

# Pathways for transmission of angiostrongyliasis and associated risks

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# EATING SNAILS AND SLUGS INTENTIONALLY

- Raw snails
- First case in Brasil – a dare when drunk
- Recent case in Hawaii – also a dare
- Under-cooked or raw snails a delicacy
  - e.g. apple snails (*Pomacea*, *Pila*) in Thailand



*Pomacea canaliculata*



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# INFECTION FROM DEBRIS ASSOCIATED WITH PREPARING SNAILS FOR COOKING

- Thought to be an important pathway for infection in Taiwan – introduced apple snails (Yen et al. 1990)



Brasil  
near Belém  
2004



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# EATING SNAILS AND SLUGS UNINTENTIONALLY



- In salad and other vegetables eaten uncooked
- Small species or juveniles of larger species may not be seen
- Wash produce carefully to remove slugs and snails
- Grant proposal currently under review
  - project will screen a range of solutions for washing produce to make snails/slugs drop off



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# EATING PRODUCE CONTAMINATED WITH SLIME FROM SNAILS AND SLUGS

- Slime probably less important than snails and slugs themselves
  - no evidence of anyone becoming infected via this route
  - numbers of worms is low compared to numbers in the snails/slugs themselves

Ash 1976 Campbell & Little 1988 Chen et al. 2005



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# HANDLING INFECTED SNAILS AND SLUGS



- Handling or playing with infected snails or slugs and then transferring worms to the mouth
  - mostly children
  - school projects

Wan & Weng 2004 Graeff-Teixeira et al. 2009



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# GOING FOR THE WORLD RECORD FOR NUMBER OF SNAILS ON YOUR FACE



Fin Keleher, Utah, USA

43

The current world record!



Tania Walton, Cheshire, UK

25

Former world record



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# DRINKING CONTAMINATED WATER

- Snails/slugs crawl into rain-fed water tanks
  - Theoretically possible but no records of human infection by this pathway
  - Dilution in a large quantity of water reduces the number of infective worms likely to be ingested



Cheng & Alicata 1964 Wallace & Rosen 1969 Ubelaker et al. 1980



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# EATING PARATENIC HOSTS

- Intentionally eating raw/under-cooked freshwater shrimp
  - e.g. Tahiti and other Pacific islands
- Intentionally eating raw/under-cooked land crabs, coconut crabs, freshwater prawns
  - e.g. Micronesia
- Intentionally eating raw/under-cooked freshwater fish
- Intentionally eating raw/under-cooked frogs
- Accidentally eating terrestrial flatworms that feed on snails/slugs (*Platydemus manokwari*, *Geoplana forsterorum*), either whole or part
  - e.g. Okinawa, New Caledonia



Coconut crab – *Birgus latro*



*Platydemus manokwari*

Alicata 1964   Alicata & Jindrack 1970   Ash 1976   Asato et al. 2004



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# INTERMEDIATE AND PARATENIC HOSTS IN HAWAII

- 13 out of 16 species of snails/slugs that were tested were identified as intermediate hosts, representing a broad diversity of Gastropoda
- But no potential paratenic hosts have been screened
  - freshwater prawns, flatworms (possibly on produce), etc.



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# INFECTION THROUGH OPEN WOUNDS

- Infection from contact with snails/slugs, slime, contaminated water, paratenic hosts
  - Theoretically possible but no records of human infection by this pathway

Angus 2005



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# SEVERITY OF THE DISEASE DEPENDS ON DOSAGE

Well maybe, given what we heard yesterday...

The number of infective third-stage *Angiostrongylus cantonensis* necessary to cause disease in humans is not known

- Mice fed 20-30 3<sup>rd</sup> stage worms – no effects
- Mice fed 70-100 3<sup>rd</sup> stage worms – serious neurological effects and death
- Pigs infected with 20,000 worms – only 1 in 5 showed cerebral pathology
- Calves infected with 70,000 worms – all showed cerebral pathology but only 1 showed clinical symptoms
- A dog infected with 2,000 worms – paralysis of hind legs
- A monkey infected with several hundred worms – eosinophilic meningitis

Mackerras & Sandar 1955 Alicata and Jindrak 1970 Prociv et al. 2000

Reviewed by Hollingsworth & Cowie 2006



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# RELATIVE RISKS

- Severity of the disease depends on dosage – therefore:
- Intentionally eating a raw, heavily infected slug or snail - or paratenic host – poses great risk
  - Partial cooking will reduce but not necessarily eliminate the risk
  - Thorough cooking will eliminate the risk
- Accidentally eating a raw, heavily infected slug or snail, perhaps on vegetables/produce, also poses great risk
- Eating vegetables/produce contaminated by slime from infected snails seems to pose a lesser risk
- Drinking contaminated water poses relatively low risk because of dilution
- Infection via open wounds may pose relatively low risk



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# CONTROL AND MANAGEMENT

- Control vector populations (rats, slugs/snails) to reduce rate of infection in vectors
- Manage intermediate and paratenic hosts to reduce likelihood of accidental ingestion
- Develop methods to clean vegetables/produce of intermediate and paratenic hosts
- Educate the public so that people do not deliberately eat raw intermediate and paratenic hosts and take care to clean vegetables/produce so as not to eat them accidentally



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THANKS

Questions?

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