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Taenia solium Taeniosis/Cysticercosis: Epidemiology and Impact

Arve Lee Willingham, D.V.M., Ph.D.
Associate Dean for Research and Postgraduate Studies
Director, One Health Center for Zoonoses & Tropical Veterinary Medicine
Professor of One Health




Photo: H. Ngowi

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Learning Objectives

- Understand the life cycle of *Taenia solium* and transmission of taeniosis/cysticercosis
- Become familiar with social and economic determinants of *Taenia solium* taeniosis/ cysticercosis (TSTC)
- Become aware of societal impacts of TSTC

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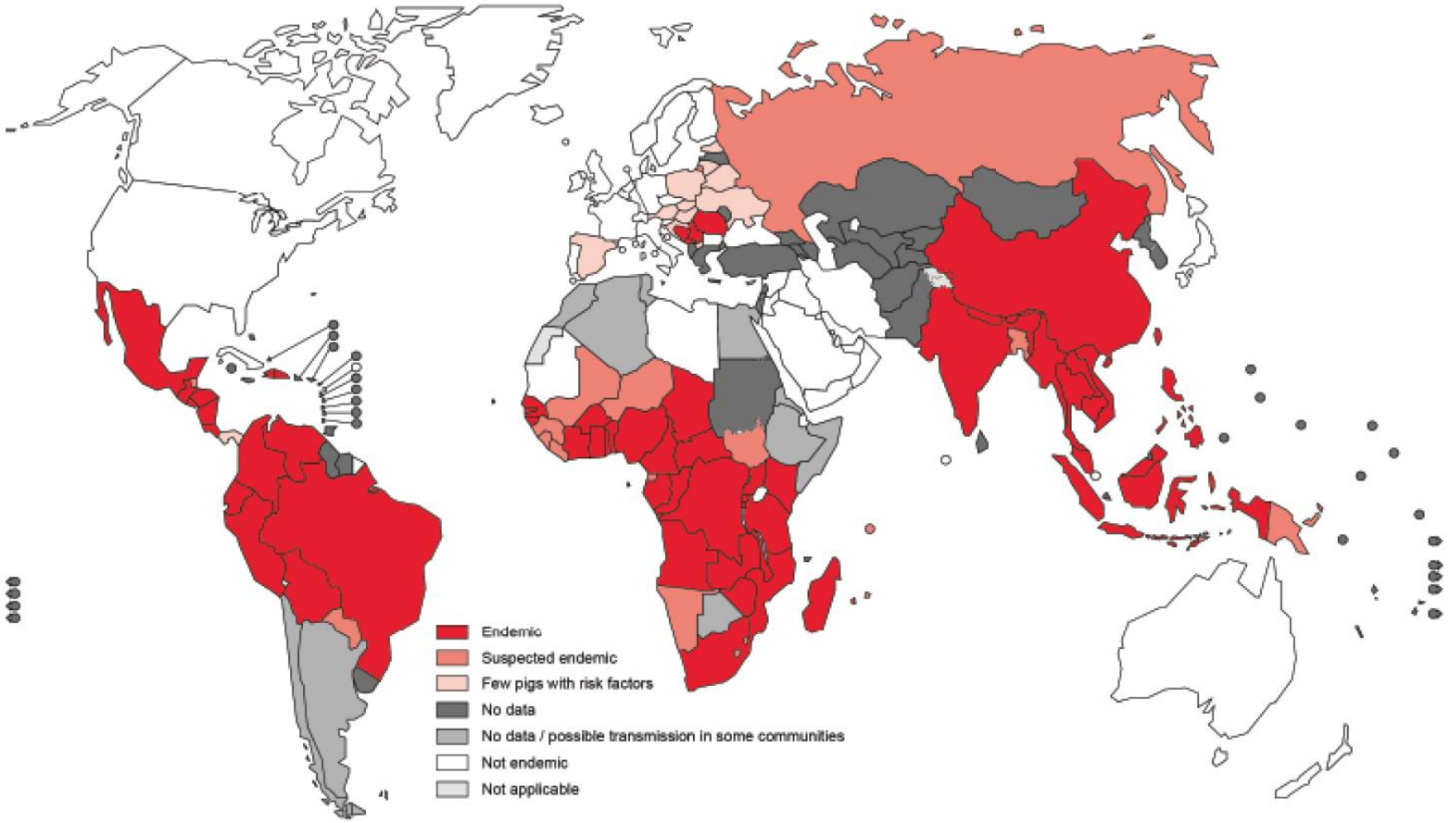
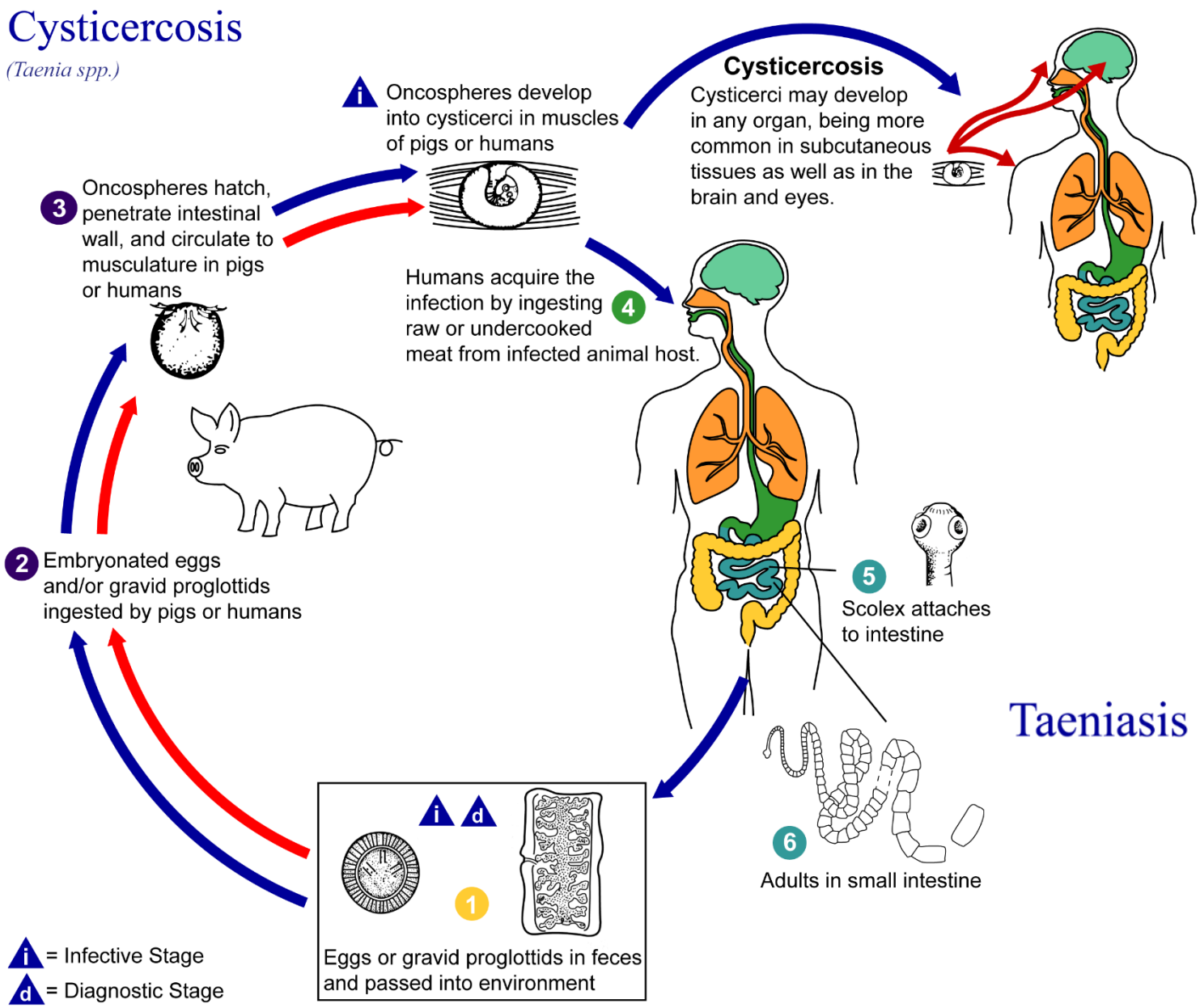
Distribution of *Taenia solium* Taeniosis/Cysticercosis

- Endemic in pig raising/pork consuming areas
- Associated with poverty
  - inadequate sanitation – open defecation
  - poor pig husbandry practices – roaming pigs
  - lack of proper pig slaughtering facilities, pork inspection & control
- Spread by people/pig movement
  - immigration
  - overseas workers
  - international travel
  - marketing and transport of pigs
- Often focal

Distribution of *Taenia solium* infection, worldwide, 2015



WHO (2016). *Taenia Solium* taeniasis/cysticercosis diagnostic tools. Report of a stakeholder meeting, Geneva, 17–18 December 2015. http://www.finddx.org/wp-content/uploads/2016/06/Taenia-solium-Taeniasis-cysticercosis-diagnostic-tools.pdf



CDC/Alexander J. da Silva, PhD/Melanie Moser

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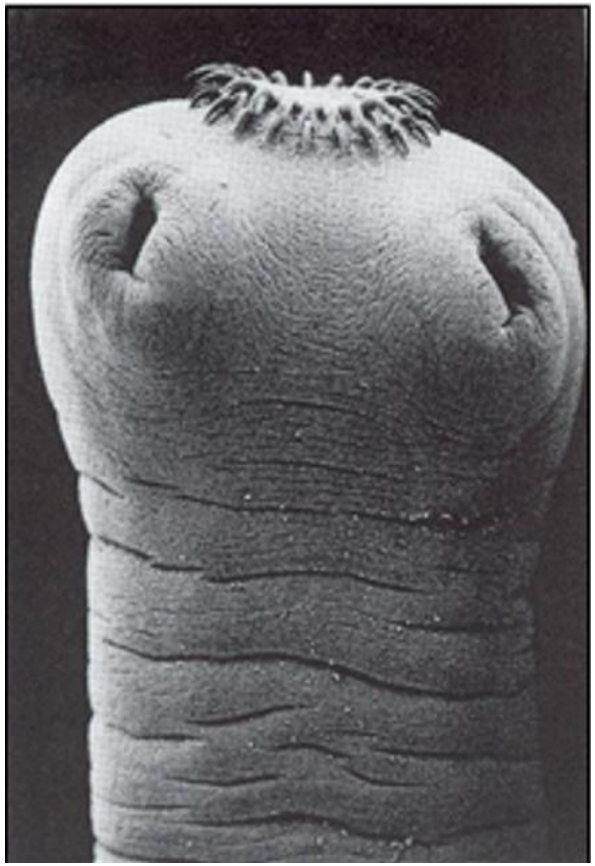
Adult *Taenia solium* tapeworm

The head (scolex) of a *Taenia solium* tapeworm has four suckers and a double row of about 30 hooks



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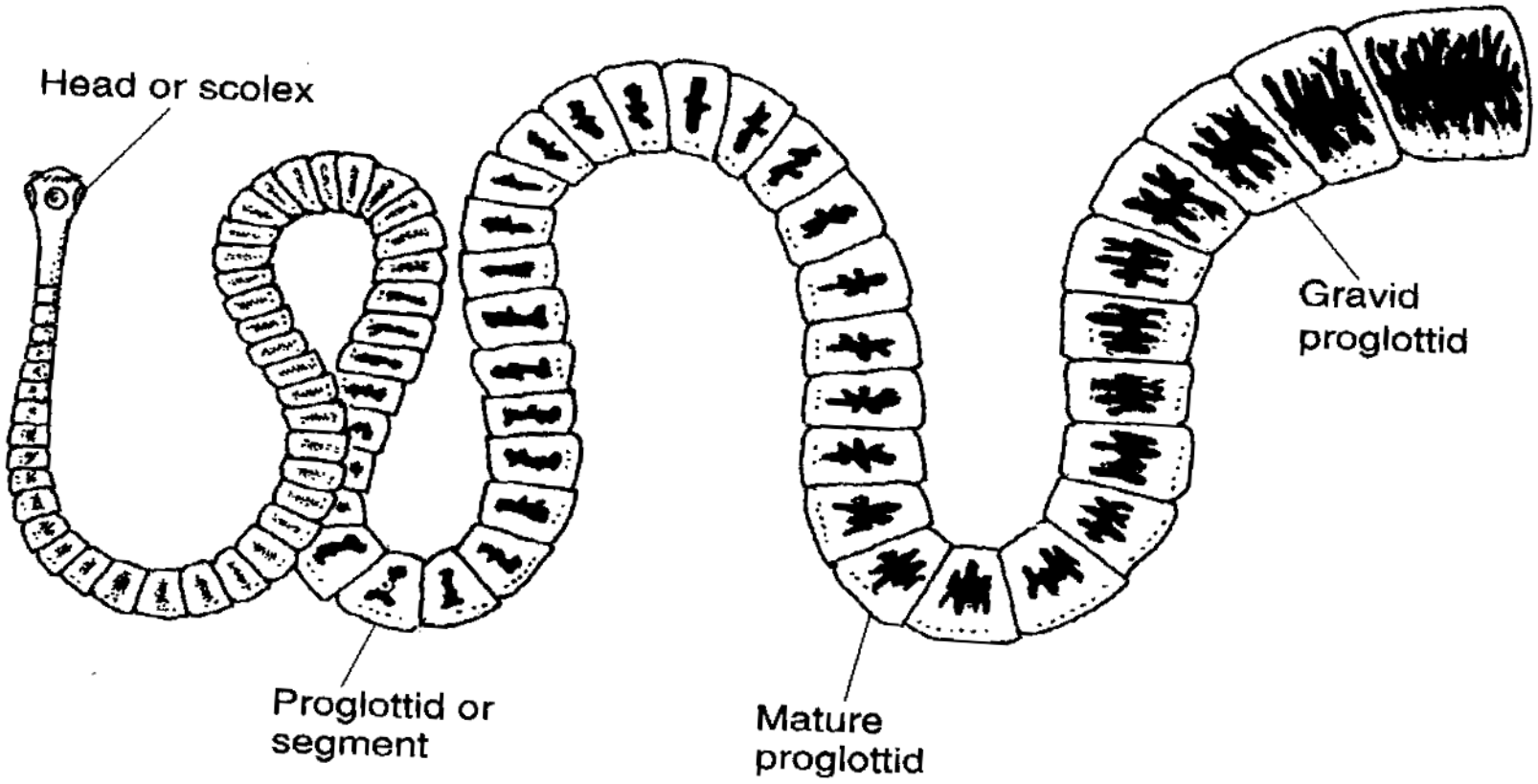
Adult *Taenia solium* tapeworm



The adult *Taenia solium* tapeworm can grow to more than 3 meters long in the human small intestine and release **more than 50,000 eggs per day**

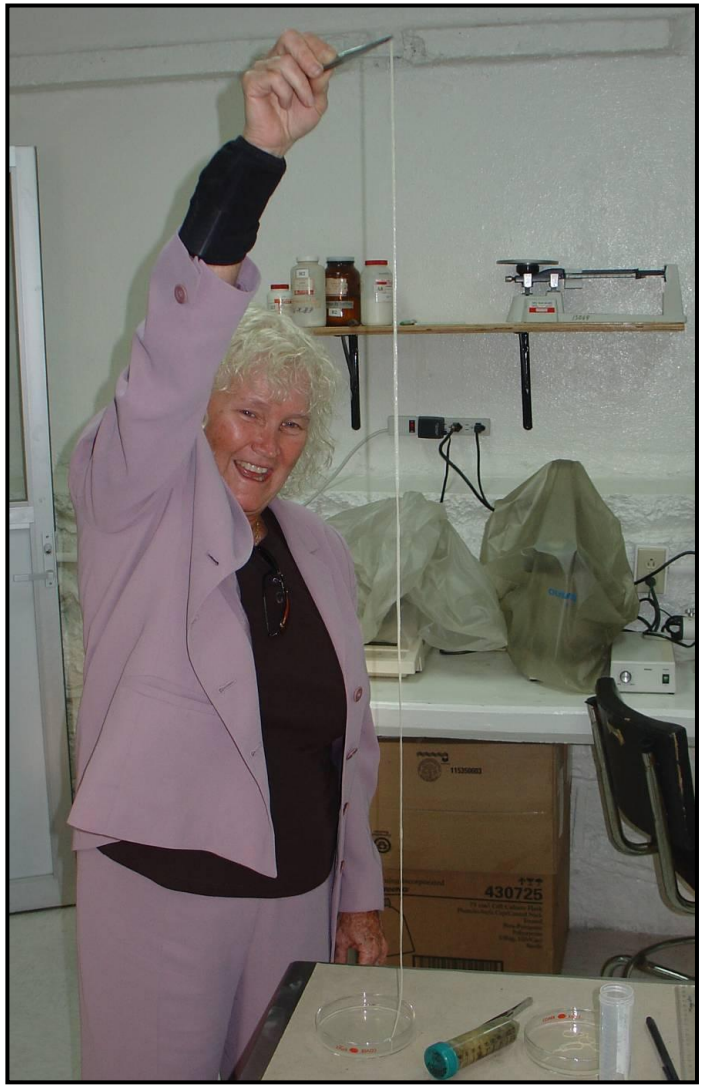
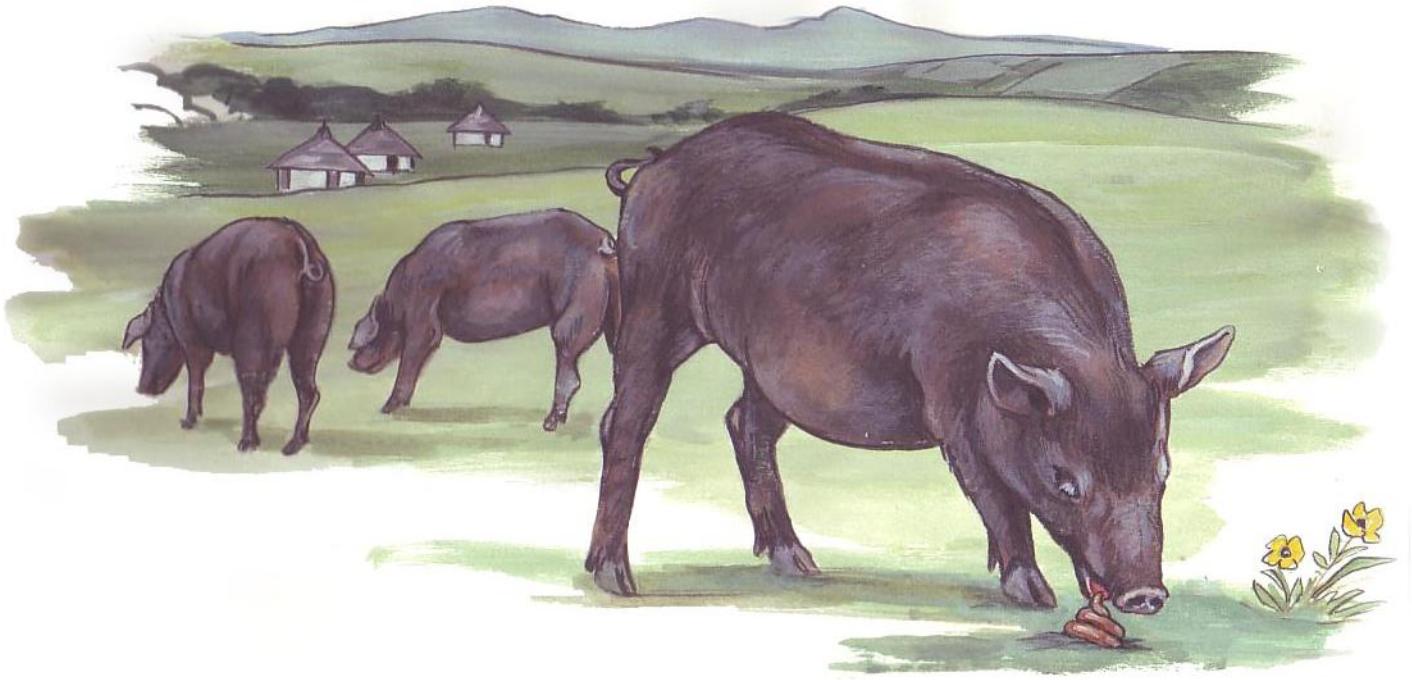


Photo: A. L. Willingham

Taenia solium eggs appear like other *Taenia* eggs

They can spread easily - contaminating the soil, food and water supply

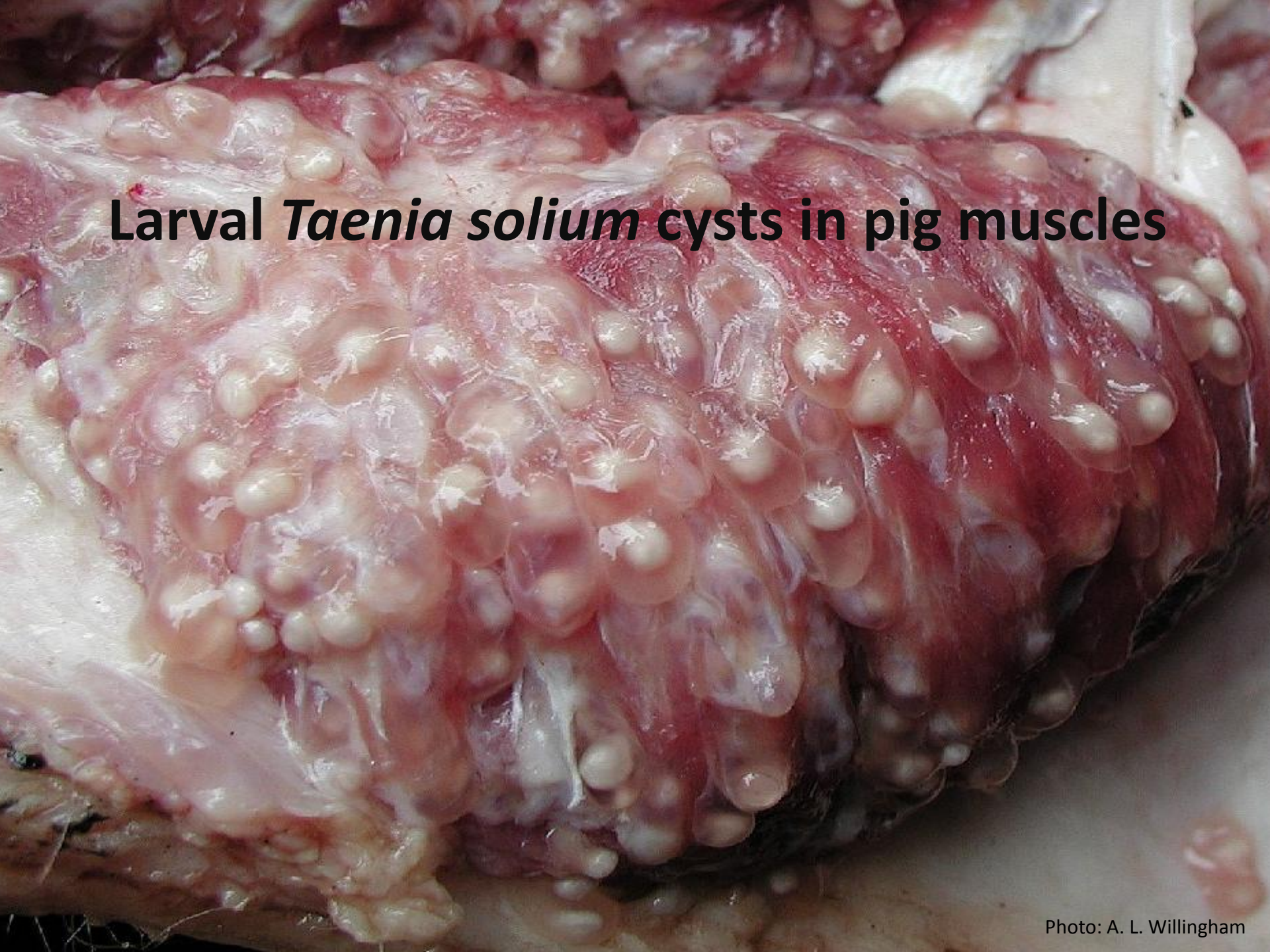
Pig infection



Free-range pigs become infected by ingesting tapeworm eggs passed into the environment with human faeces

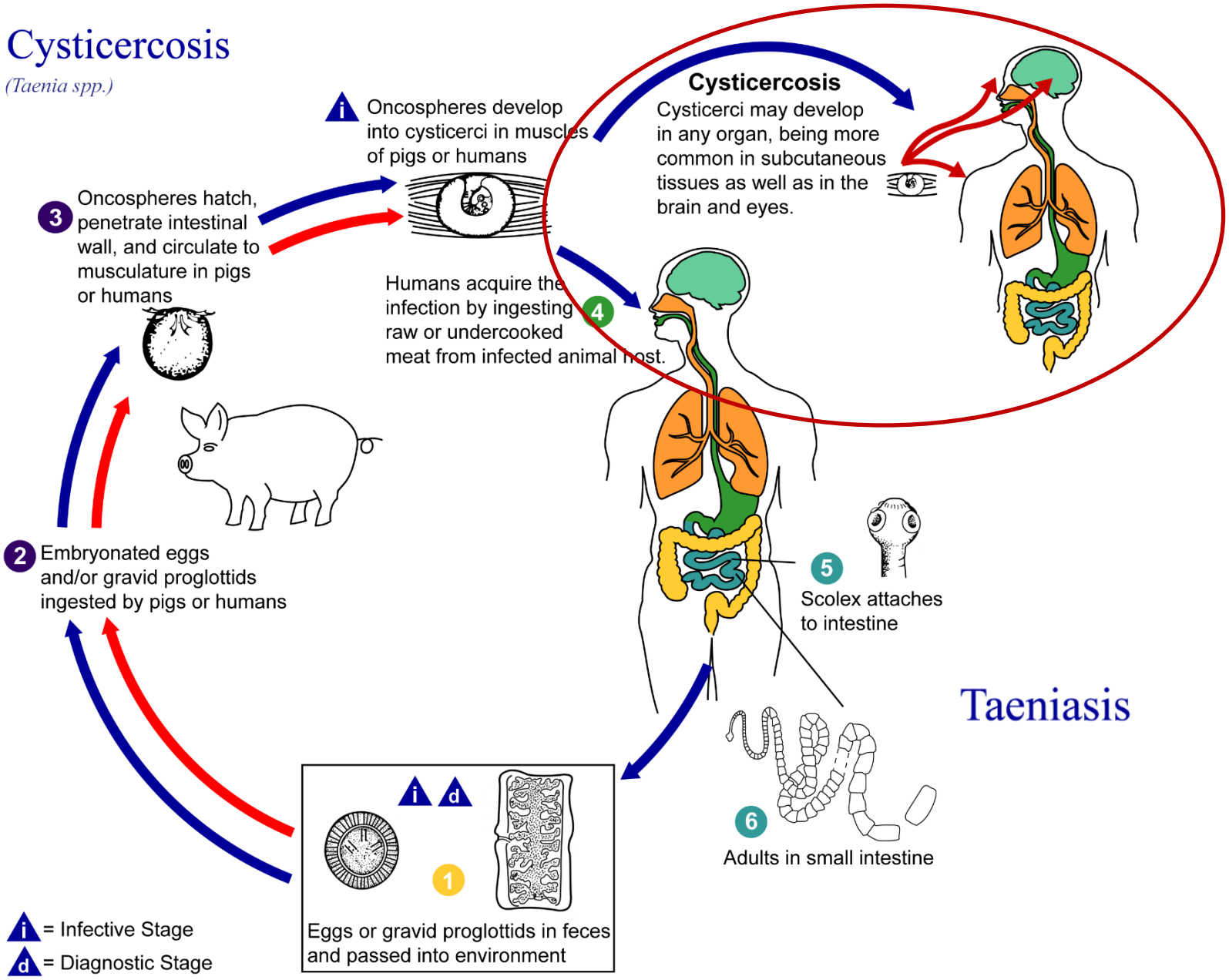
Larval *Taenia solium* cysts on pig's tongue

Photo: A. L. Willingham


Larval *Taenia solium* cysts in pig muscles
Photo: A. L. Willingham

Cysticercosis

(Taenia spp.)



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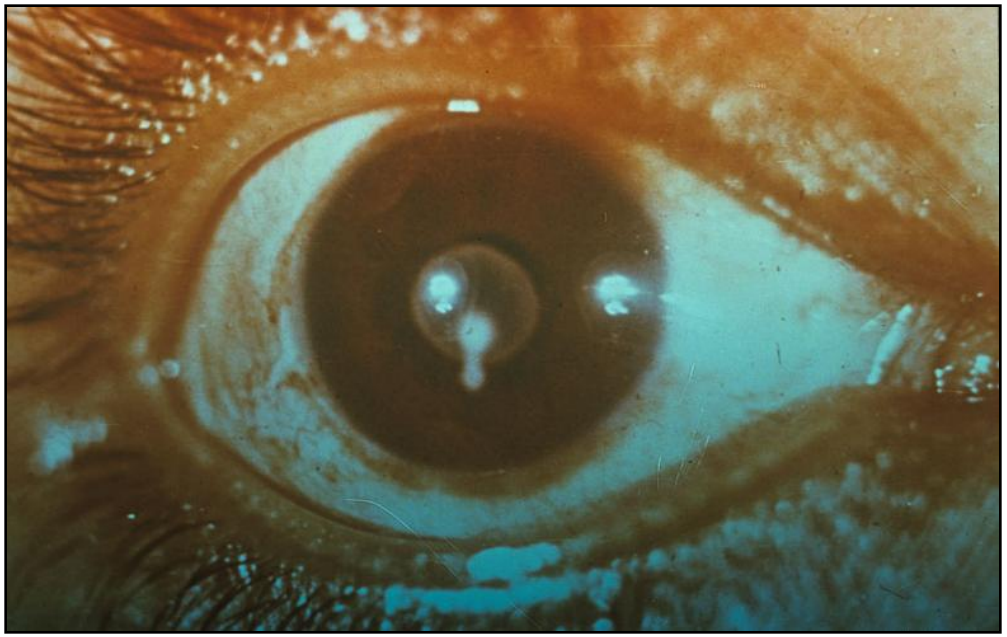
Subcutaneous cysts in an Asian cysticercosis patient

Photo: N. V. De

Taenia solium cysticercus in anterior chamber of human eye



ASTMH/Zaiman “A Pictorial Presentation of Parasites”

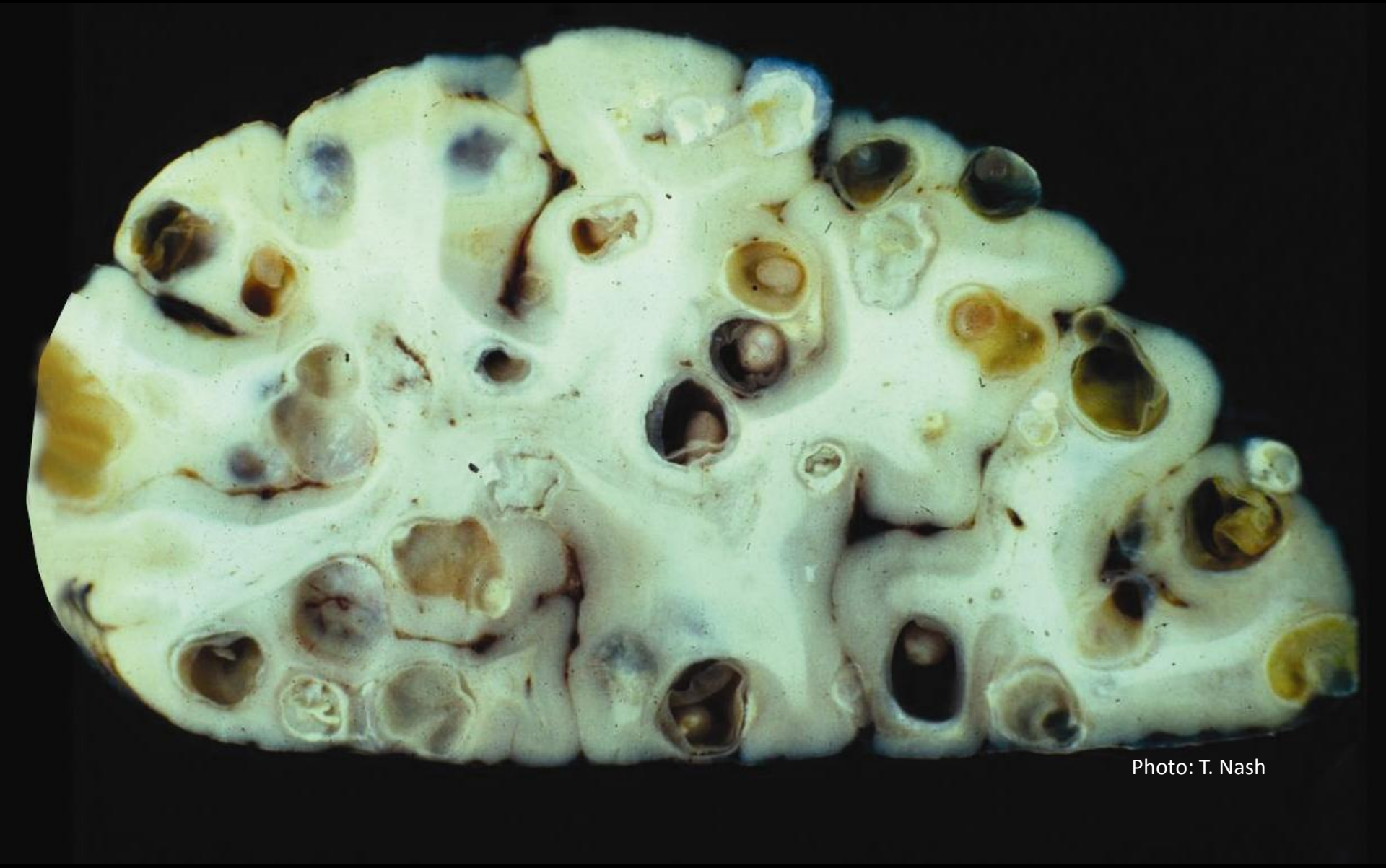
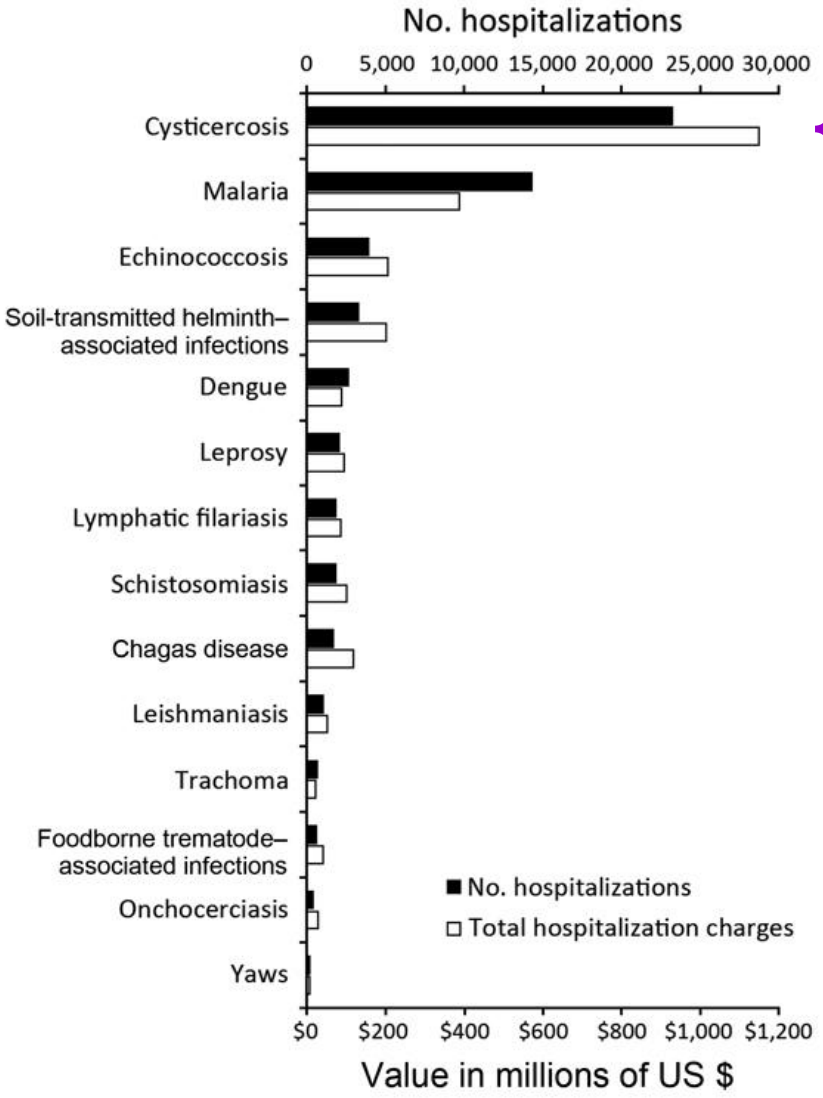


Photo: T. Nash

Neurocysticercosis - the most common preventable cause of epilepsy!

Frequency and total charges of hospitalizations in USA during 2003-2012 for 13 WHO-designated NTDs and malaria



- 23,266 hospitalizations
- $1,043,109,000 charges

Source: O'Neal S & Flecker RH (2015). *Emerging Infectious Diseases*, 21: 969-976.

Burden of Neurocysticercosis - Peru

- Treatment costs and productivity losses consumed 54% of an annual minimum wage salary during the first year of treatment and 16% during the second year
  - Diagnosis (36%) and drug therapy (27%) represented the most expensive health care-related costs.
  - Symptoms caused an average loss of 44.5 hours/month of productive activity
- Two-thirds of wage-earners lost their jobs owing to symptoms and only 61% were able to re-engage in wage-earning activities
- More than one-half reported missing new employment opportunities owing to their illness, and 48% of those with jobs reported that they were unable to perform all of their job-related tasks

Source: Rajkotia Y et al. (2007). *Transactions of the Royal Society for Tropical Medicine and Hygiene*, 2007, 101: 840–846.

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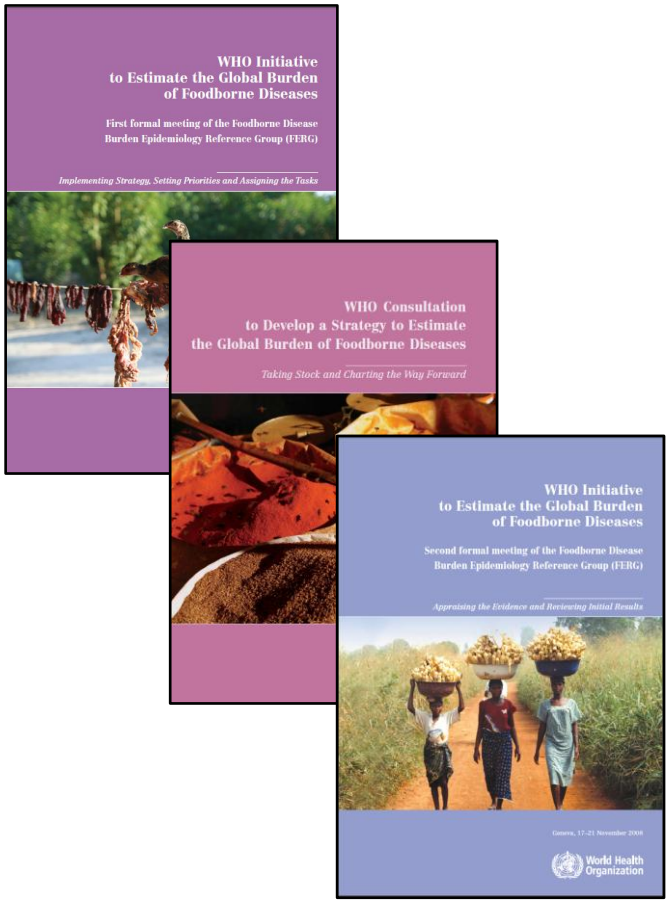
WHO Initiative to Estimate the Global Burden of Foodborne Diseases



- Experts appointed as Foodborne Disease Burden Epidemiology Reference Group (FERG)
- Focused on contamination of food with enteric and parasitic pathogens, chemicals and toxins
- Estimated the global burden (expressed in disability-adjusted life-years) of priority foodborne hazards based on results of systematic reviews

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Disability-Adjusted Life Years (DALY)

- Represents the disease-related loss of one year of full health because of premature death or disability
- Provides a summary measure of the burden of disease
- Used to assess and compare the relative impact of different diseases on populations
- Does not quantify full societal impact as it does not reflect economic burden, e.g. cost of illness, losses in agricultural and food sectors, trade impacts

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Priority Foodborne Hazards

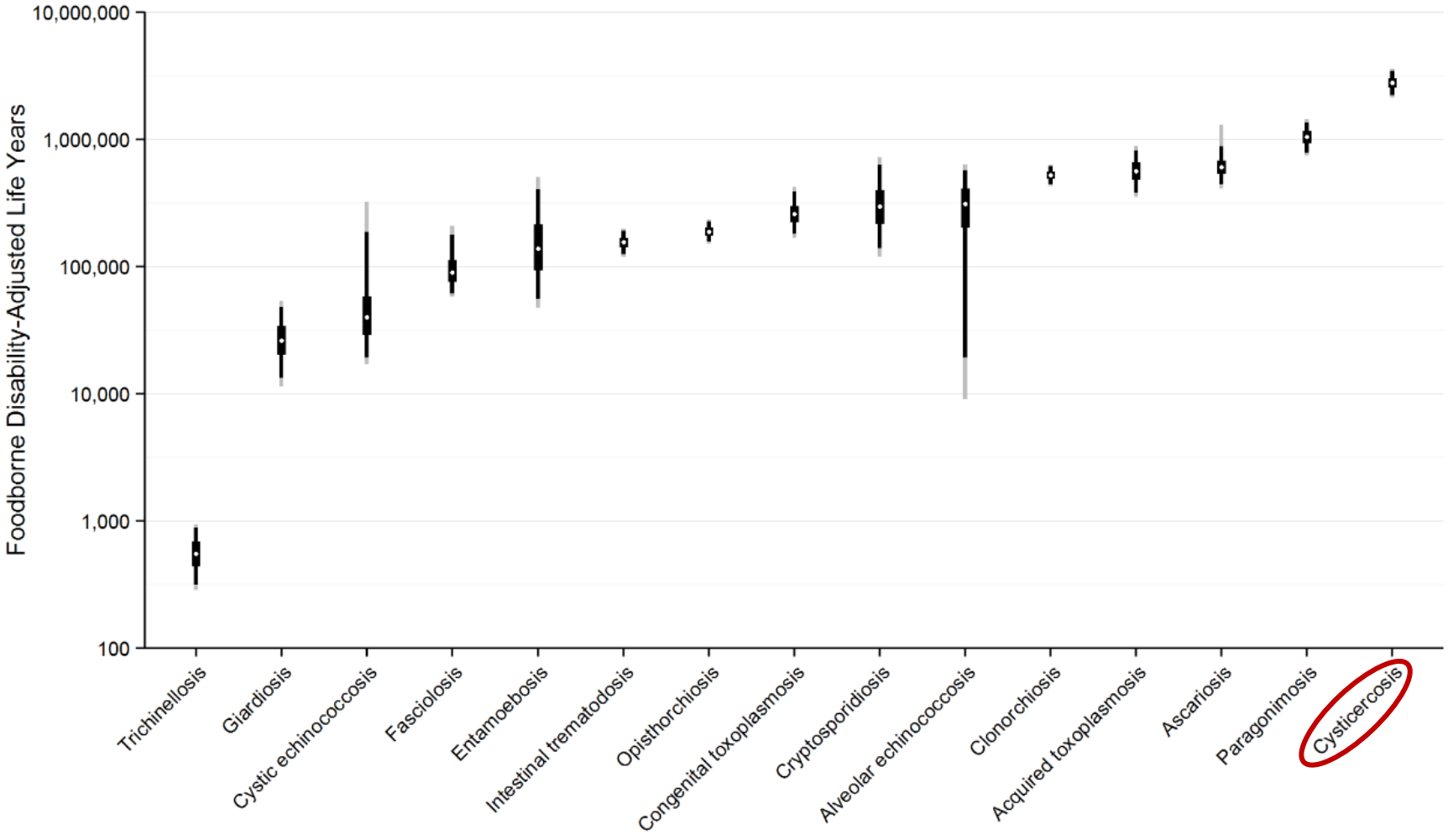
- **Enteric Pathogens**
  - *Brucella* spp.
  - *Campylobacter* spp.
  - *Escherichia coli* - Enteropathogenic
  - *Escherichia coli* - Enterotoxogenic
  - *Escherichia coli* - Shiga toxin producing
  - *Listeria monocytogenes*
  - *Mycobacterium bovis*
  - *Salmonella enterica (non-typhoidal)*
  - *Salmonella* Paratyphi A
  - *Salmonella* Typhi
  - *Shigella* spp.
  - *Vibrio cholerae*
  - Hepatitis A virus
  - Norovirus
  - *Entamoeba histolytica*
  - *Cryptosporidium* spp.
  - *Giardia* spp.

- **Parasitic Diseases**
  - *Ascaris* spp.
  - *Clonorchis* spp.
  - *Echinococcus granulosus*
  - *Echinococcus multilocularis*
  - *Fasciola spp.*
  - Intestinal flukes
  - *Opisthorchis* spp.
  - *Paragonimus* spp.
  - *Taenia solium*
  - *Toxoplasma gondii*
  - *Trichinella* spp.

- **Chemicals & Toxins**
  - Aflatoxin
  - Cassava cyanide
  - Dioxins

Ranking of Foodborne Parasitic Diseases

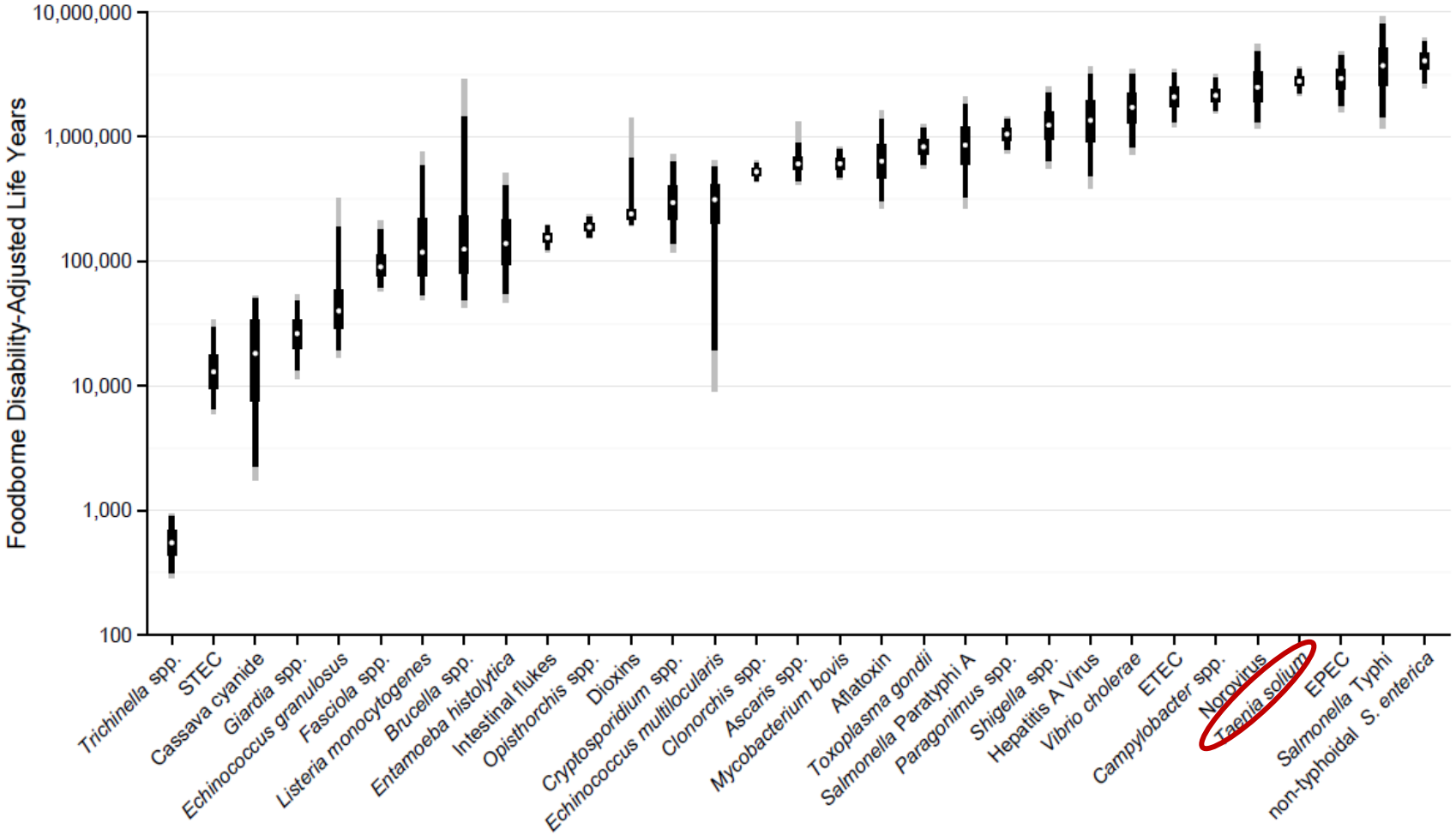
Based on Disability–Adjusted Life Years at the Global Level



Source: Torgerson et al, (2015). World Health Organization Estimates of the Global and Regional Disease Burden of 11 Foodborne Parasitic Diseases, 2010: A Data Synthesis. *PLoS Medicine* 12(12): e1001920. doi:10.1371/journal.pmed.1001920

Ranking of Foodborne Hazards

Based on Disability–Adjusted Life Years at the Global Level



Source: Havelaar et al. (2015). World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010. PLoS Med 12(12): e1001923. doi:10.1371/journal.pmed.1001923

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Top Ten Foodborne Hazards

1. Non-Typhoidal *Salmonella enterica*
2. *Salmonella* Typhi
3. Enteropathogenic *Escherichia coli*
4. ***Taenia solium***
5. Norovirus
6. *Campylobacter* spp.
7. Enterotoxigenic *Escherichia coli*
8. *Vibrio cholerae*
9. Hepatitis A Virus
10. *Shigella* spp.

Source: Havelaar et al. (2015). World Health Organization Global Estimates and Regional Comparisons of the Burden of Foodborne Disease in 2010. PLoS Med 12(12): e1001923. doi:10.1371/journal.pmed.1001923

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Top Ten Foodborne Parasites

1. ***Taenia solium* (pork tapeworm): In pork**
2. *Echinococcus granulosus* (hydatid worm or dog tapeworm): In fresh produce
3. *Echinococcus multilocularis* (tapeworm): In fresh produce
4. *Toxoplasma gondii* (protozoa): In meat from small ruminants, pork, beef, game meat (red meat and organs)
5. *Cryptosporidium* spp. (protozoa): In fresh produce, fruit juice, milk
6. *Entamoeba histolytica* (protozoa): In fresh produce
7. *Trichinella spiralis* (pork worm): In pork
8. *Opisthorchiidae* (family of flatworms): In freshwater fish
9. *Ascaris* spp. (small intestinal roundworms): In fresh produce
10. *Trypanosoma cruzi* (protozoa): In fruit juices

Source: FAO-WHO 2014 Report *Multicriteria-based ranking for risk management of food-borne parasites*

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Taenia solium Cysticercosis

Major consequences

- Causes epilepsy and death in humans
- Makes pork unsafe to eat
- Reduces the value of pigs and pork
- Major constraint for smallholder pig production & marketing
- Stigmatization of individuals and communities

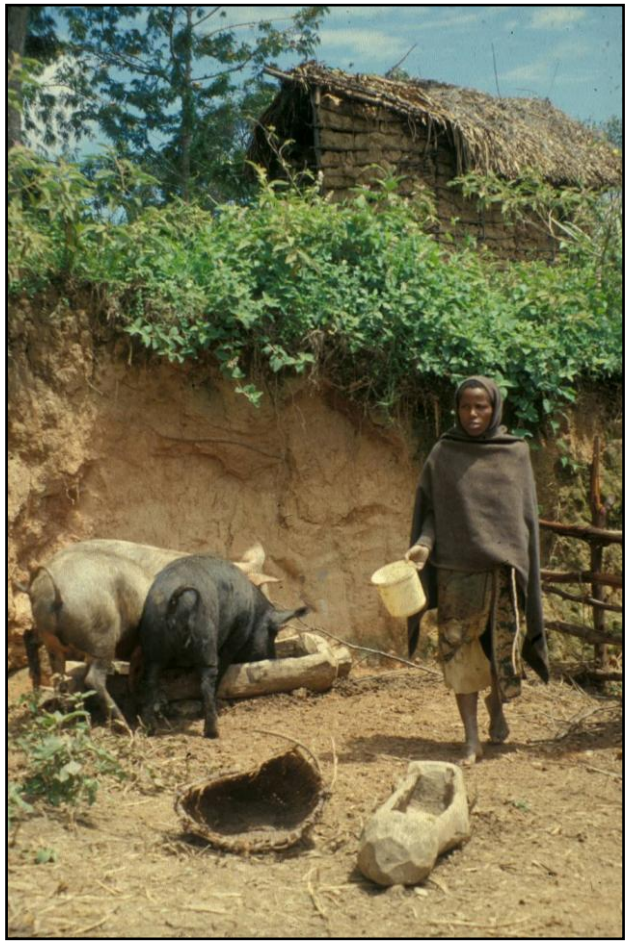

Photo: A. L. Willingham

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Taenia solium cysticercosis potentially controllable

- Humans are the only definitive hosts
- Human tapeworm infections sole source of infection for intermediate host pigs
- Domestic pigs can be managed
- No wildlife reservoirs exist

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Combating *Taenia solium* taeniosis/ cysticercosis

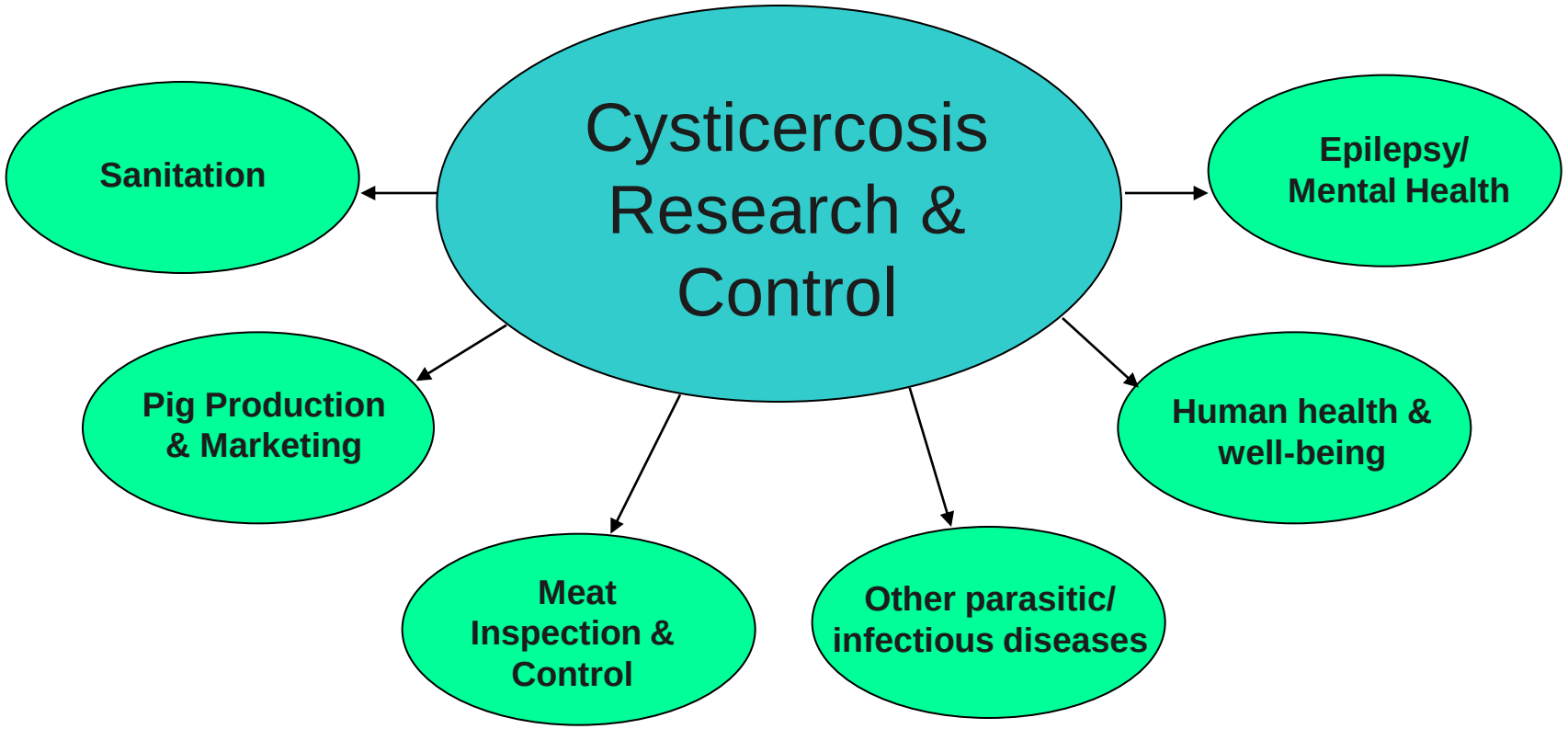
Photo: RUSVM

Photo: G. Dias

Photo: A. L. Willingham

An opportunity for improving human health and livestock production

Combating TSTC as a catalyst/entrypoint for community engagement



Promoting a transdisciplinary "One Health" systems approach