Water and the Ecology of Disease: Examples from Ghana and West Africa

Jonathan D. Mayer
Professor of Epidemiology and Geography;
Adjunct Professor of Medicine (Allergy and Infectious Diseases), Family Medicine, and Health Services
Disease Ecology

- Considers roles of
  - Agent-host interactions
  - Environment
  - Culture
  - Behavior
  - Population

- Coincidence in time and space of agent and host

- Examples
Role of Water in Infectious Diseases in W. Africa

- Many/most major infectious diseases have water component
- Waterborne
- Others directly tied to water and water quality
Waterborne

- Infectious diarrheas
  - Bacterial
  - Viral
  - Other pathogens

- These are well known and well described, eg
  - Periodic cholera outbreaks
Water as Breeding Grounds or Habitat for Intermediate Hosts

- Schistosomiasis
- Buruli ulcer (M. ulcerans)
- Onchocerciasis
- Malaria
Example of Volta River Dam

- Akosombo River dammed for hydropower
- Created largest human made lake in world
- Completed 1965
- Unanticipated health effects
Changing Epidemiology of Schisto Post-Dam

- Tremendous increase up-river in lake
- Questionably greater increase downriver
- Also increases in malaria, onchocerciasis
Schistosoma species

Major forms of human schistosomiasis caused by 5 species of water-borne trematodes, or blood flukes, called schistosomes

- **Urinary disease**
  - S. haematobium
  - S. intercalatum

- **Hepatic / Intestinal disease**
  - S. mansoni
  - S. japonicum
  - S. mekongi
Schistosomiasis

- 200 million people infected
- 600 million people at risk of infection
- 11,000 deaths per year
- 1.7 million DALYs lost per year
- 85% of all schistosomiasis cases in sub-Saharan Africa
  - Yemen and Mindanao also highly endemic
- Endemic but low levels
  - North Africa, Middle East, Yangtze River basin in China, Mekong River in Laos and Cambodia, several islands in the Philippines
Schistosomiasis

Infections with Schistosoma species
- Acute infection
- Incubation period
- Maturation, coupling, production of eggs

Schistosomiasis disease is characterized by chronic inflammation and fibrosis around ectopic parasite eggs lodged in tissues of various internal organs.
Detailed Schistosomiasis Life Cycle

**Schistosomula** → **Adult Worms**
(circulation to portal blood supply) → (male & female adults in blood vessels)

**HUMAN** (definitive host)

**Cercaria** (Free-swimming infective stages penetrate wet skin)

**Eggs (ova)** in feces or urine (hatch in fresh water)

**SNAIL** (intermediate host)

**Miracidium** (free-swimming larvae penetrate snails)

**Sporocyst** (2 generations in snail host)
Migration of Mature Worm Pairs

- Mature worm pairs migrate to venules of bowel or bladder depending on species
- Females lay eggs daily
- Eggs pass through walls of end-organs to exit the body in stool or urine
- Some eggs are trapped in organ walls
- Some eggs are swept back in portal circulation to the liver
Schistosoma species

Major forms of human schistosomiasis caused by 5 species of water-borne trematodes, or blood flukes, called schistosomes

- **Urinary disease**
  - S. haematobium
  - S. intercalatum

- **Hepatic / Intestinal disease**
  - S. mansoni
  - S. japonicum
  - S. mekongi
Schistosomiasis

- 200 million people infected
- 600 million people at risk of infection
- 11,000 deaths per year
- 1.7 million DALYs lost per year
- 85% of all schistosomiasis cases in sub-Saharan Africa
  - Yemen and Mindanao also highly endemic
- Endemic but low levels
  - North Africa, Middle East, Yangtze River basin in China, Mekong River in Laos and Cambodia, several islands in the Philippines
Schistosomiasis

Infections with Schistosoma species
- Acute infection
- Incubation period
- Maturation, coupling, production of eggs

Schistosomiasis disease is characterized by chronic inflammation and fibrosis around ectopic parasite eggs lodged in tissues of various internal organs.
Buruli Ulcer

- M ulcerans
- Endemic in Ghana, Benin, Togo, Nigeria, Cote d’Ivoire, Australia
- Ecology not fully known
- Associated with water
- Water insects may be intermediate host
- Surgery only cure
  - Anti mycobacterials usually not definitive
Current Work in Nima

- Largest slum in Accra
- 150,000 people on 6 km-2
- Census has not been fully analyzed
- Health status unknown
  - Anecdotally poor