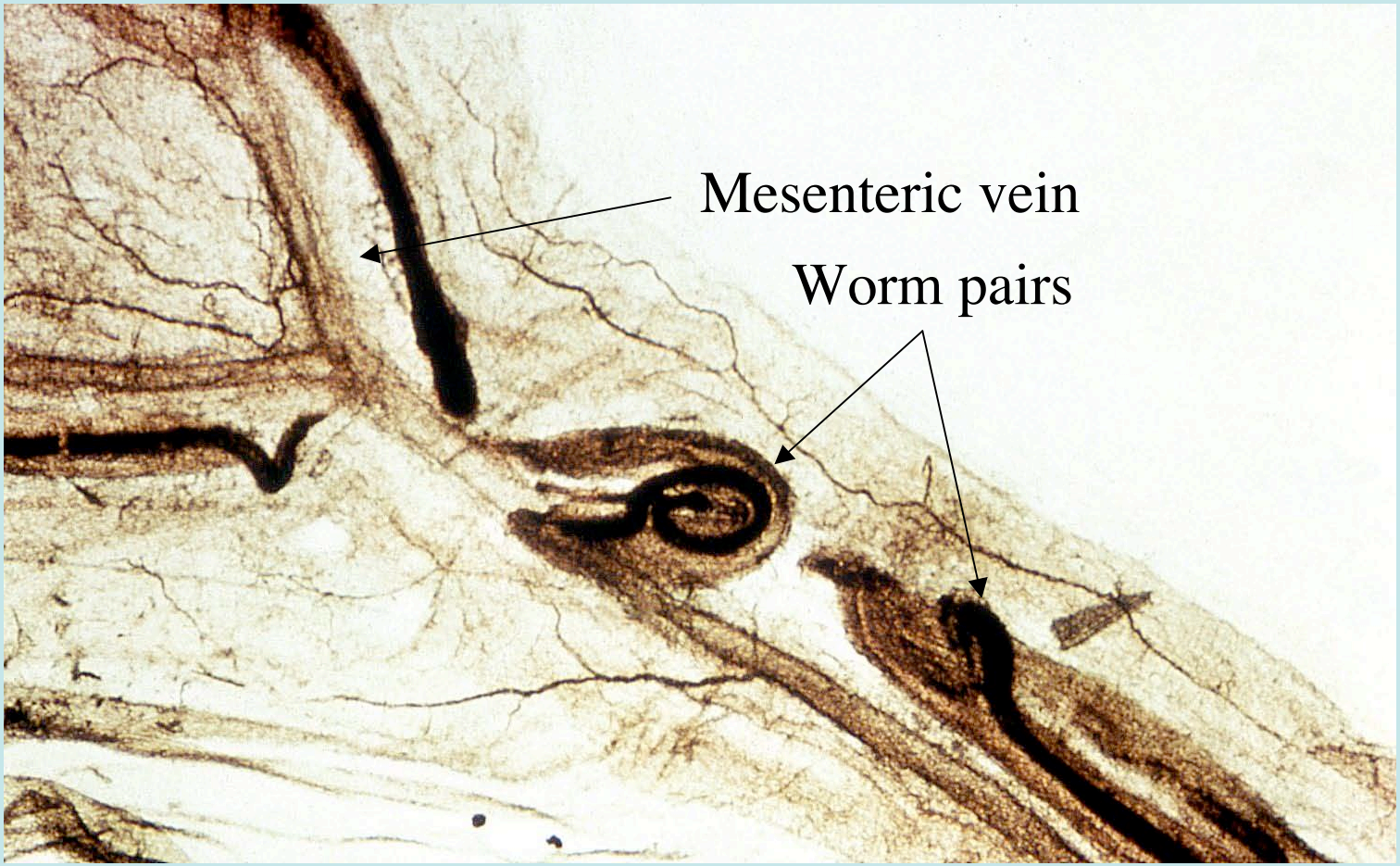
□raying Man□□

□argasso Sea Hors□

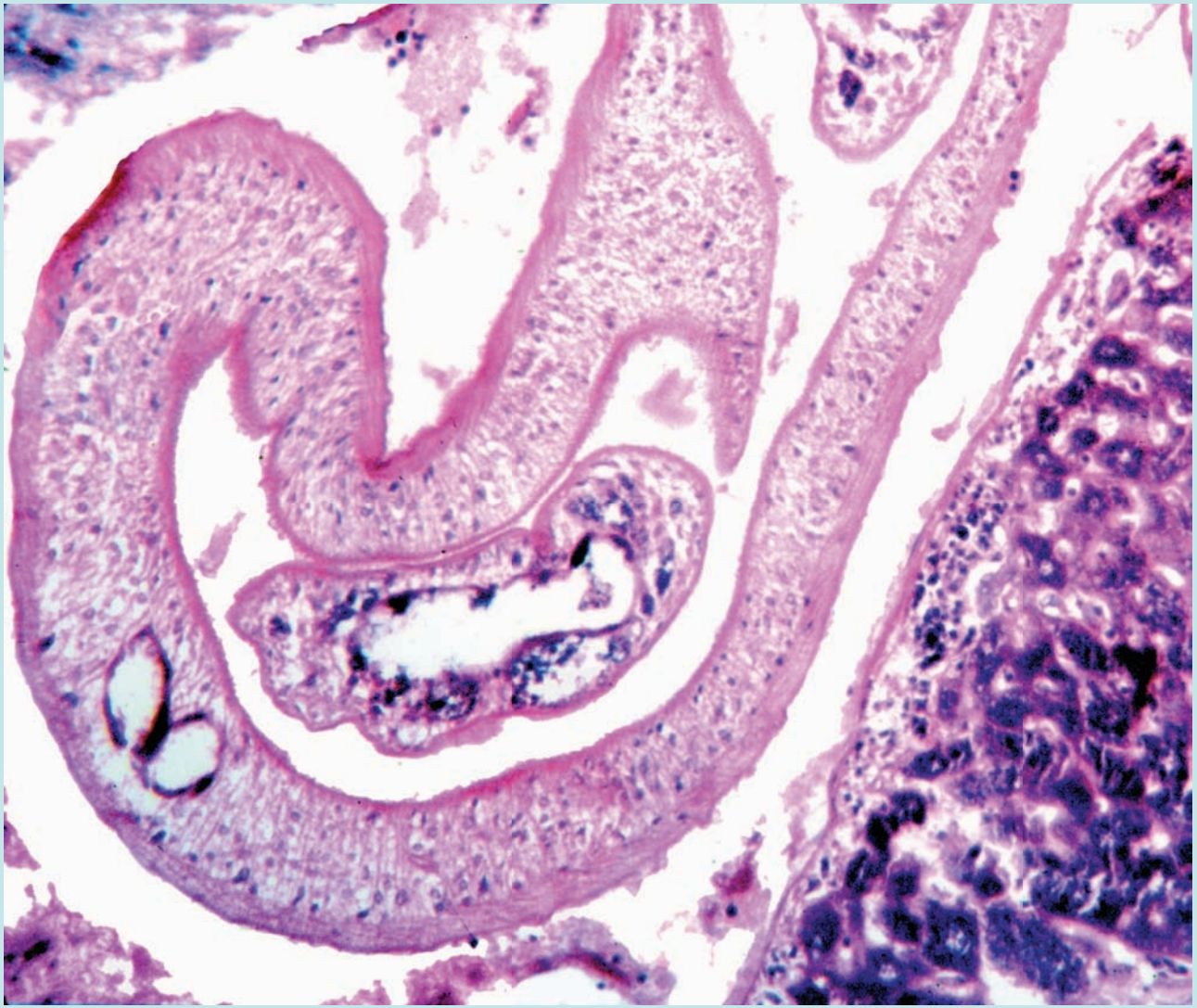
Schistosome adults live up to 20 years in the bloodstream and avoid immune attack employing a unique set of molecular mechanisms. One scheme employs host serum proteins on the tegumental surface as camouflage, much the same way as the decorated crab uses coral. If we could unravel the molecular mechanism(s) as to how schistosomes accomplish this astounding feat, perhaps we could eventually learn to transplant heterologous tissues at will!



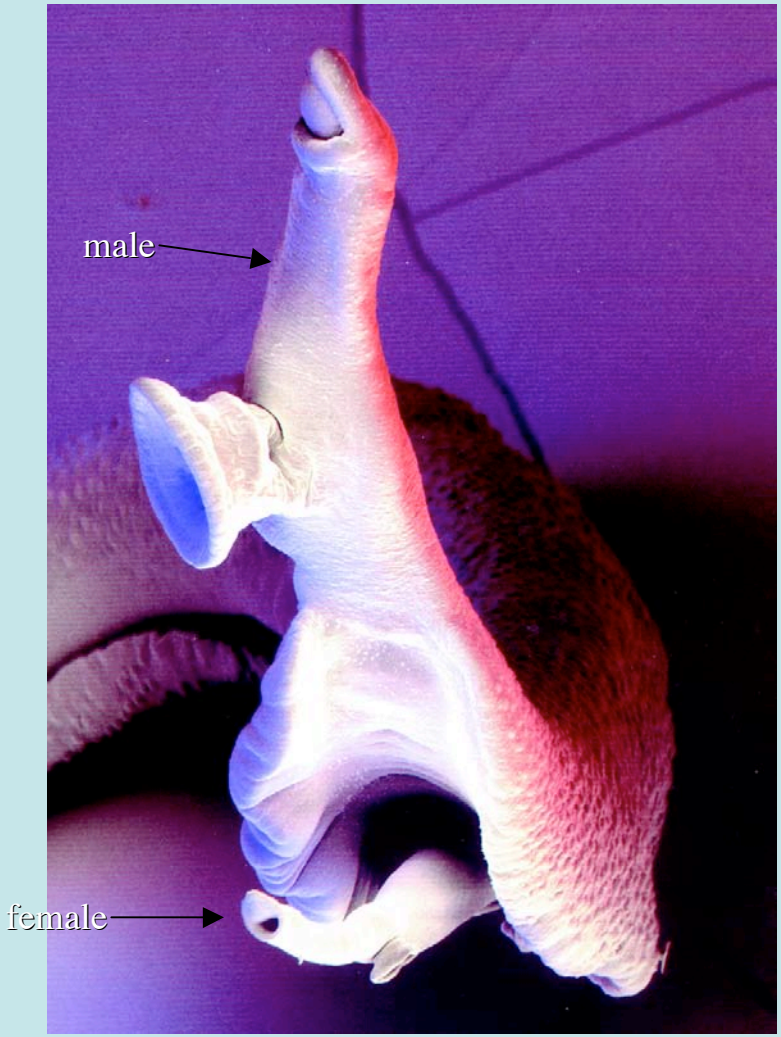
Schistosoma mansoni in situ



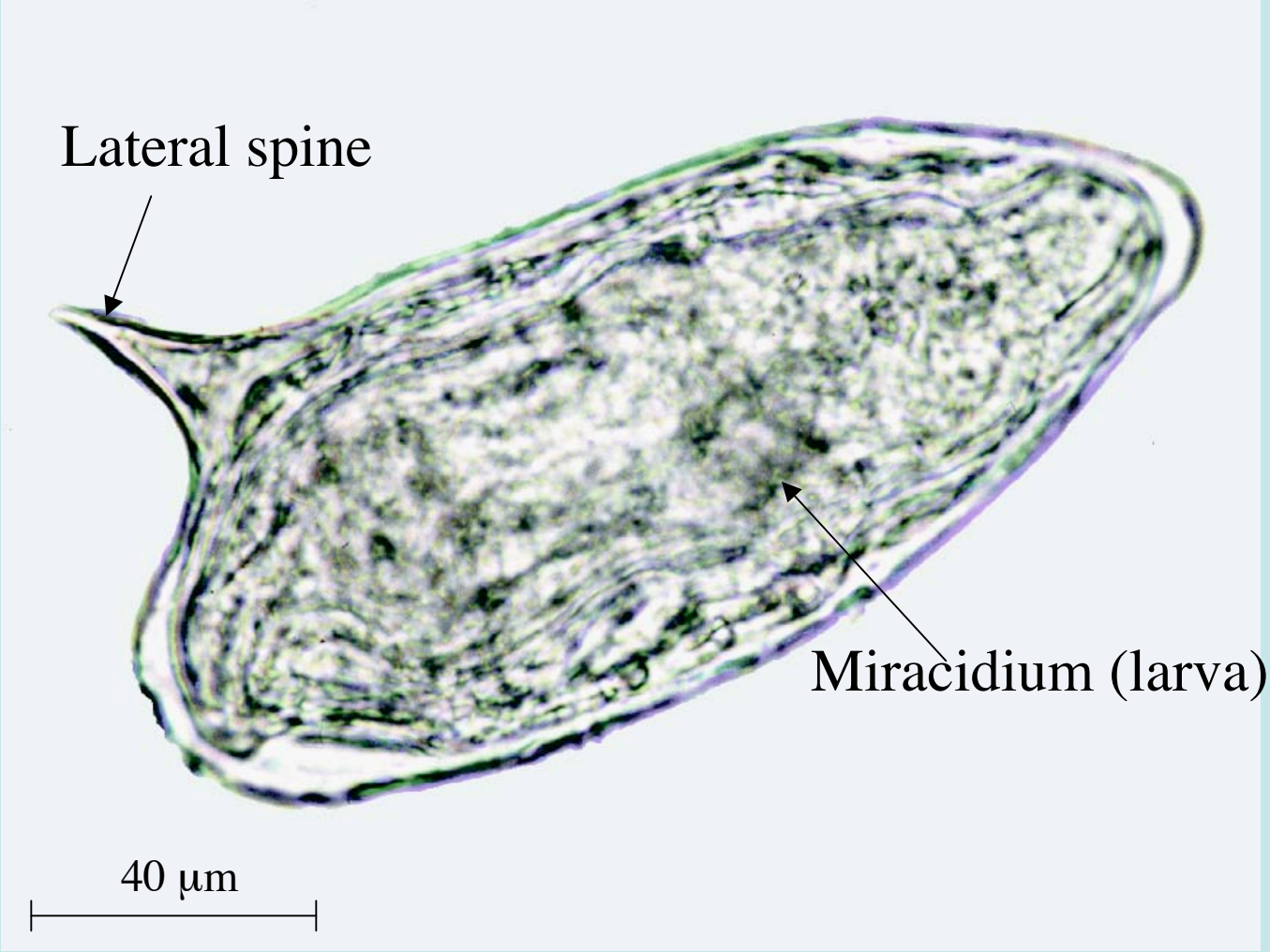
Cross section of a pair of adult schistosomes in situ in a mesenteric venule



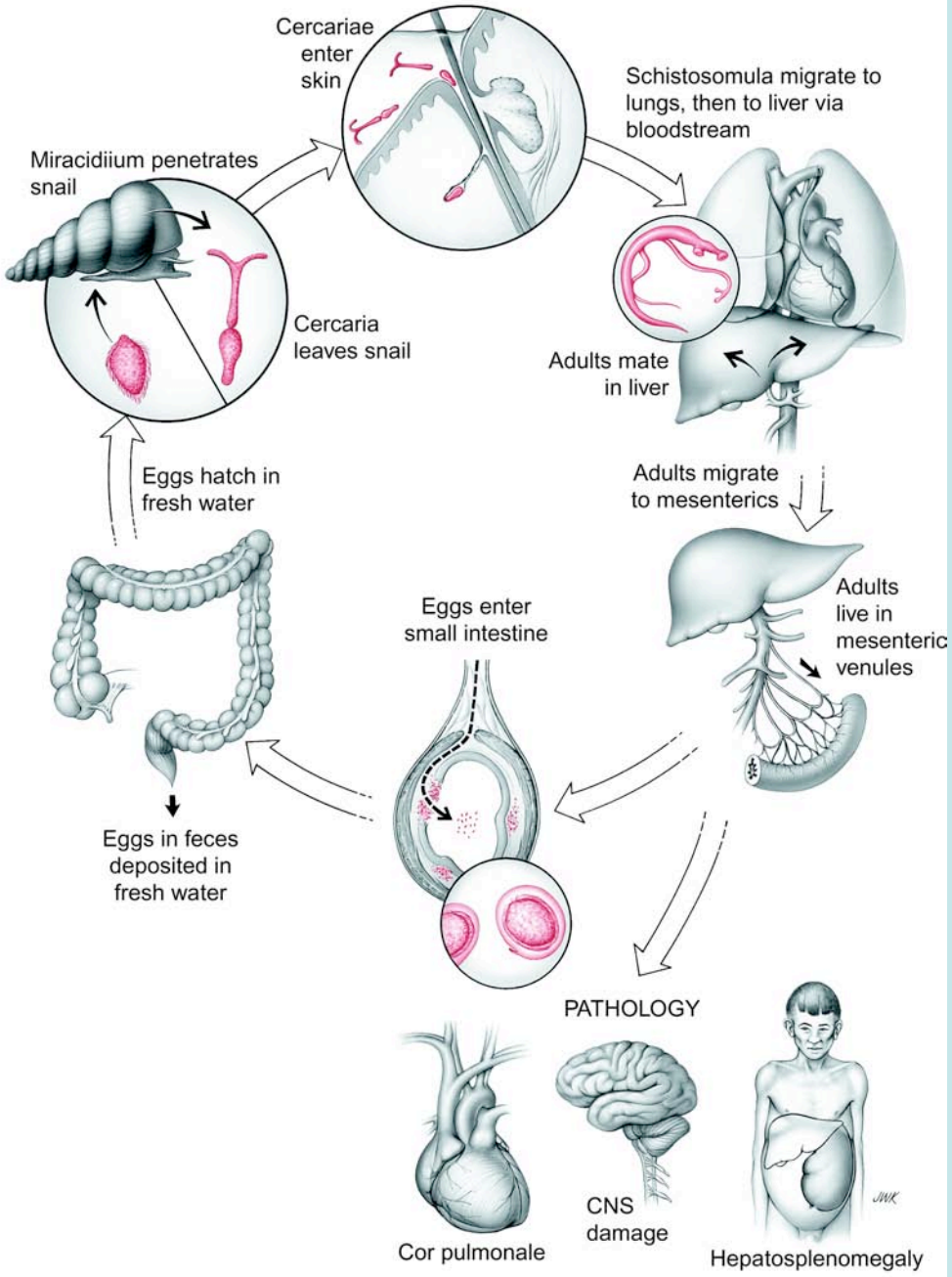
Female lies within gynecophoral canal. *S.mansoni* 300 eggs / day



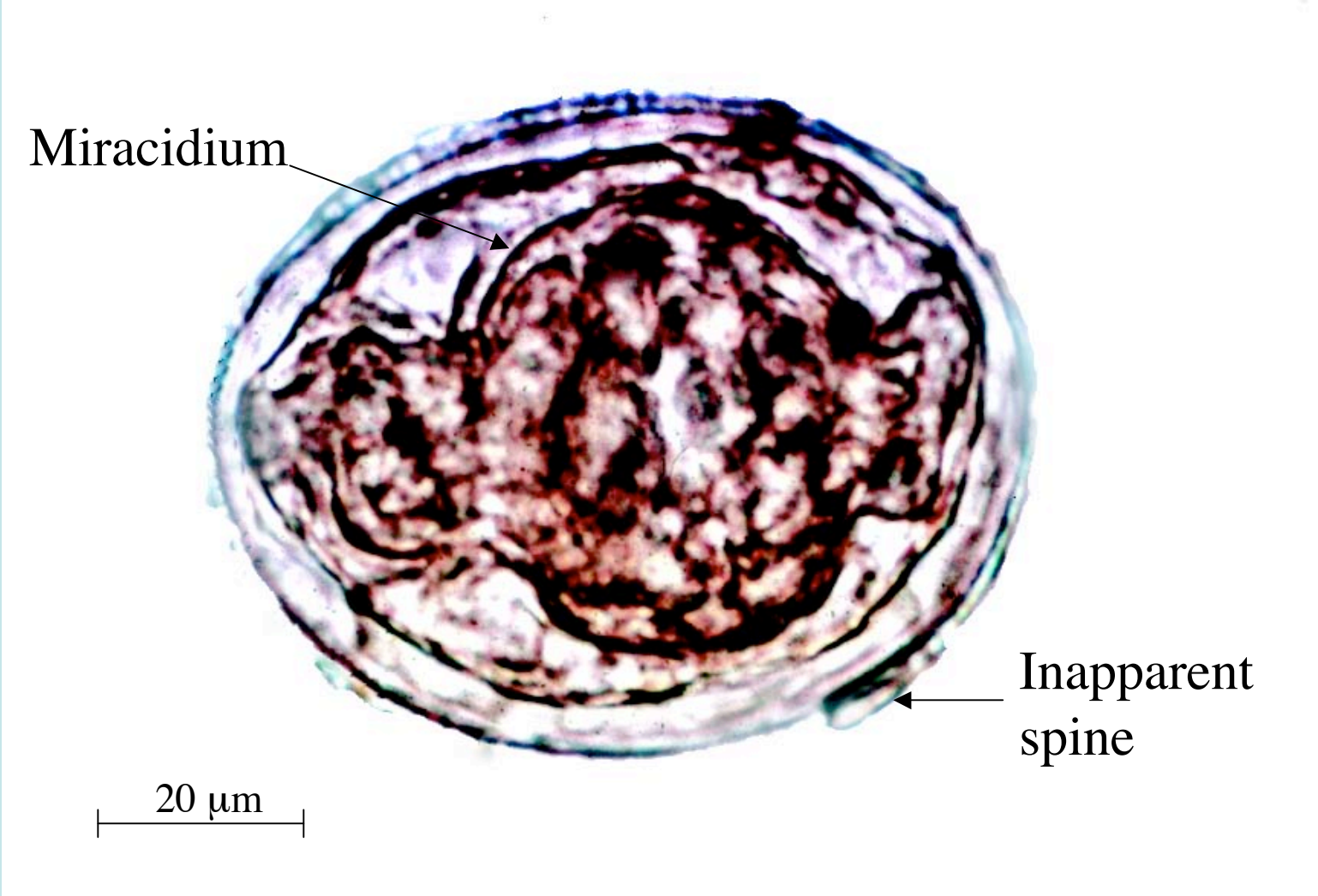
Embryonated egg of *Schistosoma mansoni*



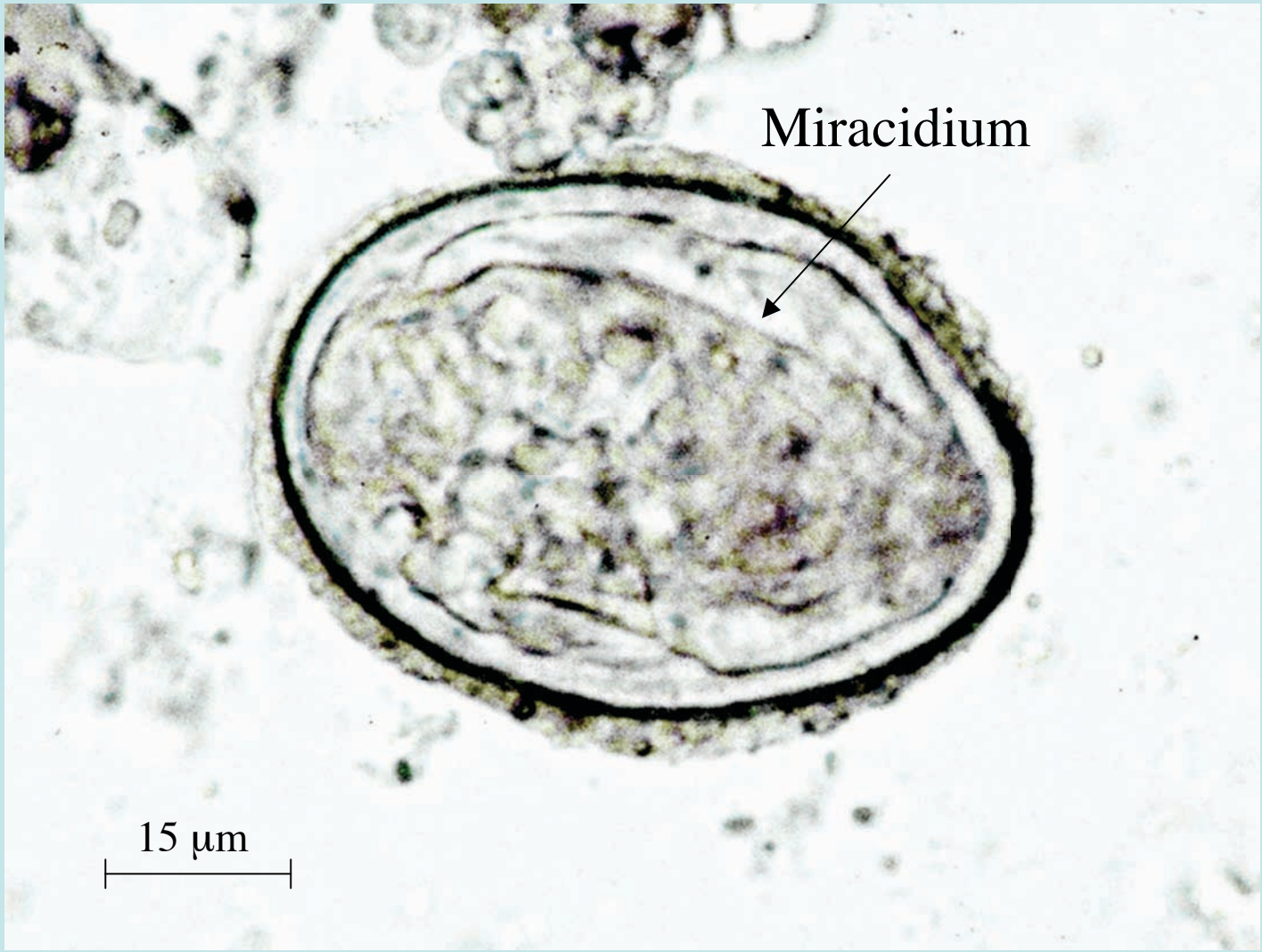
Schistosoma japonicum



Embryonated egg of *Schistosoma japonicum*

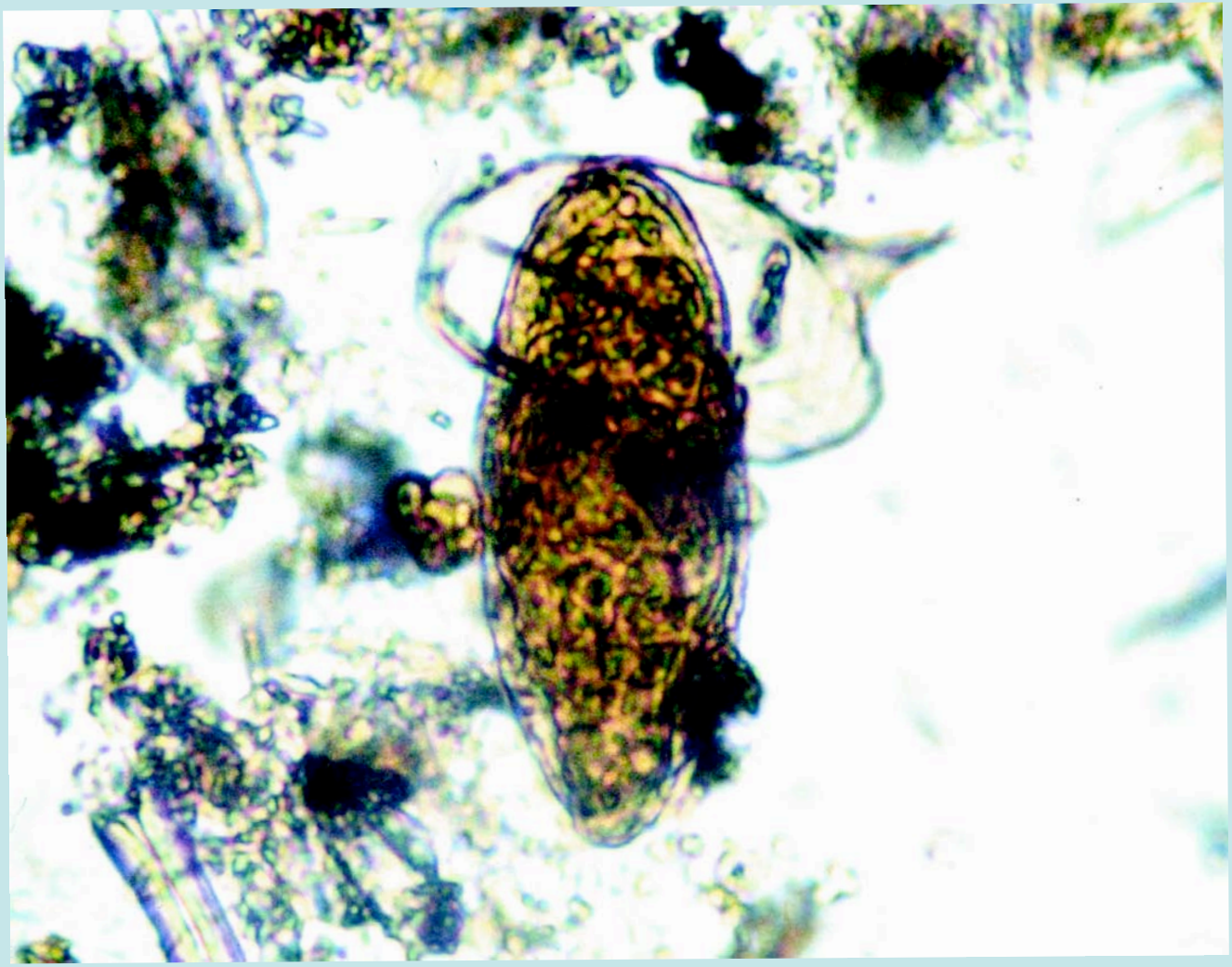


Embryonated egg of *Schistosoma mekongi*



Biomphilaria glabrata, the most common intermediate snail host for *Schistosoma mansoni*

Miracidium of *Schistosoma mansoni*
caught in the act of hatching



Miracidium of *Schistosoma mansoni*

SEM of a cercaria of *Schistosoma mansoni*

Photo: D. Scharf

Oncomelania nosophora, a snail intermediate host for *Schistosoma japonicum*

Pathogenesis caused by eggs:

1. Miracidium inside egg in small intestine releases proteases, dissolves tissues, induces bleeding and diarrhea.

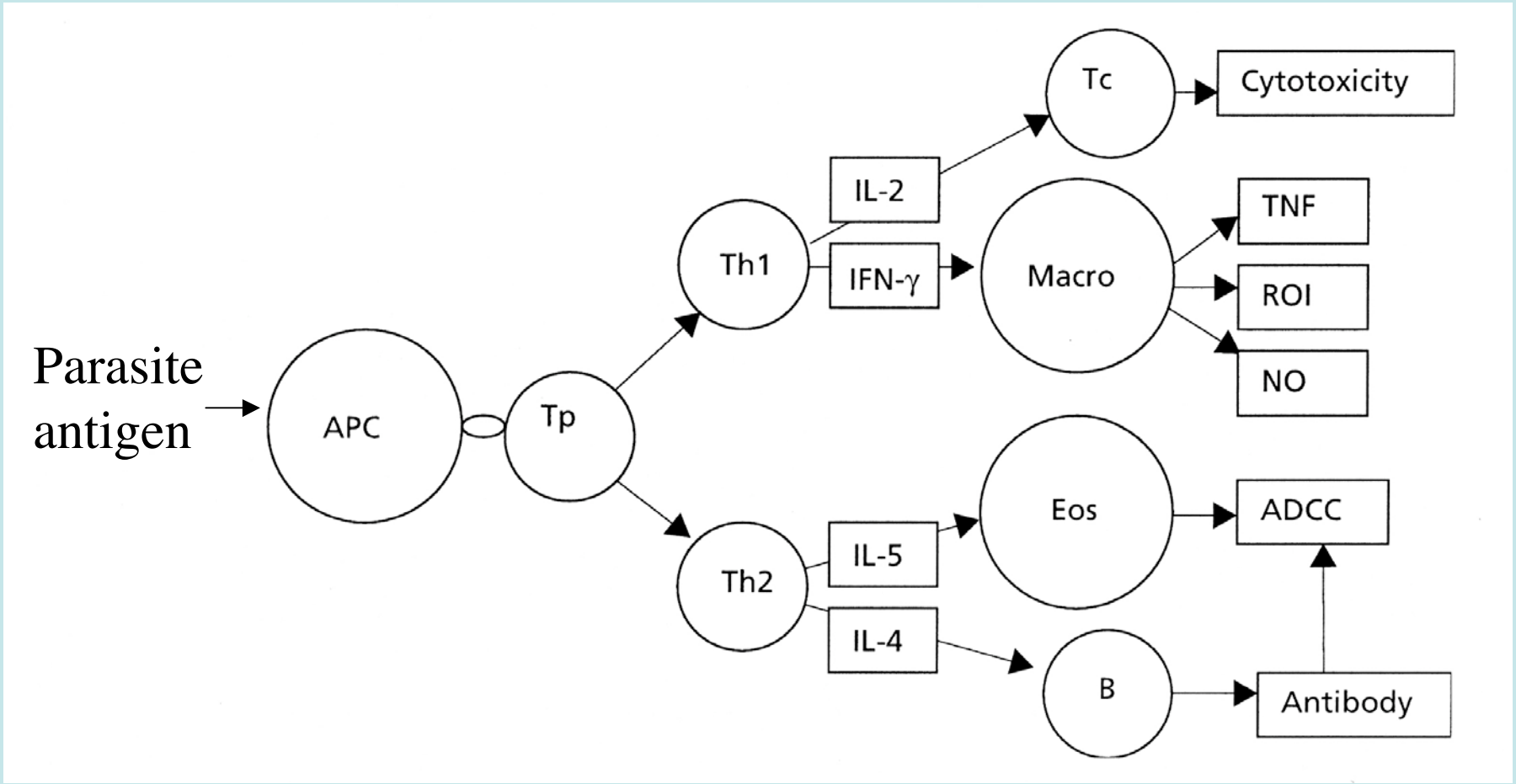
2. Eggs (50% of those produced) wash back into liver, lodge in pre-sinusoidal capillaries, eventually block flow of blood.

3. Blockage of portal circulation results in portal hypertension.

4. Portal hypertension leads to induction of embryonic circulatory paths, eggs then by-pass liver. Toxic brain syndrome may ensue.

5. Adults avoid immune detection by:
    a. camouflage strategy, incorporating host serum proteins on tegumental surface.
    b. synthesizing β-2 microglobulin-like molecule on tegumental surface.

Immunity and Schistosomiasis



Th2 protective immune responses and IgE. Down-regulated Th1 response increase susceptibility to other Infectious Diseases eg HIV

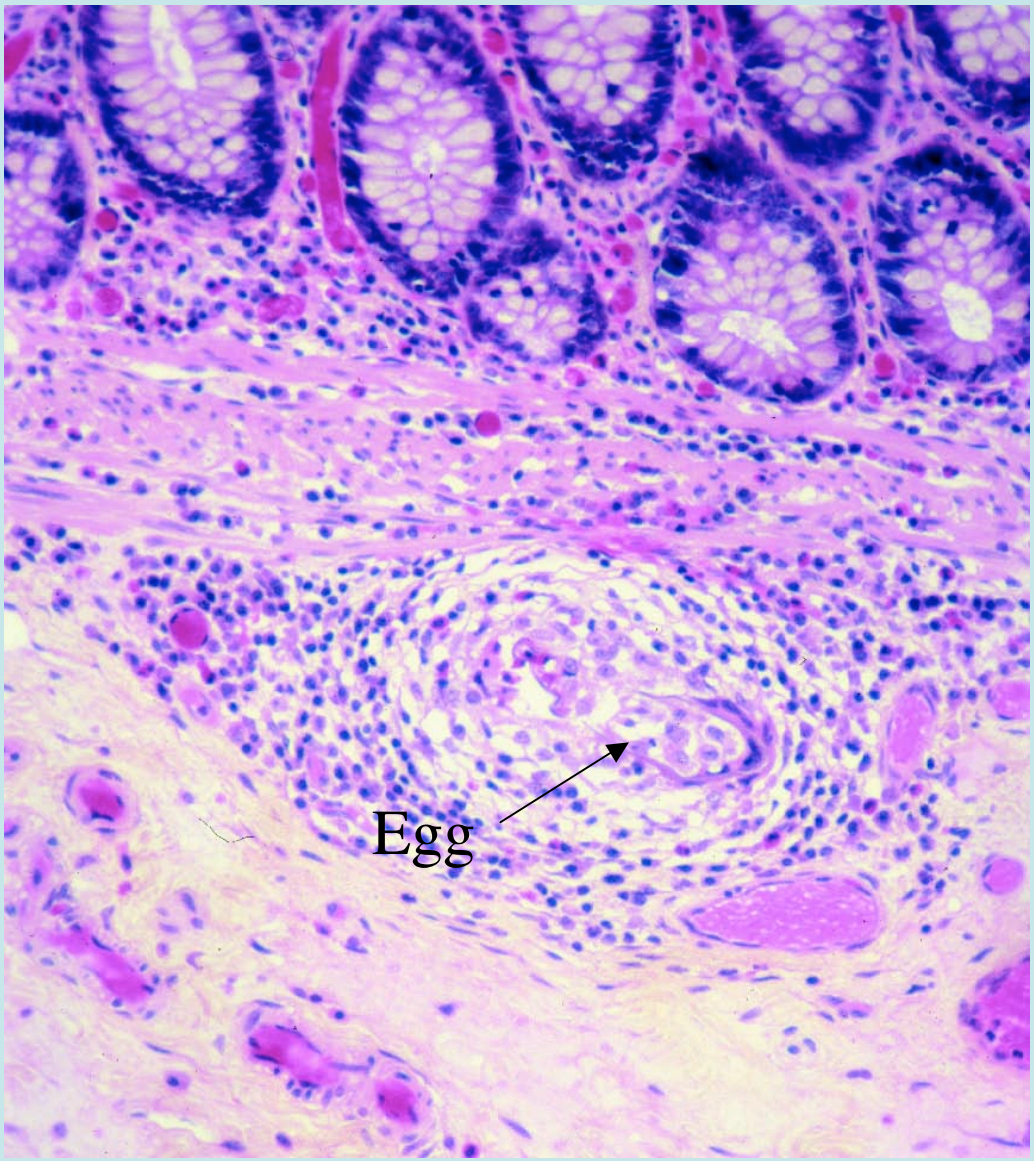
Population Genetics of Susceptibility

Caatinga do Moura (Brazil)

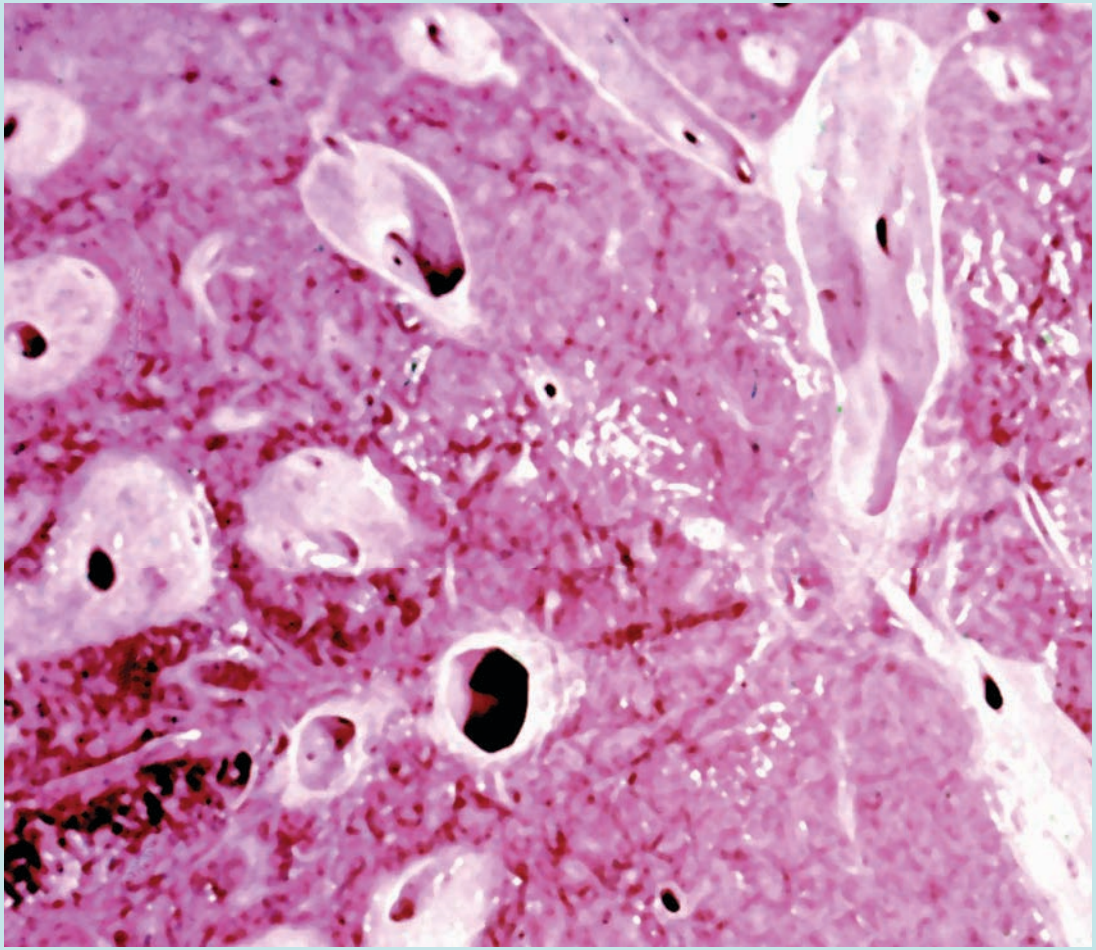
Worm pairs	Children
1	13
3	8
4	5
6	4
7	1
9	2
13	1
15	1
72	1

More worms correlated with increased egg production and pathology

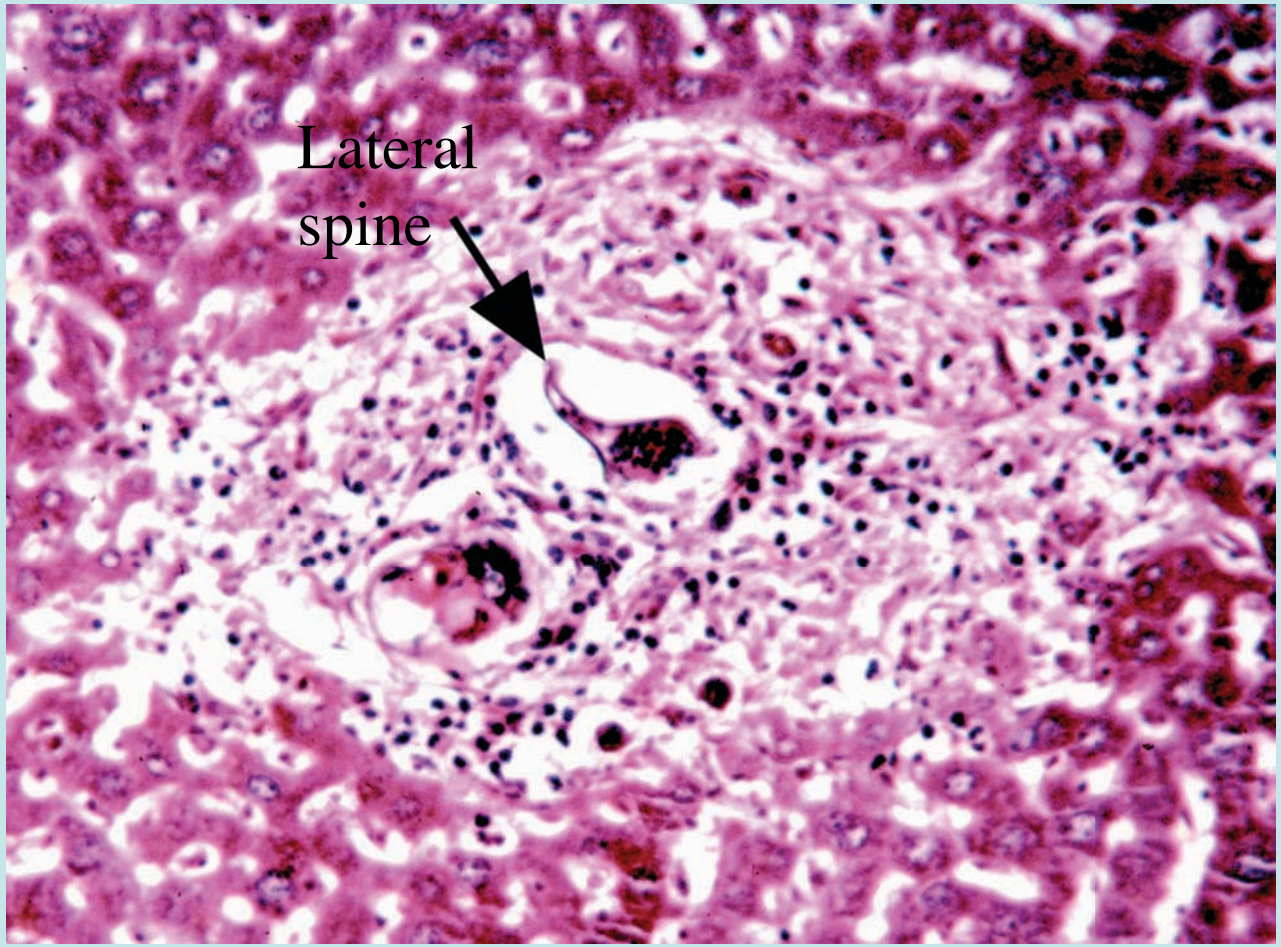
Schistosome egg in tissue of the small intestine. Note intense granuloma



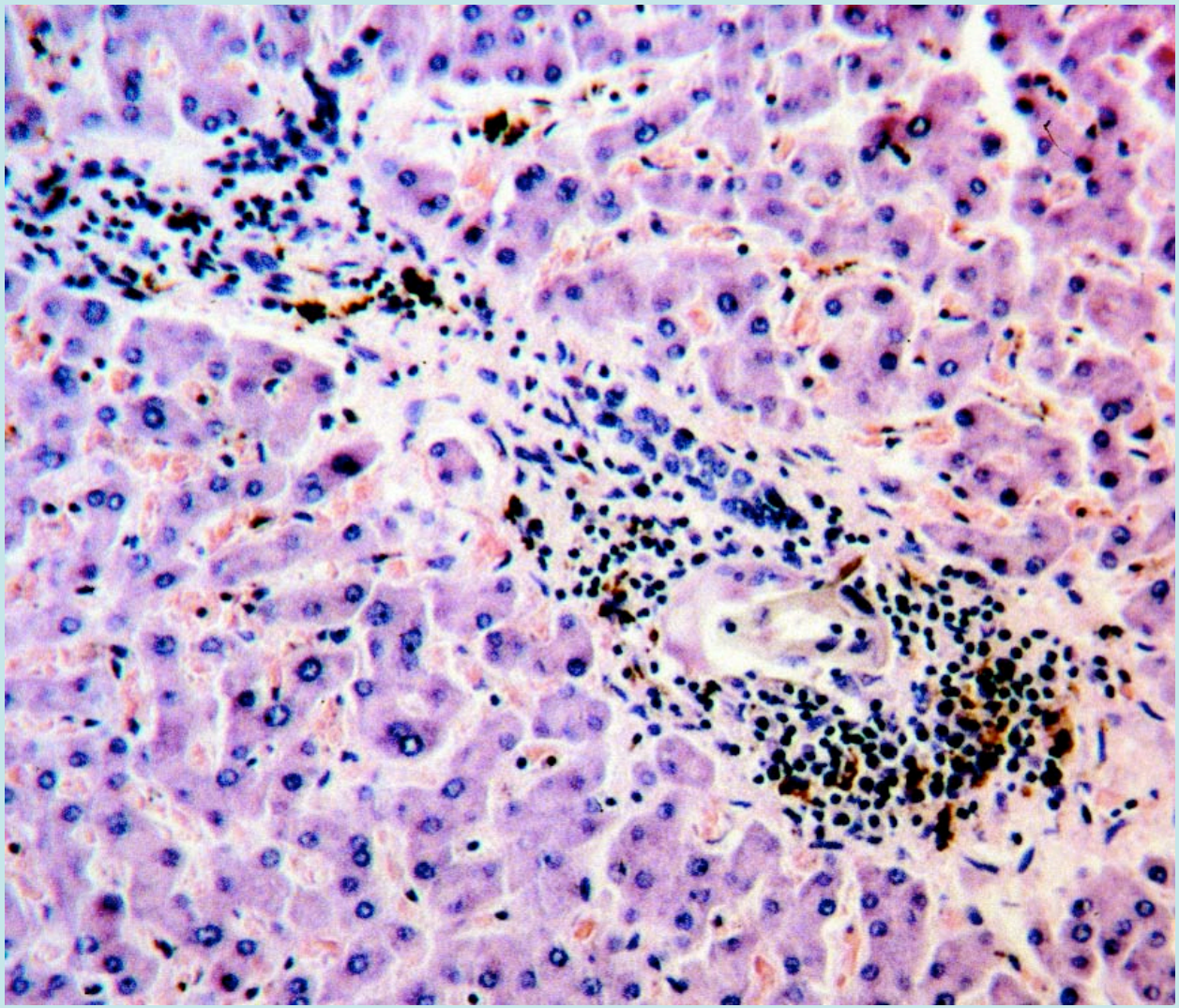
Pipe stem fibrosis in liver due to heavy infection with *Schistosoma mansoni*. Note normal liver tissue next to fibrotic vessels



Granuloma in liver surrounding eggs of *Schistosoma mansoni*



Granuloma surrounding an egg of *Schistosoma mansoni* in liver tissue



Clinical Disease:

Acute Phase

1. "Katayama Fever"
2. Paralysis
3. CNS involvement

Chronic Phase

1. GI bleeding and diarrhea
2. Portal hypertension due to blockage of pre-sinusoidal capillaries
3. Esophageal varices
4. Ascites
5. Rupture of varices, bleeding, death
6. *Cor pulmonale*, right side heart failure, death
7. Toxic brain syndrome

Diagnosis:

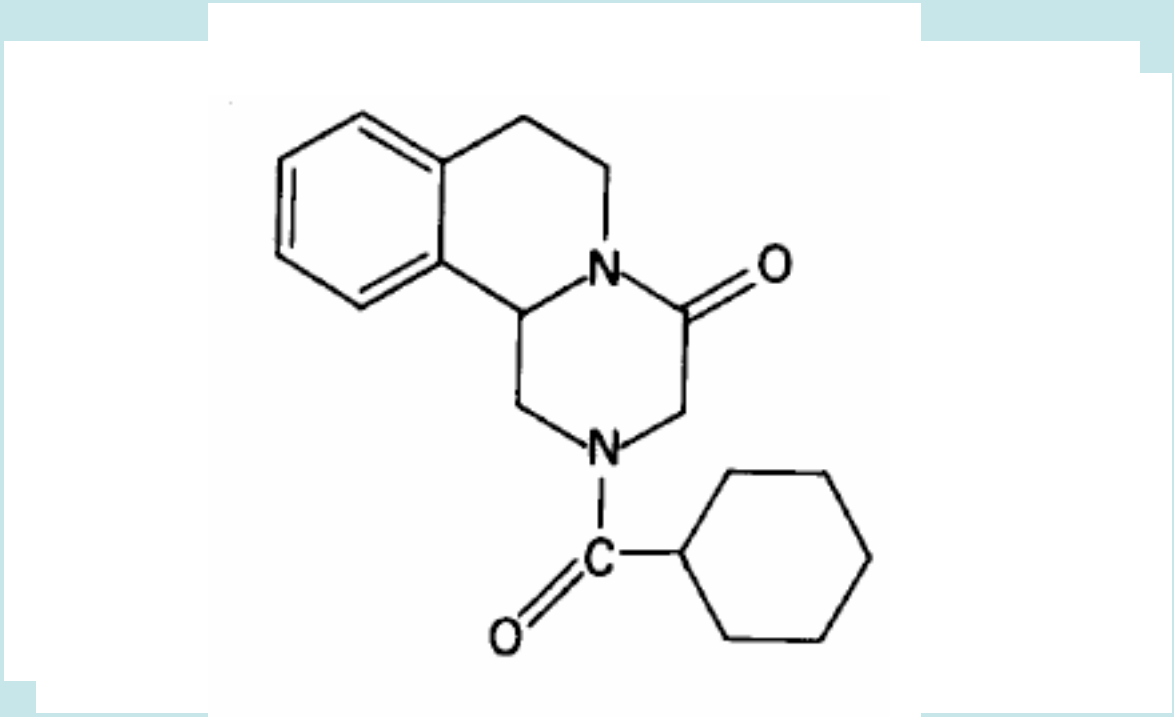
1. Microscopic examination of feces, urine, rectal "snip" for eggs.

2. Capture ELISA for detecting circulating antigens (experimental).

3. Serological tests (e.g., ELISA): indirect measure of exposure, not active disease.

Biopsy of rectal tissue revealing eggs of *Schistosoma mansoni*

Drug of Choice:
Praziquantel



Mode of Action:

Interferes with Ca^{2+} ion channels, leads to disrupted tegument.

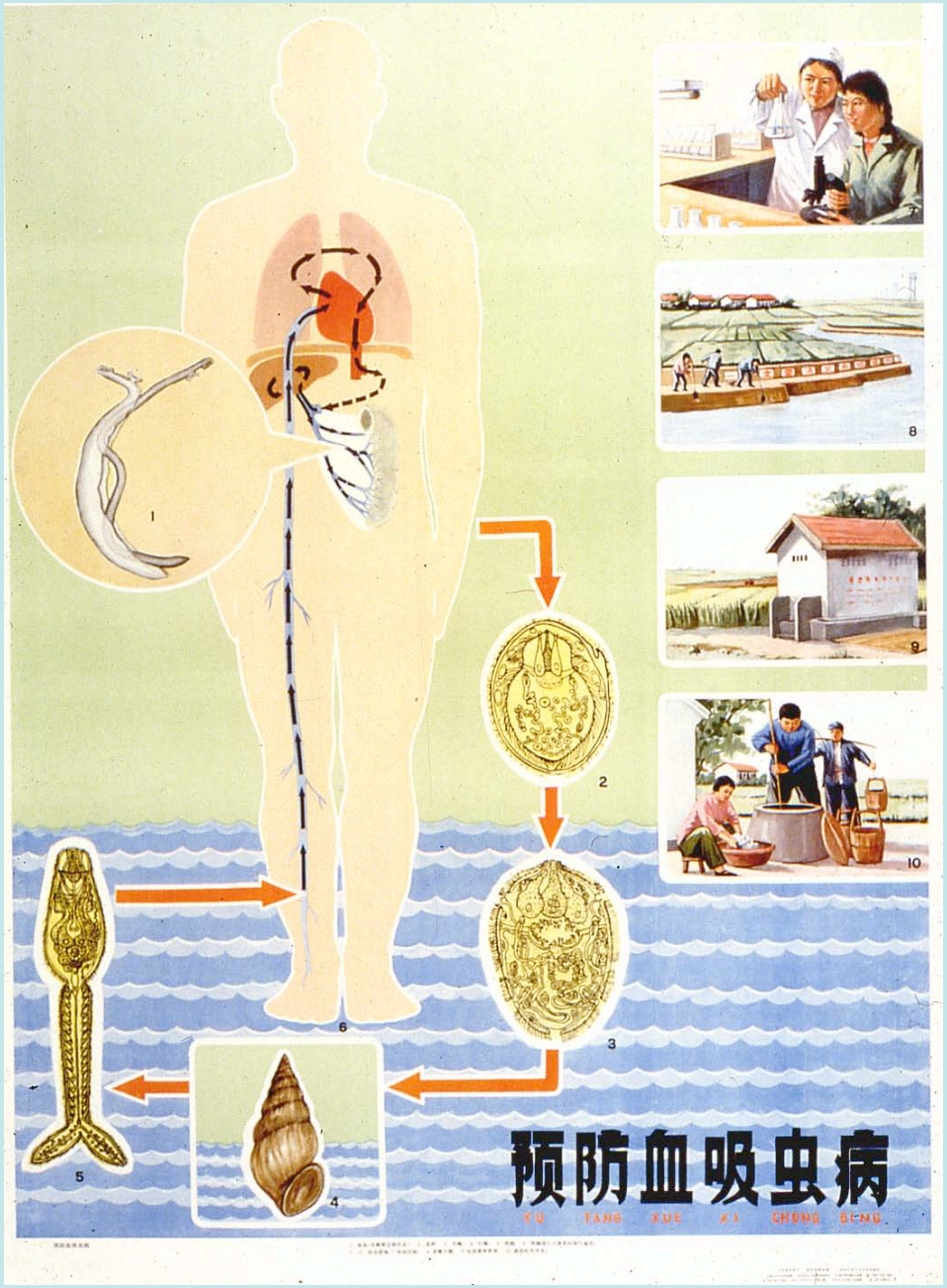
This drug is more effective if the patient has already developed antibodies against tegumental antigens.

Did Katyama fever stop Mao's Advance on Taiwan?

兵 = Soldier

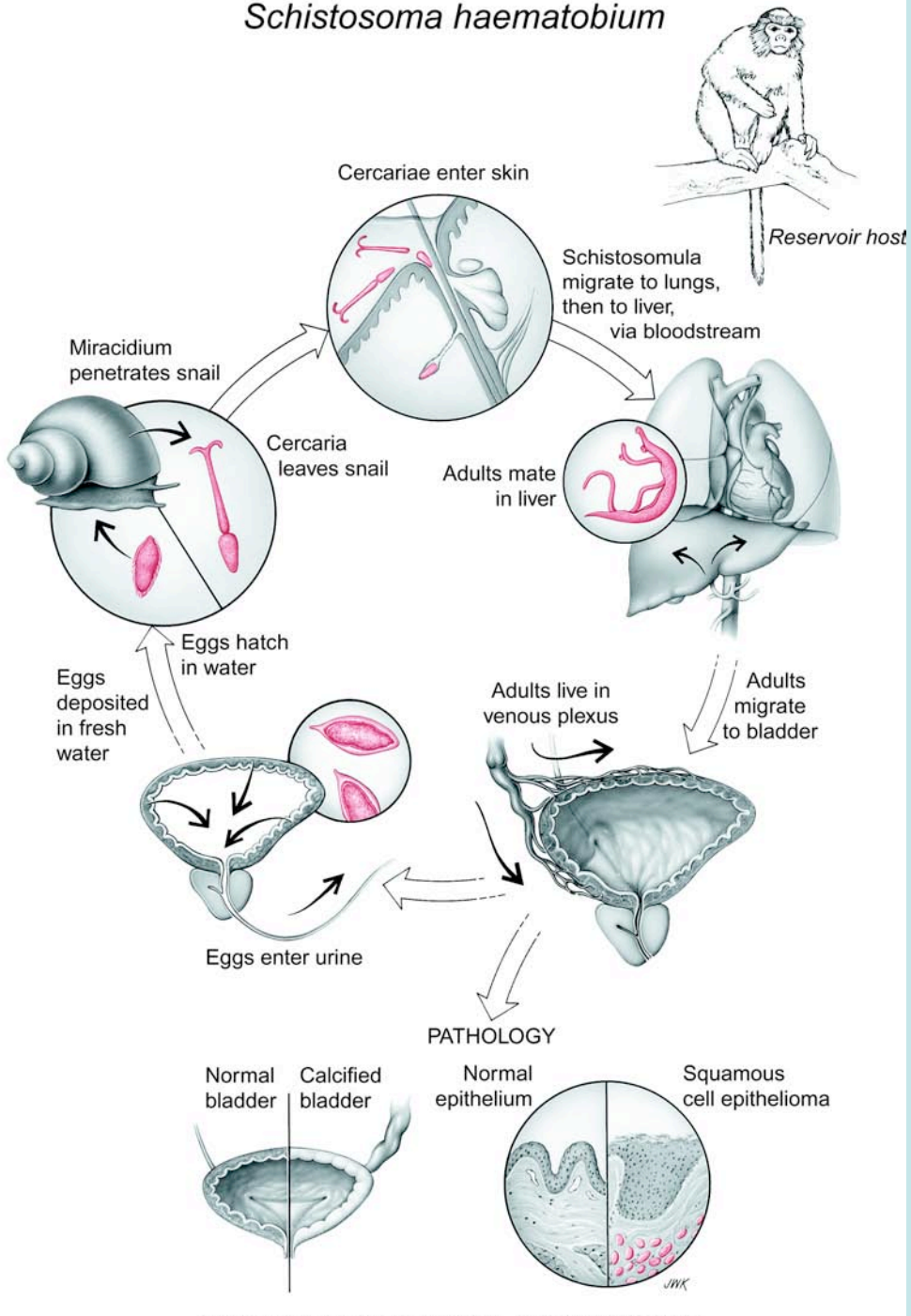
Prevention is the best public health control approach to any infectious disease

Shanghai delta: Oncomelania snails removed by hand

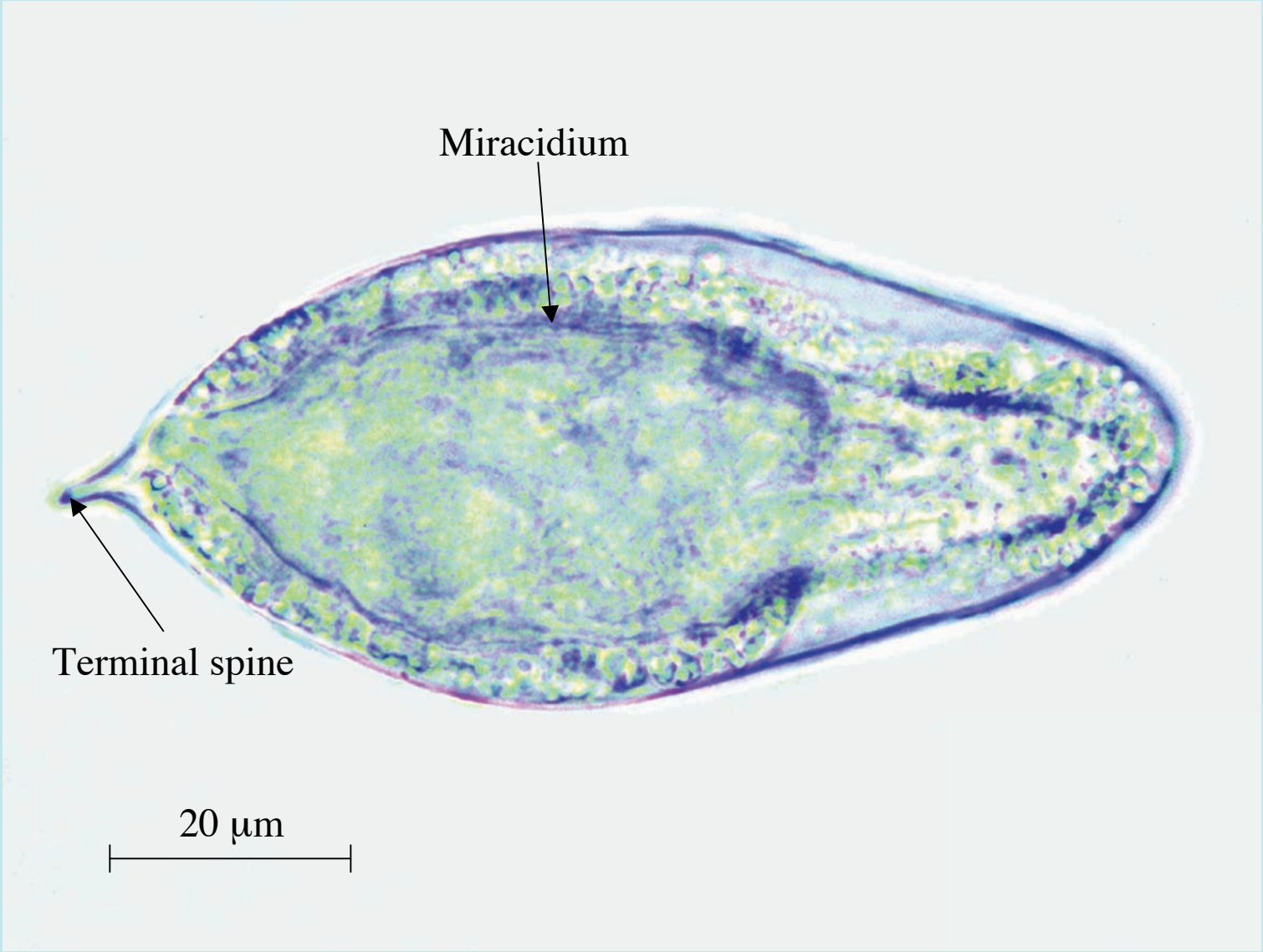


Schistosoma haematobium

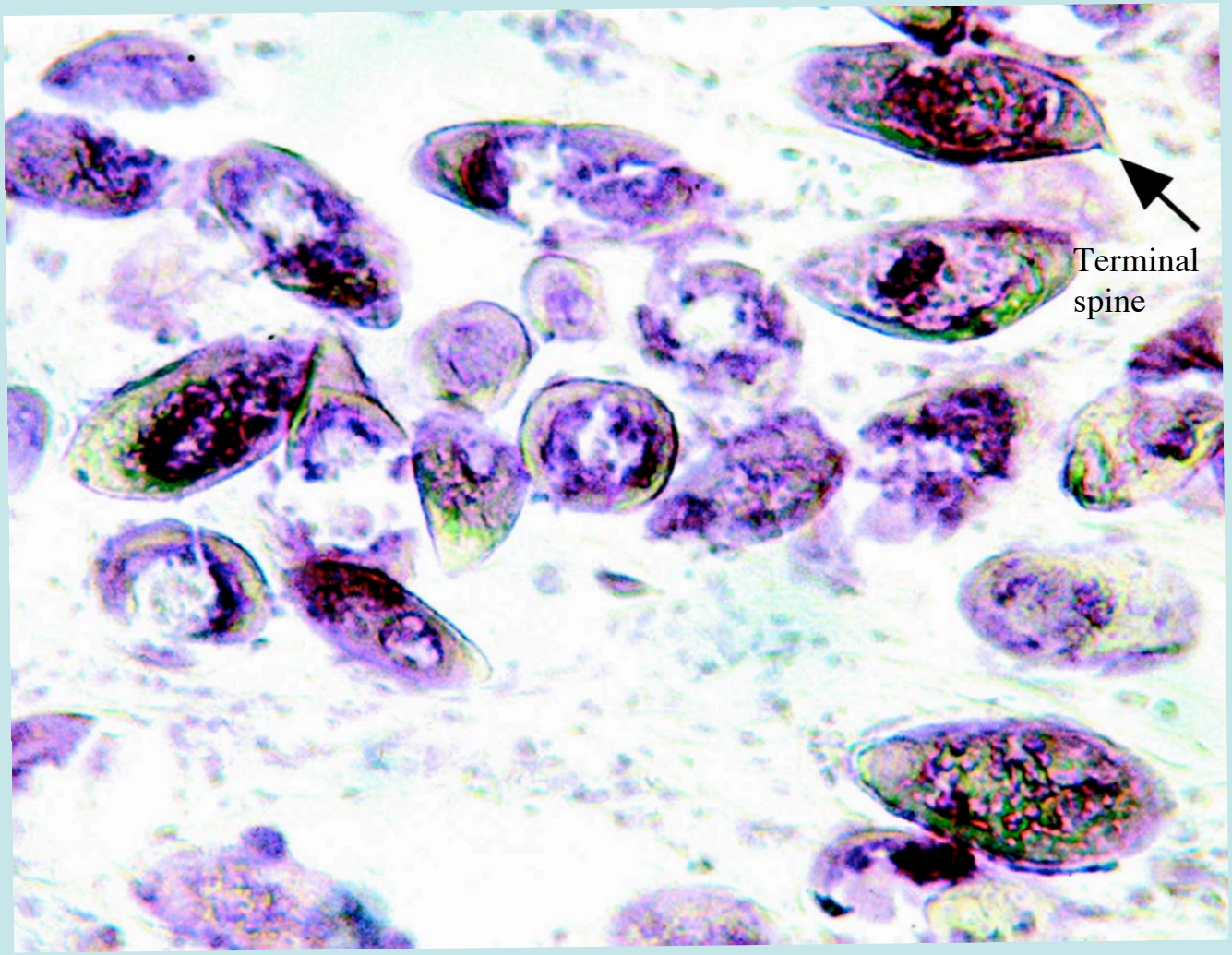
Schistosoma haematobium



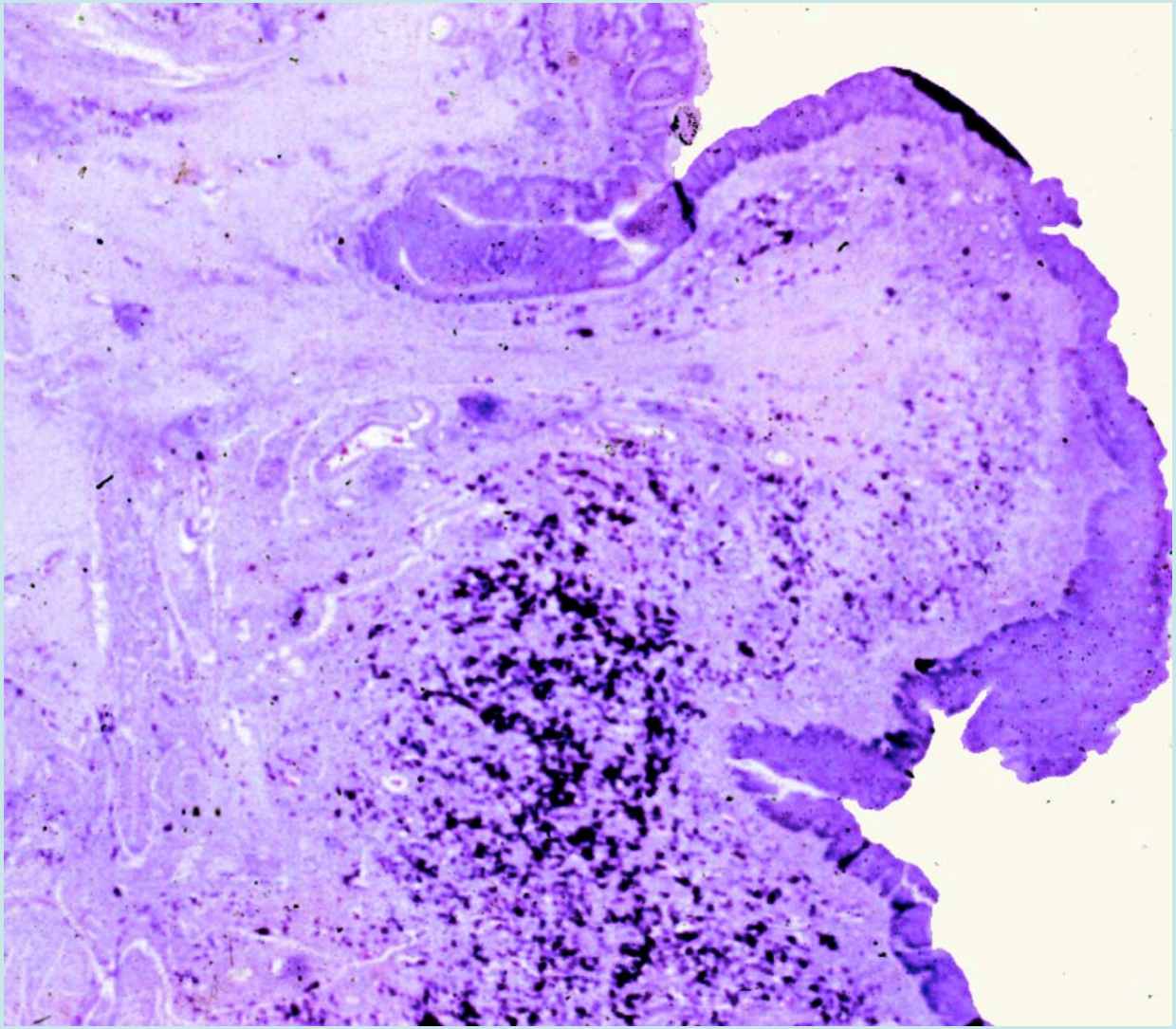
Embryonated egg of *Schistosoma haematobium*



Schistosoma haematobium eggs in bladder wall



Histological section of bladder with pseudopolyp due to chronic infection with *Schistosoma haematobium*

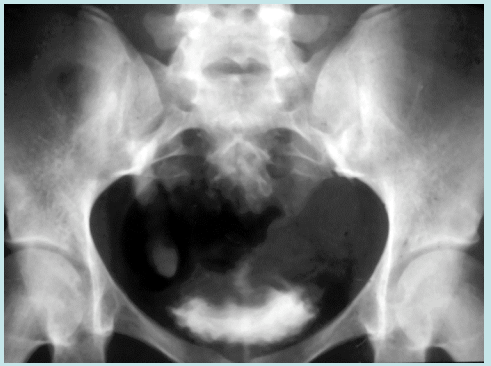


Pathogenesis:

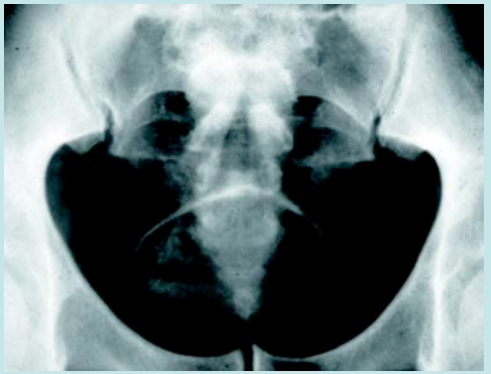
Eggs lodge in bladder wall, induce cellular changes associated with granuloma formation.

Clinical Disease:

1. Squamous cell epithelioma

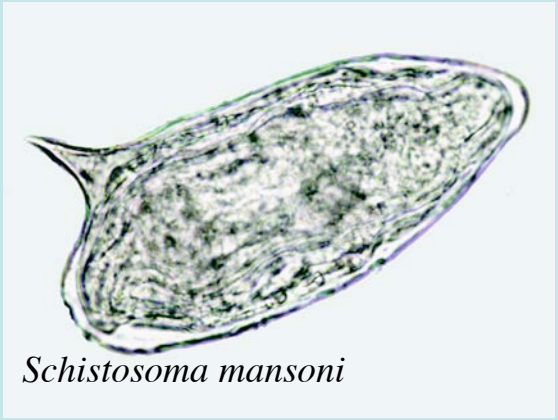


2. Calcification of dome of bladder due to accumulation of dead eggs

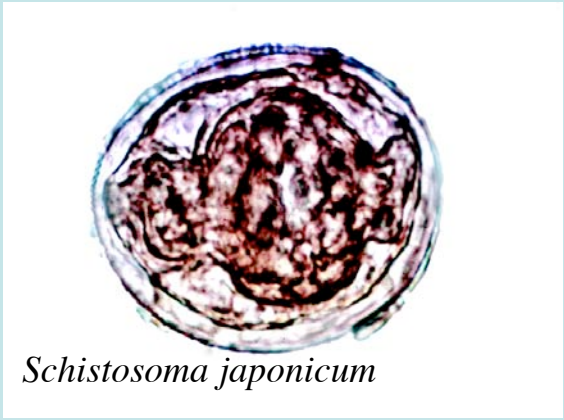


3. Hydronephrosis

Summary of Schistosome Egg Morphology

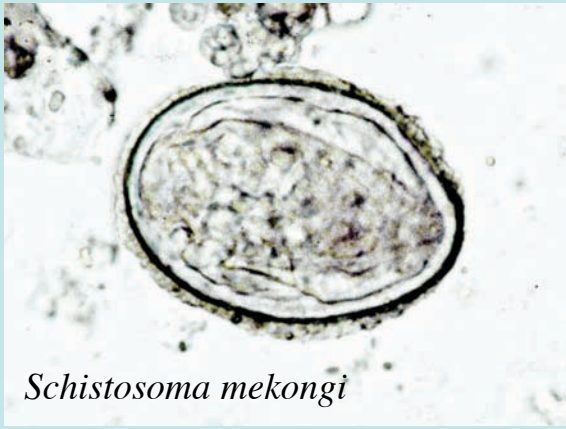


Schistosoma mansoni



Schistosoma japonicum

Schistosoma haematobium

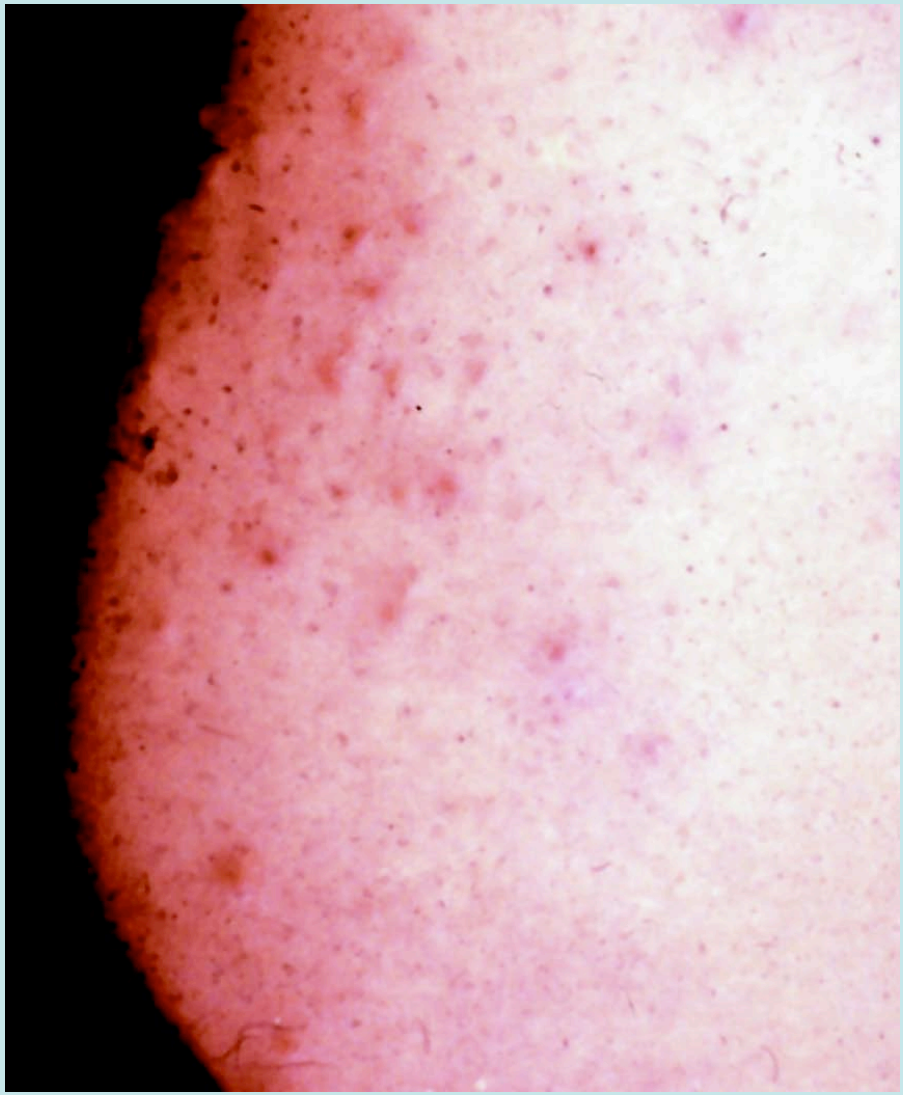


Schistosoma mekongi

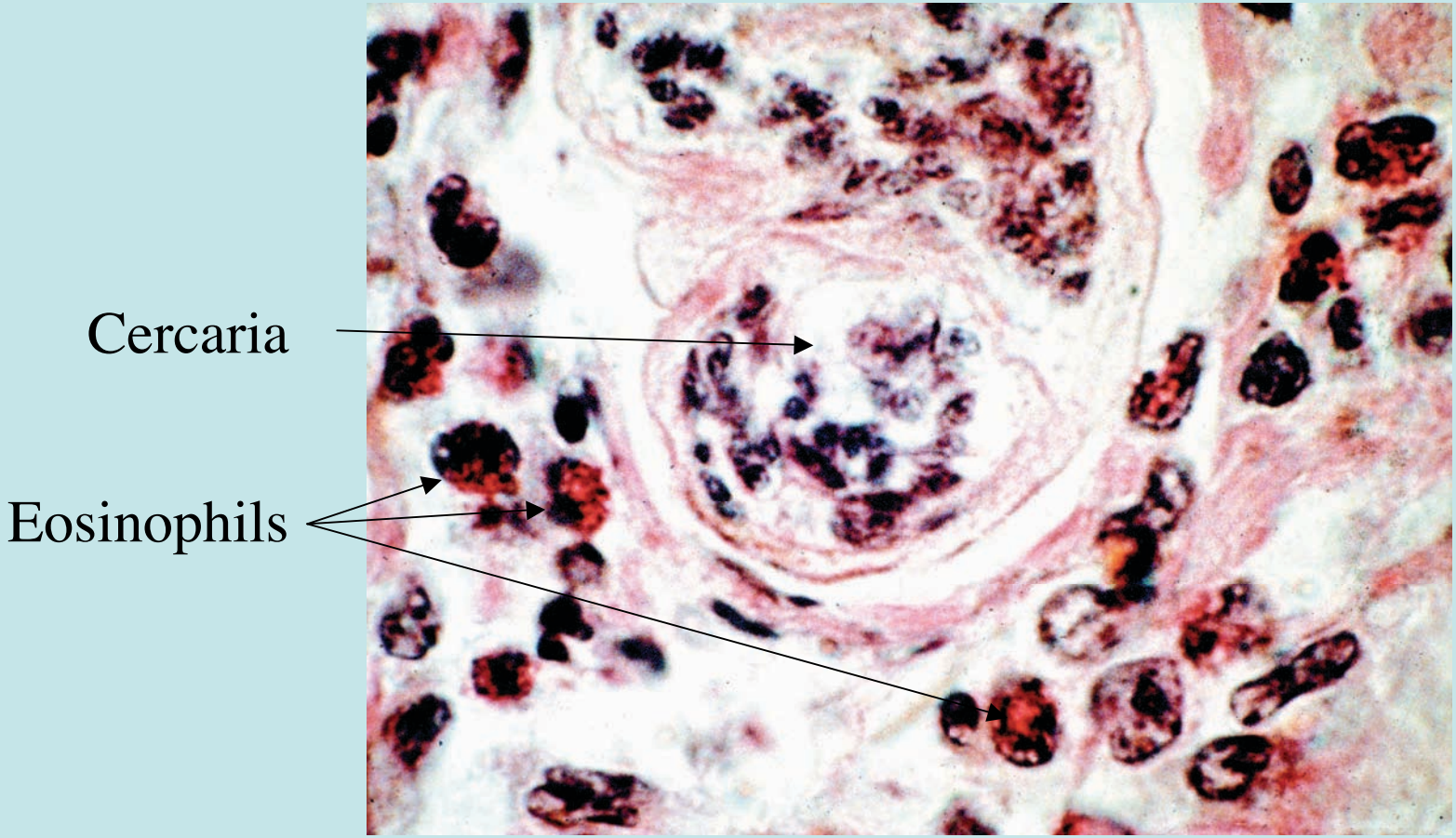
75 μm

30 μm

“Swimmer’s Itch”



Cercaria of *Schistosoma mansoni* in skin surrounded by eosinophils



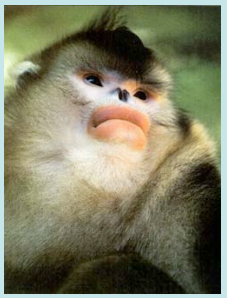
Th2 protective mechanism:
Eosinophils and specific IgE antibodies combine to kill the parasite

See:http://www.brown.edu/Courses/Bio_160/Projects1999/schisto/schistobody.html

Medical Ecology:

Transmission is encouraged by:

1. Dam building, irrigation projects (e.g., 3 Gorges Dam, China).

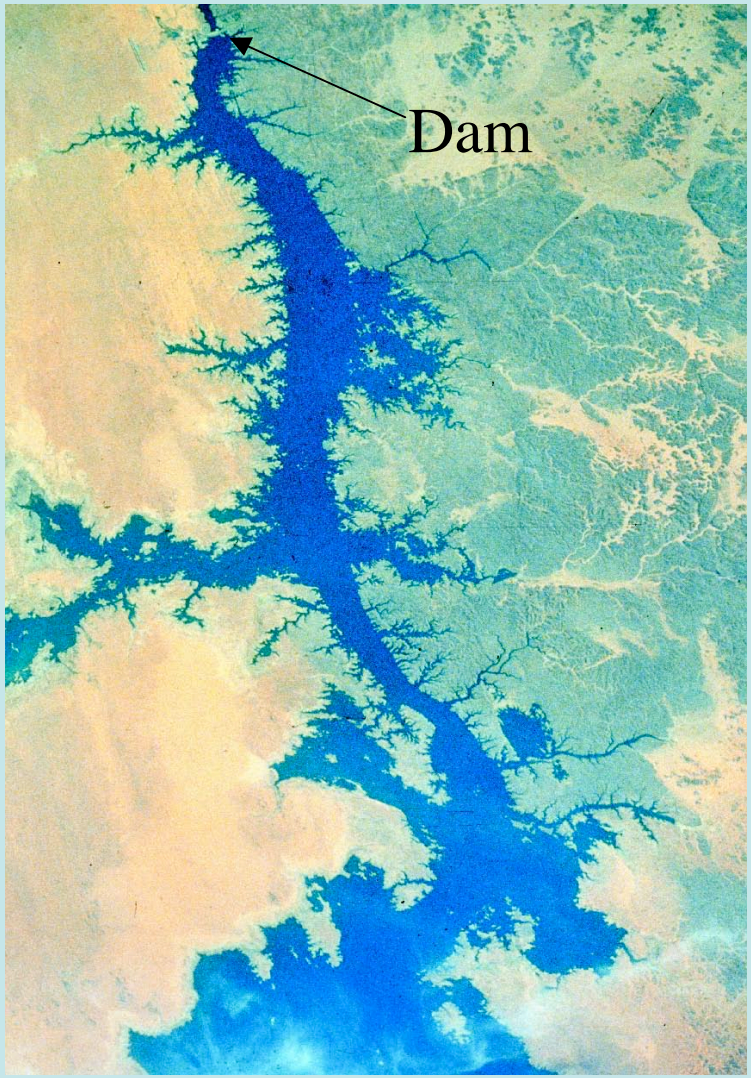


2. Reservoir hosts (primates, oxen).

3. Indiscriminate dispersal of feces and urine into environment.

Three Gorges Dam

Lake Nasser and the Aswan high dam in Egypt



NASA photo courtesy S. Musgrave, P&S class of 1964

Prevention and Control:

1. Sanitary disposal of feces

Prevention and Control (cont'd)

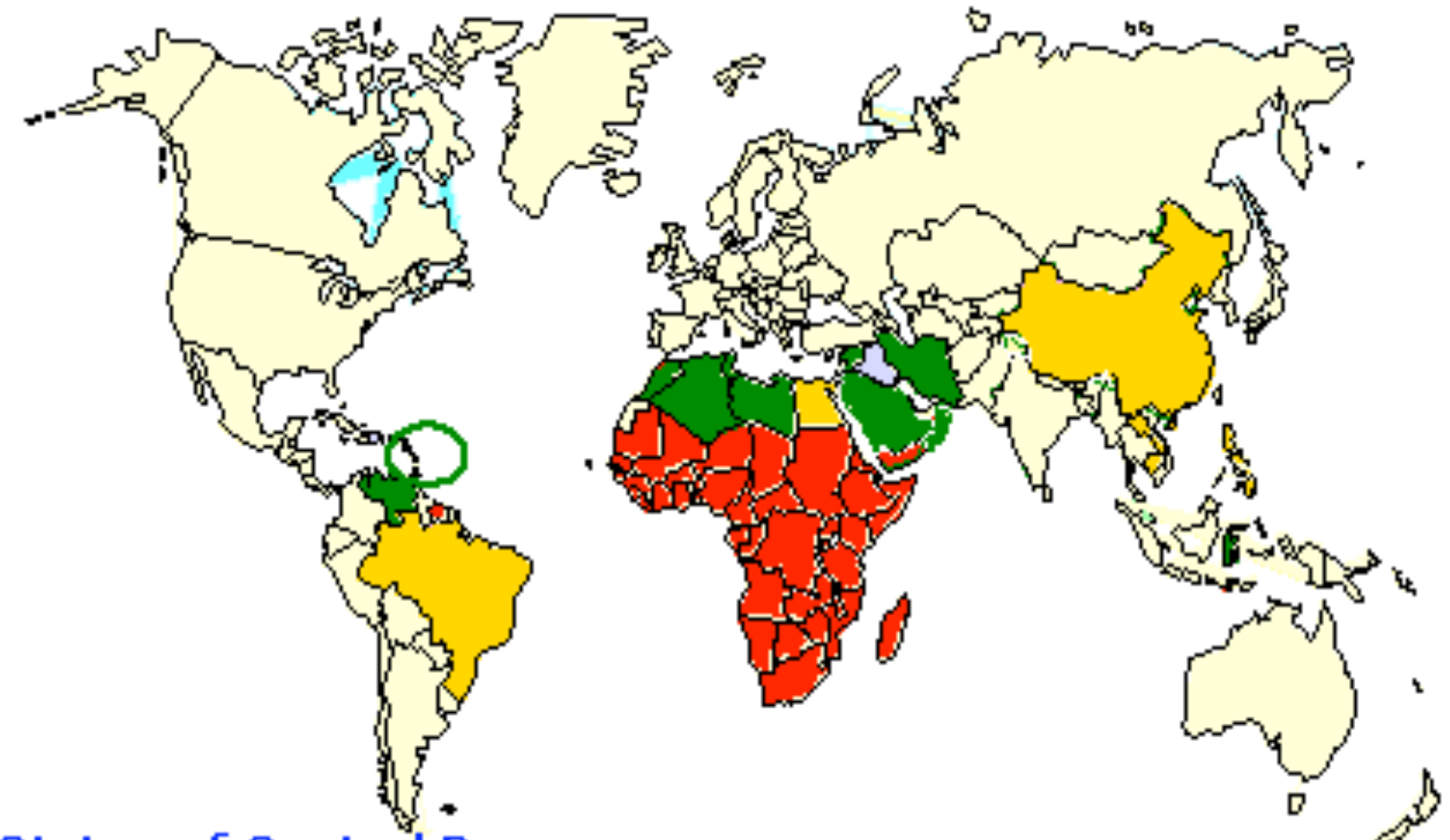
2. Public health education.

3. Snail control.

4. Community-based drug programs (praziquantel).

5. Vaccine development for reservoir hosts (e.g., water buffalo).

Global Distribution of Schistosomaisis



Status of Control Programs

- almost eradicated
- ongoing large-scale control programmes
- limited or no control

Source: WHO

..\alternate schisto clips-H.264 100Kbps.mov

Global Network for Neglected Tropical Diseases

http://www.GNNTDC.org

- Schistosomiasis Control Initiative
- International Trachoma Initiative
- Helen Keller International
- Liverpool School - GAELF
- Human Hookworm Vaccine Initiative
- Earth Institute at Columbia Univ.
- Task Force for Child Survival
  - Mectizan Donation Program
  - Albendazole Donation Program
  - Mebendazole Donation Program

GNNTDC

GLOBAL NETWORK FOR NEGLECTED TROPICAL DISEASE CONTROL