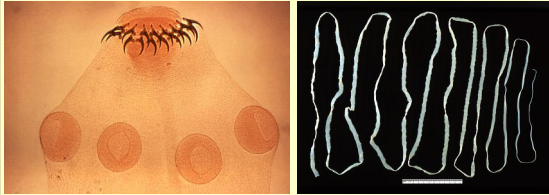



### Infections caused by Cestods - Part I



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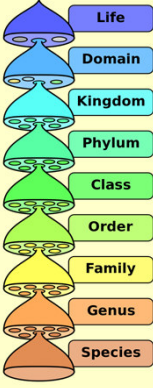
### Helminths – “ Worms “

**2 major phyla**

- Nematodes (roundworms)
  - Intestinal worms (soil transmitted worms)
  - Filarial worms
- Platyhelminths (flat worms)
  - Trematods (flukes)
  - Cestods (tapeworms)

**35 animal phyla**

- Nematodes: > 25.000 species
- Platyhelminths: appr. 25.000 species

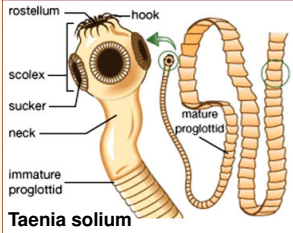


en.wikipedia.org

### Cestods – Structure of adults

**Tapeworms consist of**

- Scolex
  - Equipped with suckers, grooves (bothria) or hooks
  - Means of attachment to the intestinal wall
- Actively growing neck region (strobila)
  - Chain of segments (proglottids), variable in number
    - mature towards end of chain
  - Mature proglottids are largely composed of hermaphrodite sexual organs



**Taenia solium**

### Cestods – general aspects

- All cestodes are parasitic and their life histories vary
- typically the adults live in the digestive tracts of vertebrates (definite host)
- and often as juveniles in the bodies of other species of animals (intermediate host)
- Over a thousand species have been described
- all vertebrate species may be parasitised by at least one species of tapeworm.

### Cestods – general aspects

- Cestodes are unable to synthesise lipids and are entirely dependent on their host
  - lipids are needed for reproduction
- tapeworms absorb nutrients through its skin as the food being digested by the host flows over and around it.
- The adults can reach more than 10 m in length, with more than 3,000 proglottids. Immature eggs are discharged from the proglottids (up to 1,000,000 eggs per day per worm)

### Diphyllobothrium latum

#### Fish tape worm

### Diphyllobothrium latum Geographic Distribution

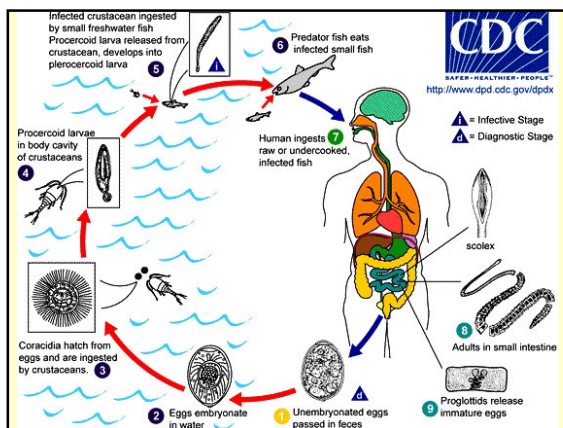
- Northern Hemisphere (Europe, North America, and Asia) and in South America (Uruguay and Chile).
- Freshwater fish infected with *Diphyllobothrium* sp. larva may be transported to and consumed in geographic areas where active transmission does not occur
- Cases of *D. latum* infection associated with consumption of imported fish have been reported in Brazil.

### Diphyllobothrium species

- *D. latum*
- *D. pacificum*
- *D. cordatum*
- *D. ursi*
- *D. dendriticum*
- *D. lanceolatum*
- *D. dalliae*
- *D. yonagoensis*
- *D. nihonkaiense*=*D. klebanovskii*



Diphyllobothrium latum scolex, SEM



### Diphyllobothrium – life cycle

- Immature eggs are passed in feces.
- eggs mature ( $\approx$  18 to 20 days) and yield oncospheres which develop into a coracidia.
- Coracidia ingested by a suitable first intermediate host (freshwater crustacean, e.g. a copepod)
- Coracidia develops into proceroid larvae

### Diphyllobothrium – life cycle

- copepod ingested by a suitable second intermediate host  $\rightarrow$  proceroid larvae migrate into the fish flesh
- there they develop into a plerocercoid larvae, the infective stage for humans.
- humans can acquire the disease by eating infected host fish raw or undercooked.
- in humans the plerocercoid develops into adults residing in the small intestine

### Diphyllobothrium latum Clinical presentation

- Can be a long-lasting infection (decades)
  - Most infections are asymptomatic.
- Manifestations may include**
- abdominal discomfort
  - diarrhea, vomiting, and weight loss
  - Massive infections may result in intestinal obstruction
  - Migration of proglottids can cause cholecystitis or cholangitis
  - Vitamin B12 deficiency with pernicious anemia has been described in the past

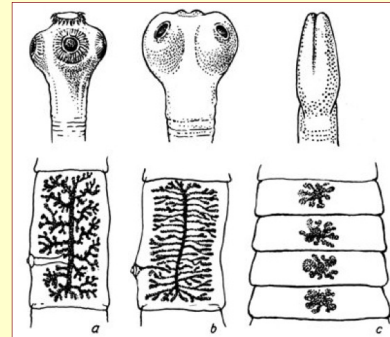
### Diphyllobothrium Laboratory Diagnosis

- Identification of eggs in the stool by microscopy
  - High sensitivity (95%) due to high no. of excreted eggs
  - usually concentration techniques not required
- Identification of proglottids passed in the stool and staining can also be of diagnostic value



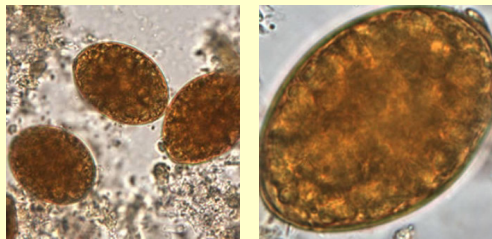
Diphyllobothrium proglottides CDC

### Cestods: Scolex and proglottids of tapeworms



Taenia solium – pork tapeworm Taenia saginata – beef tapeworm Diphyllobothrium latum – fish tapeworm spektrum.de

### Diphyllobothrium spp. eggs

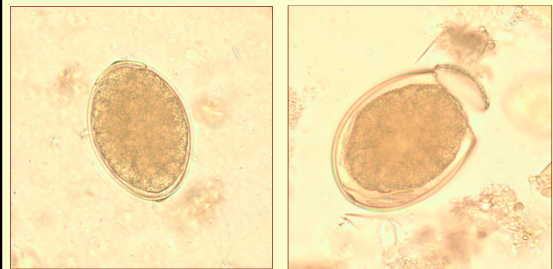


Eggs of *D. latum* in an iodine-stained wet mount

- oval or ellipsoidal
- range in size from 55 to 75  $\mu\text{m}$  by 40 to 50  $\mu\text{m}$
- operculum at one end

DPDx

### Diphyllobothrium spp. eggs



Stool sample, unstained wet-mount

DPDx

### Diphyllobothrium Treatment

#### Praziquantel

- Adults: 5-10 mg/kg orally in a single dose
- Children: dosage is the same as for adults
- praziquantel should be taken with liquids during a meal

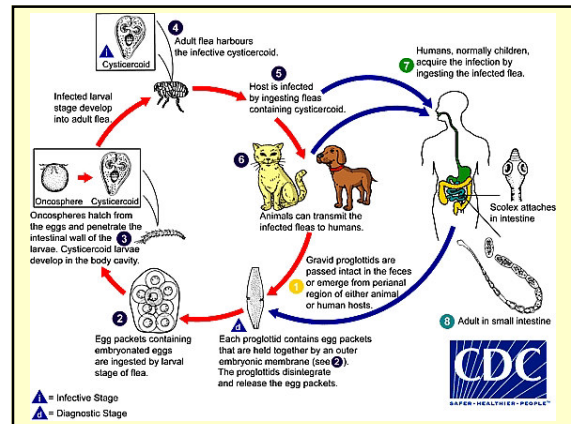
#### Alternative: Niclosamide (Yomesan® 500mg Tbl.)

- Adults: niclosamide 2 g orally once
- Children: 50 mg/kg (max. 2 g) orally once
- Niclosamide must be chewed thoroughly or crushed and swallowed with a small amount of water

**Dipylidium caninum**  
(double-pore tapeworm, flea tapeworm, cucumber tapeworm)

## Dipylidium caninum

- Zoonotic tapeworm
- Ubiquitous tapeworm of dogs and cats
- Human infections have been reported in Europe, the Philippines, China, Japan, Argentina, and the United States.
- Fleas of dogs are intermediate host
- Humans can be infected accidentally by ingestion of infected dog fleas
  - Usually children
  - Uncommon infection
- Worms can develop to maturity in the human gut



## Dipylidium caninum Clinical Presentation

- Usually asymptomatic in humans
  - Mild gastrointestinal disturbances may occur.
- Pets may exhibit behavior to relieve anal pruritis (such as scraping anal region across grass or carpeting)
- The infection is self-limiting in the human host and typically spontaneously clears by 6 weeks

## Dipylidium caninum Diagnosis

- Most striking feature in animals and children consists of the passage of proglottids
  - Proglottids have the size of rice grains
  - found in the perianal region, in the feces, on diapers, and occasionally on floor covering and furniture
  - Shed usually intact in the stool
  - Hardly any eggs in the stool
  - proglottids are motile when freshly passed and may be mistaken for maggots or fly larvae

DPDx

Adult tapeworm of *D. caninum*. The scolex of the worm is very narrow and the proglottids, as they mature, get larger.

*Dipylidium caninum* adults measure 10-70 cm long. As proglottids mature, they break off from the parent strobilia.

DPDx

*D. caninum* proglottid. The genital pores are clearly visible in the carmine-stained proglottid.

## Dipylidium caninum

- eggs are round to oval (average size 35 to 40 µm; range 31 to 50 µm by 27 to 48 µm)
- contain an oncosphere that has 6 hooklets.

*D. caninum* egg packet, containing 8 visible eggs, wet mount

DPDx

### Dipylidium caninum treatment of humans

**Praziquantel,**

- Adults: 5-10 mg/kg orally in a single-dose therapy
- not approved for treatment of children < 4 years
- but has been used in children as young as 6 months

**Niclosamide**

- Effective, alternative

- Appearance of proglottids after therapy is indication for retreatment.
- The infection is self-limiting in the human host and typically spontaneously clears by 6 weeks.


### Hymenolepis nana The Dwarf Tapeworm

### Hymenolepiasis


Hymenolepiasis is caused by two cestodes (tapeworm) species:

- *Hymenolepis nana* (the dwarf tapeworm)
  - probably the most common tapeworm in humans
  - also common in mice
- and *Hymenolepis diminuta* (rat tapeworm)
  - frequently found in rodents
  - infrequently seen in humans

### Hymenolepis nana Morphology




Scolex with rostellum and 4 suckers




3 adult Hymenolepis nana tapeworms, each 15-44mm.

- Length: 2-4 cm, 100 -200 proglottids
- Scolex 0.3 mm, Rostellum with 20-30 hooklets

### Hymenolepis diminuta Morphology



Scolex with 4 suckers but without rostellum



Adult Hymenolepis diminuta tapeworms,

- Length: 20-60 cm, 800 -1000 proglottids
- Scolex 0.2-0.4 mm, Rostellum without hooklets

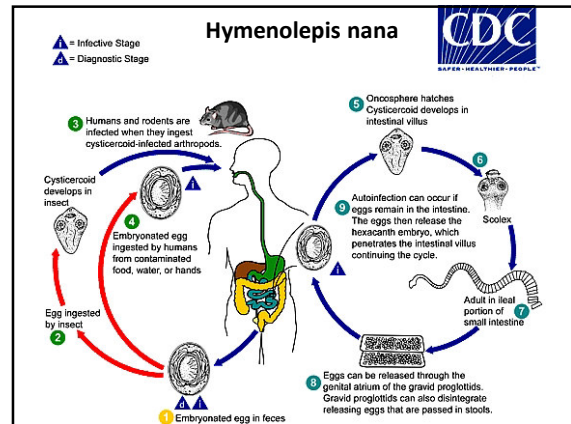
### Hymenolepiasis Geographic Distribution

- *Hymenolepis nana* is the most common cause of all cestode infections
- encountered worldwide
- estimated 75 million people infected
- In warm climates and under poor hygienic conditions prevalence in children 2-3%
- In temperate areas its incidence is higher in children and institutionalized groups.

- *Hymenolepis diminuta* has been reported from various areas of the world. Less frequent.

### Hymenolepiasis Clinical presentation

- The adult worms live in the small intestine (ileum)
- *Hymenolepis nana* and *H. diminuta* infections are most often asymptomatic
- Heavy infections with *H. nana* may cause
  - Gastrointestinal discomfort
  - Abdominal pain
  - Poor appetite / anorexia
  - Diarrhea
  - Weakness
  - Headaches
- Complications (rare): dehydration from prolonged diarrhea



### Cysticercoid

A **cysticercoid** is the larval stage of certain tapeworms. The cysticercoid larva contains the invaginated scolex of the parasite.

### Hymenolepis spp. Transmission

**Humans and other animals can become infected in 2 ways:**

- when they intentionally or unintentionally eat material containing embryonated eggs (e.g. food contaminated by insects)
- when they intentionally or unintentionally ingest arthropods containing the cysticercoid stage

### Hymenolepis nana Internal autoinfection cycle

***H. nana* is**

- the only cestode that parasitizes humans without requiring an intermediate host
- the entire life cycle to be completed in the bowel
- → infection can persist for years although lifespan of an adult is only 4-6 weeks

**How does that happen?**

- Eggs release their larva (oncospere) already within the lumen of the bowel
- Oncosphere attaches to the mucosa and develops via cysticercoid stage to an adult worm

### Hymenolepis nana Internal autoinfection cycle

- No reports on *Hymenolepis* hyperinfection syndrome in patients with
  - HIV-Infection
  - Corticosteroid therapy
 (in comparison to *Strongyloides stercoralis*)

## Diagnostic Tests

### Microscopy

- Examination of the stool for eggs and parasites confirms the diagnosis
- Concentration techniques + repeated examinations recommended to detect light infections

### Serology

- The cercocyst stage has contact with the host immune system → sufficiently predictable antibody response
- ELISA, sensitivity about 80%

## Hymenolepis nana

### Morphology of eggs



- Eggs of *H. nana*, showing 6 hooks in the oncosphere and 4-8 polar filaments within the space between the oncosphere and outer shell.
- smaller than those of *H. diminuta*, with a size range of 30 to 50 µm

## Hymenolepis nana

### Morphology of eggs



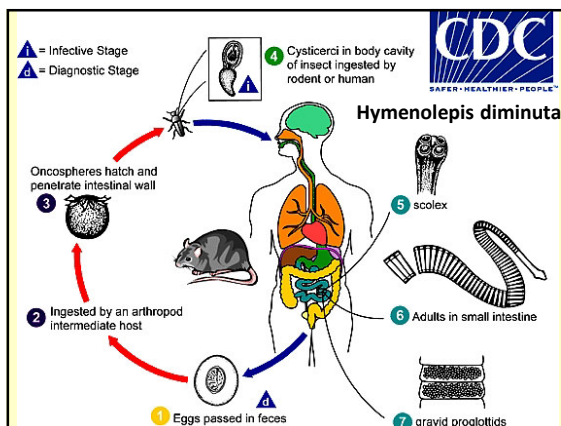
parasite.org.au

## Hymenolepis diminuta

### Morphology of eggs



- eggs are round or slightly oval, size 70 - 85 µm X 60 - 80 µm,
- striated outer membrane and thin inner membrane.
- The space between the membranes is smooth or faintly granular.
- The oncosphere has six hooks. There are no polar filaments extending into the space between the oncosphere and the outer shell.



- The red flour beetle (*Tribolium castaneum*) is a species of beetle in the family Tenebrionidae, the darkling beetles (larval stages called "mealworms")
- worldwide pest of stored products, particularly food grains
- Potential intermediate host for *Hymenolepis diminuta*

### Hymenolepiasis Treatment

**Praziquantel**

- Adults and children: 25mg/kg in a single-dose therapy

**Alternatives:**

**Niclosamide**

- Adults: 2 g in a single dose for 7 days
- Children 11-34 kg: 1 g in a single dose on day 1 then 500 mg per day orally for 6 days
- Children > 34 kg: 1.5 g in a single dose on day 1 then 1 g per day orally for 6 days

**Nitazoxanide**

- Adults, 500 mg orally twice daily for 3 days
- Children aged 12-47 months: 100 mg orally twice daily for 3 days
- Children 4-11 years: 200 mg orally twice daily for 3 days

### Hymenolepiasis Prevention

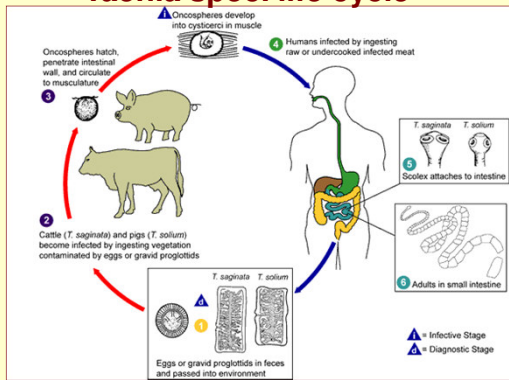
- H. nana* infection is most common in areas where sanitation and handwashing are challenging
- Hand hygiene: washing their hands with soap and warm water
- Food hygiene: washing, peeling, or cooking all raw vegetables and fruits with safe water before eating

### Taenia saginata Taenia solium Taenia asiatica

### Taeniasis Geographic Distribution

- Taenia saginata* and *T. solium* are worldwide in distribution
- Taenia solium* is more prevalent in poorer communities
  - humans living in close contact with pigs
  - eating undercooked pork
- Taenia asiatica* is limited to Asia, described in Taiwan, South Korea, Indonesia, the Philippines, Thailand, south-central China, Vietnam, Japan and Nepal

### Taenia spec. life cycle



### Taeniasis

#### Clinical Presentation of intestinal infestation

- Taenia saginata* taeniasis produces only mild abdominal symptoms
  - most striking feature consists of the passage (active and passive) of proglottids
  - Occasionally, appendicitis or cholangitis can result from migrating proglottids
- Taenia solium* taeniasis is less frequently symptomatic than *Taenia saginata* taeniasis
  - main symptom is often the passage (passive) of proglottids.



The most important feature of *Taenia solium* taeniasis is the risk of development of **cysticercosis**

**Taenia saginata / solium**  
Morphology

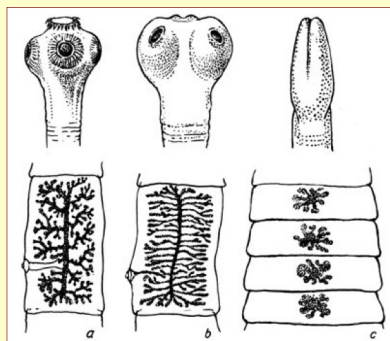
**T. saginata**

- Length of adult worms is usually < 5 m (max. 25m) with 1,000 to 2,000 proglottids
- Up to 100.000 eggs per proglottid

**T. solium**

- Length of adults 2 to 7 m with an average of 1,000 proglottids
- Up to 50.000 eggs per proglottid
- approximately 6 mature proglottids are passed in the stool per day

**Cestods: Scolex and proglottids of tapeworms**

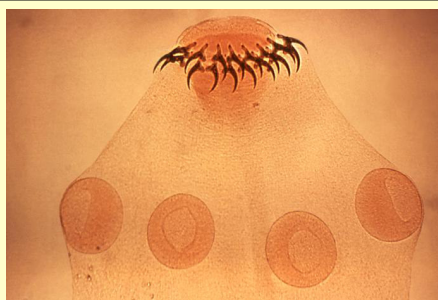


Taenia solium – pork tapeworm    Taenia saginata – beef tapeworm    Diphylobothrium latum – fish tapeworm    spektrum.de

**Taenia**  
Morphology

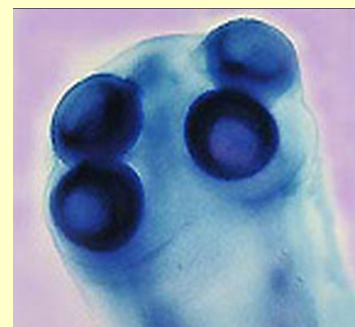


Proglottid of *T. saginata* injected with Indian Ink



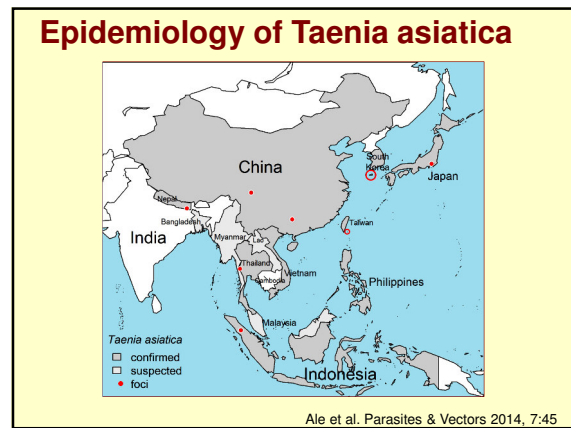
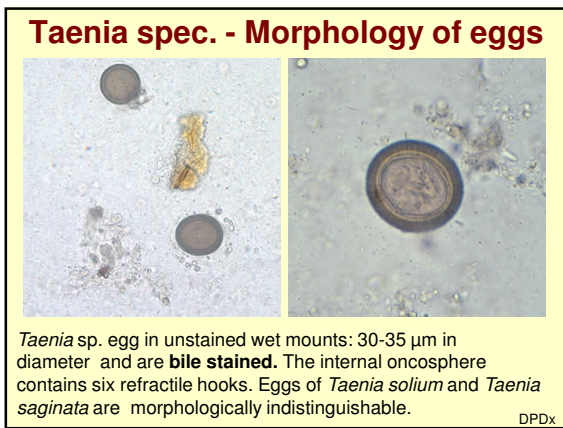
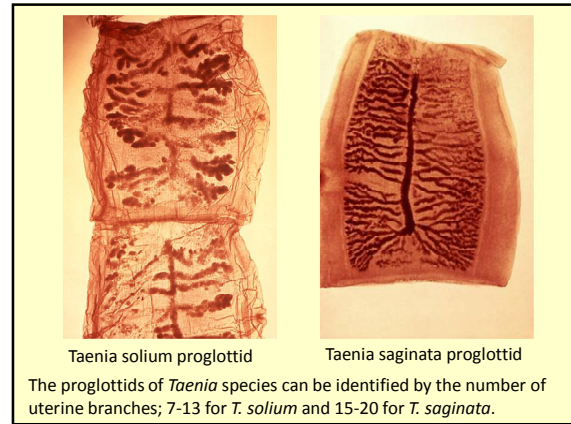
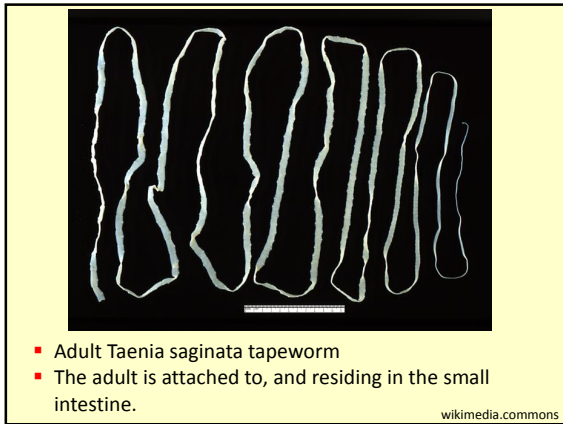
Scolex of *Taenia solium*: globular in outline with four circular suckers. Rostellum armed with double row of alternating large and small hooklets (**armed scolex**)

wikimedia.commons



Scolex of *Taenia saginata*: quadrate in outline, four circular suckers. Rostellum and hooklets are absent (**unarmed scolex**)

ASM MicrobeLibrary.org ©Garcia



***Taenia asiatica***

- First described about 50 years ago
- Based on the paradoxical observation of high prevalences of *T. saginata*-like tapeworms in non-beef consuming populations
- life cycle of *T. asiatica* is comparable to that of *T. saginata*,
  - except for pigs being the preferential intermediate host
  - liver the preferential location of the cysts
- Whether or not *T. asiatica* can cause human cysticercosis, as is the case for *Taenia solium*, remains unclear

***Taenia asiatica***

- Transmission requires in particular the consumption of raw or poorly cooked pig liver
  - transmission of *T. asiatica* shows an important ethno-geographical association !
- Molecular tools indicated that *T. asiatica* is related more closely to *T. saginata* than to *T. solium*

### Taeniasis - Diagnosis

- Microscopic identification of eggs and proglottids in feces is diagnostic for taeniasis,
  - not possible during the first 3 months following infection, prior to development of adult tapeworms (prepatence period)
  - Eggs of *Taenia* spp. are indistinguishable
- Microscopic identification of gravid proglottids (or, more rarely, examination of the scolex) allows species determination

**Take extreme care in processing unpreserved specimen. Ingestion of eggs can result in cysticercosis !**

### Taeniasis - Diagnosis

#### Serology

- Intestinal taeniasis does not result in significant antibody response
- Useful only in case of cysticercosis

### Intestinal Taeniasis Treatment

#### Praziquantel

- 5-10 mg/kg orally once for adults and for children.
- If the patient has cysticercosis in addition to taeniasis, praziquantel should be used with caution
- Praziquantel is cysticidal and can cause inflammation around dying cysts in those with cysticercosis, which may lead to seizures or other symptoms

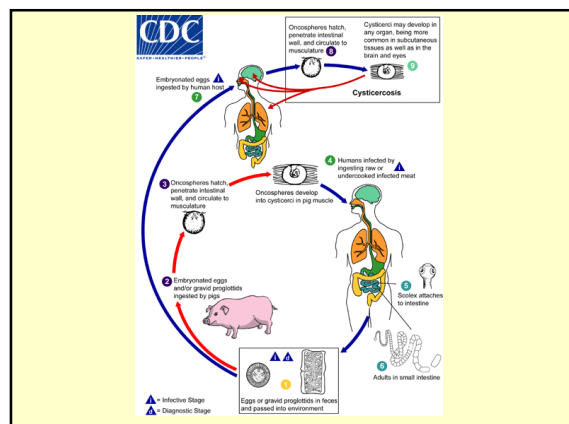
### Intestinal Taeniasis Treatment

#### Alternative: Niclosamide

- Adults: 2 g orally once
- Children 50 mg/kg orally once
- After treatment, stools should be collected for 3 days to search for tapeworm proglottids for species identification
- Stools should be re-examined for *Taenia* eggs 1 and 3 months after treatment to proof cure

## Cysticercosis

**A disease caused by the larval stage of *Taenia solium***



### Cysticercosis geographical distribution

- *Taenia solium* is found worldwide
- pigs are intermediate hosts of the parasit
  - Therefore completion of the life cycle occurs in regions where humans live in close contact with pigs and eat undercooked pork
- Taeniasis and cysticercosis are very rare in Muslim countries

### Cysticercosis geographical distribution

**But**

- human cysticercosis is acquired by ingesting *T. solium* eggs shed in the feces of a human *T. solium* tapeworm carrier
- Thus can occur in populations that neither eat pork nor share environments with pigs !

### Cysticercosis Clinical presentation

- symptoms are caused by the development of cysticerci in various sites
- Of greatest concern is cerebral cysticercosis (or neurocysticercosis) with diverse manifestations:
  - Seizures
  - Mental disturbances
  - Focal neurologic deficits
  - Signs of space-occupying intracerebral lesion
  - Death can occur suddenly

### Cysticercosis Clinical presentation

**Extracerebral cysticercosis** may present with

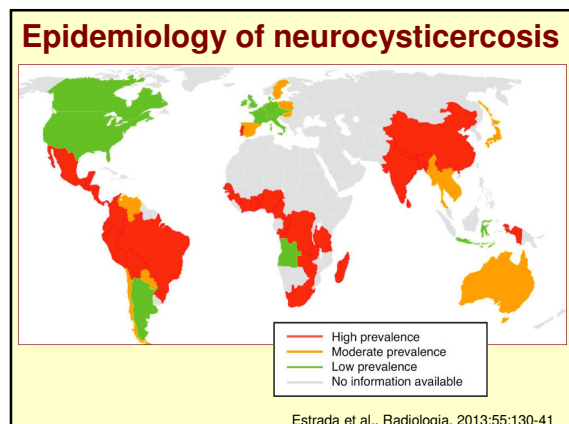
- Ocular lesions
- Cardiac
- or spinal lesions with associated symptoms
- subcutaneous nodules and calcified intramuscular nodules are common, usually asymptomatic

### Epilepsy and Neurocysticercosis (NCC)

**Systematic Review of studys from LA, SSA, Asien** (Ndimubanzi, PLOSNTDs, Nov. 2010)

- Data on the prevalence within the entire population inconsistent
- Data on NCC in patients with epilepsy showed better consistency
- Estimated prevalence from pooled data: 29.0% (95%CI: 22.9%–35.5%) of acquired epilepsy is caused by NCC

**Neurocysticercosis is the most common cause of acquired epilepsy globally**



### Prevalence of cysticercosis

- In Latin America estimated 400,000 people have symptomatic disease

#### Seroprevalence-Studies

- Mexico: between 3.1 and 3.9 %
- in areas of Guatemala, Bolivia, and Peru as high as 20 % in humans and 37% percent in pigs
- In Ethiopia, Kenya and the DR of Congo around 10% of the population seropositive
- Madagascar 16%

### Cysticercosis Diagnosis

- Imaging techniques
- Histopathology
- Serological diagnosis]
  - ELISA
  - Immunoblot
  - Individuals with intracranial lesions and calcifications may be seronegative
  - Usually not available in resource limited settings

### Neurocysticercosis Therapeutic options

#### Decision to treat is complex and depending on

- Clinical presentation
- Stage of the cysts (vital – degenerated - calcified)
- Number and location of cysts

### Neurocysticercosis Therapeutic options

- Neurosurgical intervention?
- Praziquantel
  - initially 100mg/kg, followed by 50mg/kg
- Albendazol
  - 15mg/kg for 15 days
  - Preferred treatment because of low cost and few drug interactions
  - Combination therapy?
- Steroids
  - Dexamethason 8mg daily for 15 days
  - Reduction of inflammatory reactions
- Anti-convulsive therapy

### Neurocysticercosis - Guidelines

Evidence-based guideline: Treatment of parenchymal neurocysticercosis

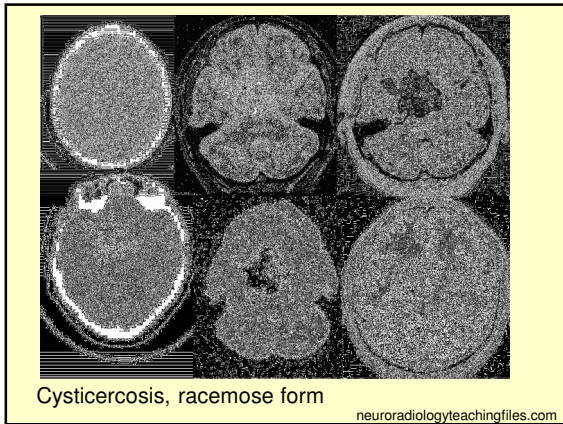
Report of the Guideline Development Subcommittee of the American Academy of Neurology

Neurology 80 April 9, 2013

- Albendazol +/- Corticosteroids effective and well tolerated
- Significant reduction in frequency of seizures
- Reduction in number and size of cysts in imaging techniques

### Racemose cysticercosis

- In subarachnoid space and fissures the cysticercus may develop into a large (- 20cm), lobulated lesion called racemose cysticercosis
- Special form, rare
- Does not build scolices
- Cysts located within the ventricles of the brain can block the outflow of CSF and cause symptoms of increased intracranial pressure



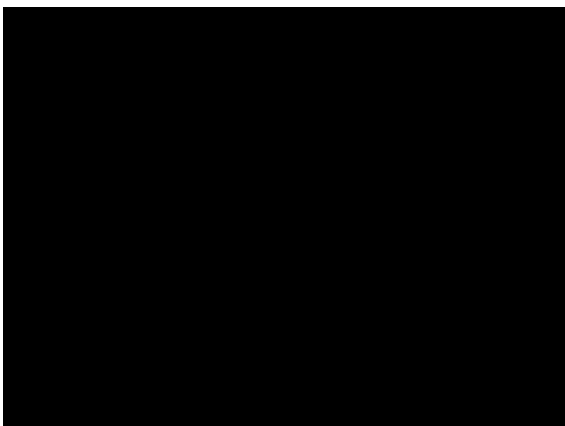
### Prevention

- Cysticercosis is considered as “tools-ready disease” according to WHO
- no animal reservoirs besides humans and pigs
- The only source of *Taenia solium* infection for pigs are humans, the definite host
- Theoretically, breaking the life cycle seems feasible

### Prevention

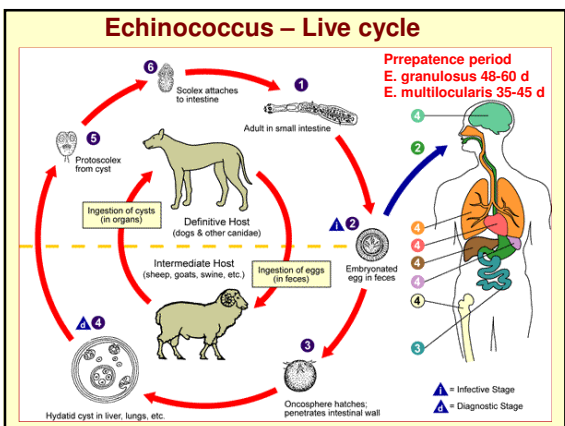
**Possible strategies**

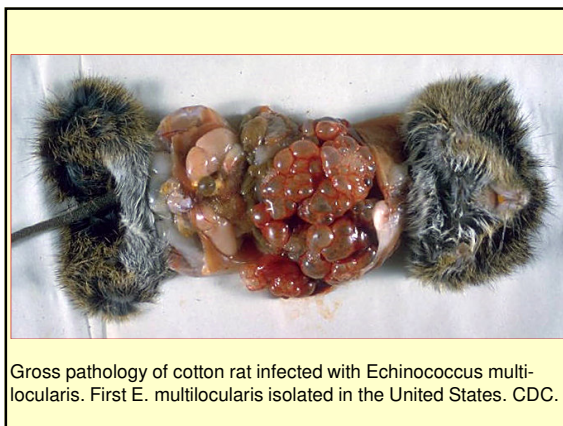
- Chemotherapy of infected individuals
- Improving sanitation and education
- Cooking of pork or freezing it
- Meat inspection
- The separation of pigs from human faeces by confining them in enclosed piggeries
- In Western European countries post pigs are housed - main reason for pig cysticercosis largely being eliminated



### Echinococcosis

- Zoonosis
- Infection occurs by oral ingestion of Echinococcus eggs
- Echinococcus eggs are excreted in the stool of infected foxes, dogs or cats
- Infection may occur by direct contact with infected animals or by ingestion of contaminated food
- Humans are an accidental intermediate host for the larval stage of the parasite
- The therapy of larval stage cestod infections continues to be a problem !





### Echinococcosis

**2 different clinical entities:**

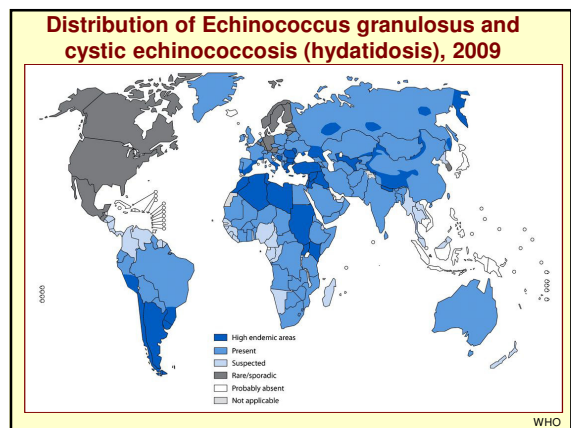
- Cystic echinococcosis
  - *Echinococcus granulosus*,
  - *E. cysticus*, Hydatidosis,
  - Dog tapeworm
- Alveolar Echinococcosis
  - Fox tapeworm
  - *Echinococcus multilocularis*

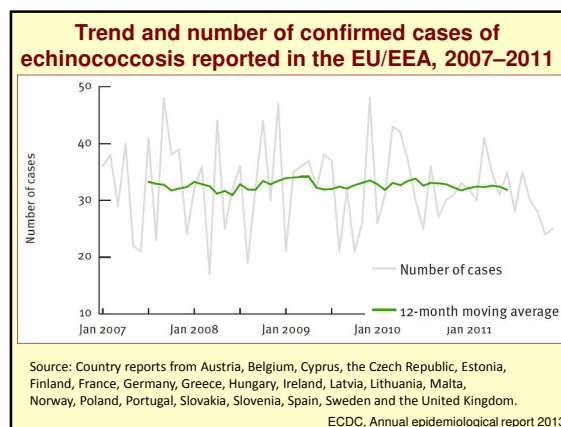
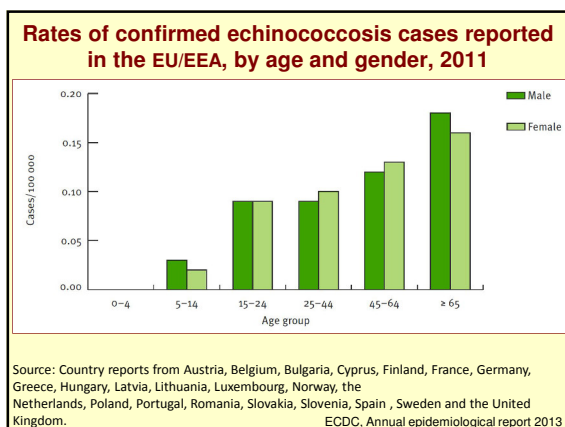
### Echinococcosis

**Rare**

- Polycystic Echinococcosis (Neotropical Echinococcosis)
- caused by *Echinococcus vogeli* or very rarely by *Echinococcus oligarthrus*

Journal of Emerging Infectious Diseases, <http://wwwnc.cdc.gov/eid/article/15/12/09-0940-11.htm>





### Echinococcosis-cases in Germany / Europe

| Year | Germany | Europe |
|------|---------|--------|
| 2007 | 89      | 966    |
| 2008 | 102     | 911    |
| 2009 | 106     | 775    |
| 2010 | 117     | 738    |
| 2011 | 142     | 783    |

- Bulgaria and Germany are the countries with the highest number of reported cases in Europe
- Bulgaria had 307 confirmed cases in 2011

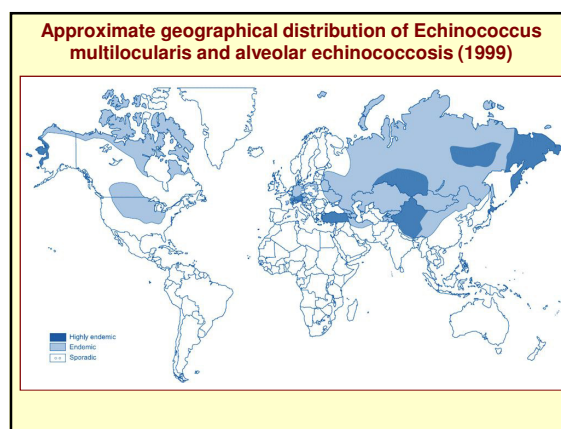
ECDC, Annual epidemiological report 2013

- ### Diagnosis of Echinococcosis
- Imaging techniques**
    - Ultrasound
    - CT
    - MRT
    - FDG-PET-CT
  - Serology**
    - Measuring serum antibodies against *Echinococcus multilocularis* or *Echinococcus granulosus*
  - Microscopy / Histology**
    - Biopsies, Aspiration
  - PCR for Echinococcus-DNA**
    - Differentiation of species possible

### Diagnosis of Echinococcosis: Imaging techniques

|     | CE1 | CE2 | CE3a | CE3b | CE4 | CE5 |
|-----|-----|-----|------|------|-----|-----|
| US  |     |     |      |      |     |     |
| MRI |     |     |      |      |     |     |
| CT  |     |     |      |      |     |     |

CE1: unilocular, simple cysts with liquid content and often with the CE1-specific "double line sign"  
 CE2: multivesicular, multiseptated cysts  
 CE3a: cysts with liquid content and the CE3a-specific detached endocyst  
 CE3b: unilocular cysts with daughter cysts inside a mucinous or solid cyst matrix  
 CE4: heterogenous solid cysts with degenerative, CE4-specific canalicular structure of the cyst content  
 CE5: cysts with degenerative content and heavily calcified wall.





### Diagnosis of Echinococcosis: Imaging techniques

- Ultrasound is the most important imaging technique for diagnosis, staging and follow-up
- MRI reproduces the details visible in sonography better than CT-scan
- In case sonography is not possible MRI with a T2-weighted series should be preferred to CT
- FDG-PET-CT might be useful prior to operation or for follow-up in cases of in E. multilocularis

Diagnosing and Staging of Cystic Echinococcosis: How Do CT and MRI Perform in Comparison to Ultrasound? Stojkovic et al., PLOSNTD October 25, 2012

### Diagnosis of Echinococcosis: Serology

- Specific antigens available
  - Available tests usually not standardised
  - Specificity and sensitivity frequently not known
- Sensitivity of serological tests is depending on different factors like location, size, stage of cysts
- Early cyst stages (C1) and the stage of involution (C5) frequently seronegative

### Diagnosis of Echinococcosis: Serology

- Screening test usually haemagglutination test
  - Fluid from a E. granulosus hydatid is used as raw antigen.
  - Sensitivity ca. 80% for CE, ca. 94-97% for AE
- Confirmation test for AE with purified / recombinant antigens
  - Em2plus-ELISA
  - Sensitivity 90-100%
  - Speceficity 95-100%

### Diagnosis of Echinococcosis: Serology

- Serological surveys in southern Germany showed a rate of seropositive cases up to 2% without evidence of echinococcus infection of the liver
- A positive serological tests does not proof that there is an infection.
- A negative serological test does not rule out for sure that there is an Echinococcus infection.

### Therapy of Echinococcosis

- **Echinococcus granulosus (cysticus)**
  - Surgery
  - PAIR (Puncture, Aspiration, Injection of a scoleccidal agent and Reaspiration),
  - Chemotherapy: Albendazol
  - „Wait and Watch“ - Strategy
- **Echinococcus multilocularis (alveolaris)**
  - Surgery
  - Chemotherapy: Albendazol, liposomal Amphotericin B
  - Liver transplantation

### Echinococcosis – When to consider?

- Cystic liver lesion, especially in patients coming from endemic areas, e.g. migrants
  - Stage CE1 difficult to differentiate from dysontogenic liver cysts
  - Serology frequently negative in case of small cysts
  - Follow up by ultrasound + serology
- Obscure hypoechoic / inhomogenous lesion in the liver with undefined margins: suspicious of an infiltrating malignant tumor
  - History: dog owner, Hunter

### Echinococcosis Prevention

- Do not feed dogs with raw offal from slaughtered animals
- Regular deworming of dogs / cats
  - Minimum every 3 months
- Careful handling of animals with high rate of echinococcus infections, e.g. foxes

### Prevention of cystic echinococcosis

**Cystic echinococcosis is controlled by preventing transmission of the parasite**

- Prevent dogs from feeding on the carcasses of potentially infected animals, esp. sheep, do not feed them on raw offal !
- Regular deworming of dogs
- Control of stray dog populations
- Restrict home slaughter of sheep and other livestock.
- Wash your hands with soap and warm water after handling dogs, and before handling food.

### Prevention of alveolar echinococcosis

**Alveolar echinococcosis can be prevented by avoiding contact with wild animals such as foxes, coyotes, and dogs and their fecal matter**

- Do not allow dogs to feed on rodents and other wild animals
- Regular deworming !
- Avoid contact with wild animals such as foxes, coyotes and stray dogs
- Do not encourage wild animals to come close to your home or keep them as pets

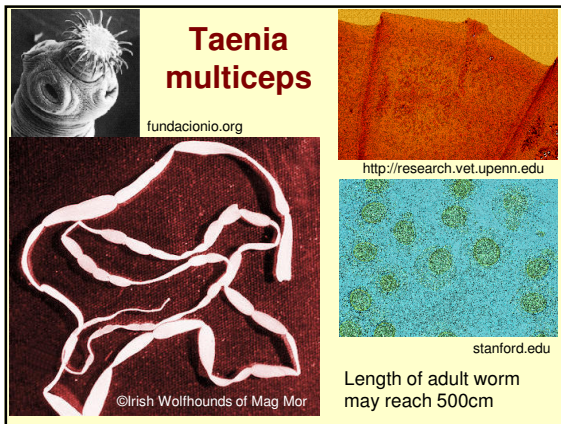
### Coenurosis

#### Taenia multiceps and Taenia serialis

- Coenurosis is infection by the metacestode larval stage (coenurus) of *Taenia multiceps* and *T. serialis*.
- Coenurosis is a zoonosis
- Coenuri of *T. multiceps* are usually found in the eyes and brain; those of *T. serialis* are usually found in subcutaneous tissue.

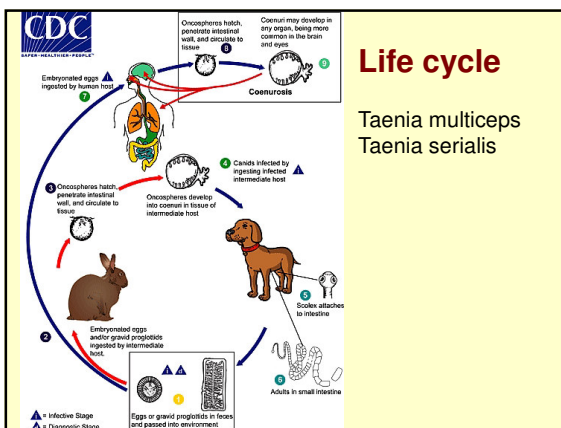
### Geographic Distribution

- Widespread, most of the cases are from Africa
- Few cases reported from sheep-raising areas of Europe, South America, the United States and Canada.
- Many **canids** can serve as definitive hosts for *T. multiceps*,
- Only **dogs and foxes** can serve as definitive hosts for *T. serialis*.
- Many animals may serve as intermediate



**Coenurosis**  
colloquial term „gid” or “sturdy”

Parasitic disease primarily of sheep causing neurological sequelae

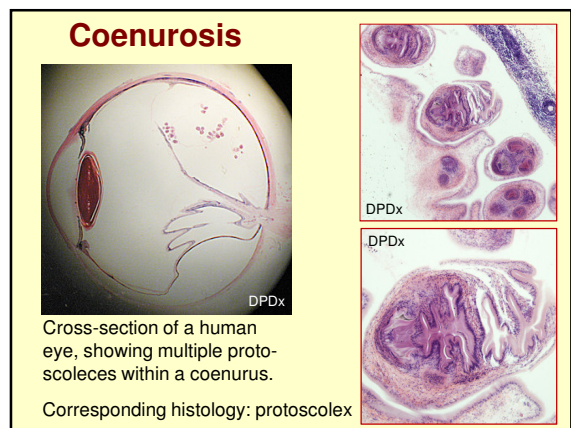


**Coenurosis**  
**Clinical Presentation**

- Coenuri in the skin or subcutaneous tissue usually present as painless nodules. The lesions are often fluctuant and tender.
  - Most subcutaneous nodules manifest on the trunk, sclera, subconjunctiva, neck, shoulders, head and limbs.
- Clinically, coenuri may mimic lymphomas, lipomas, pseudotumors, or neurofibromas.
- Coenuri in the central nervous system may cause headache, fever and vomiting

**Coenurosis**  
**Clinical Presentation**

- Localizing neurologic symptoms may also develop, including nerve palsies, jacksonian epilepsy, pachymeningitis
- obstructive or communicating hydrocephalus, and intracranial arteritis with transient hemiparesis.
- Coenuri in the eye cause both intraocular and orbital infections
  - patients may present with varying degrees of visual impairment.
  - If not removed, coenuri in the eye may cause painfu



### Laboratory Diagnosis

- Diagnosis is made by the observation of coenuri in biopsy or autopsy specimens.
- Coenuri are usually readily distinguished from cysticerci by the presence of multiple protoscolices.

### Coenurosis Treatment

- Usual treatment for intracranial coenurosis is surgical excision
- Eye surgery is an option for ocular coenurosis, recovery of vision has been reported
- Coenuri are susceptible to praziquantel, but
- In intraocular coenurosis praziquantel may cause death of the parasite followed by a severe inflammatory reaction resulting in

### Taenia crassiceps

- *Taenia crassiceps* is tapeworm of foxes and coyotes (prairie wolf) (definitive host), less frequently found in dogs and rarely in cats
- Intermediate hosts are rodents
- The larval stage (cysticercus longicollis) multiplies within internal organs of the intermediate host by asexual budding

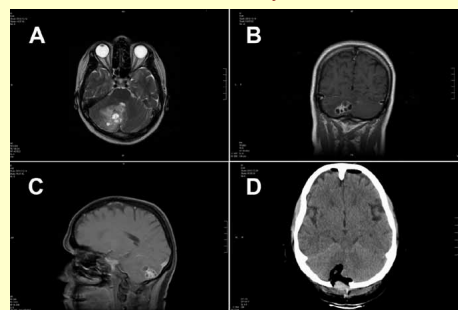
### Taenia crassiceps human cases

- Very rarely found in humans
- Infection of humans is thought to occur after consumption of food or water contaminated with infective ova shed in carnivore feces
- Nearly all recognized cases involving the muscles or subcutis of humans have been associated with underlying immunosuppression
- In contrast, intraocular infections do not

### Taenia crassiceps Geographic distribution

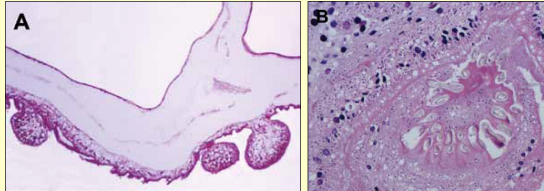
- Northern hemisphere
  - North America, Europe, and Russia
- Prevalence among foxes in Germany (24%) and Lithuania (26.4%) is high, in Denmark (0.2%) low

Cerebellar Cysticercosis Caused by Larval *Taenia crassiceps* Tapeworm in Immunocompetent Woman, Germany



Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 19, No. 12, December 2013

**Cerebellar Cysticercosis Caused by Larval *Taenia crassiceps* Tapeworm in Immunocompetent Woman, Germany**



- A) Section through parasite body showing multiple connected bladders (asexual buddings) at the caudal end.  
 B) Transverse section through the parasite's protoscolex showing numerous hooklets, similar to *T. solium* tapeworm larvae.

Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 19, No. 12, December 2013

**Cerebellar Cysticercosis Caused by Larval *Taenia crassiceps* Tapeworm in Immunocompetent Woman, Germany**

- The source of infection for the patient remained unclear
- Her dog was probably the major risk factor
  - allowed to roam freely in the nearby forest
  - Did not have regular deworming
- Preventive measure: carnivorous pets should undergo regular deworming !

**Cerebellar Cysticercosis Caused by Larval *Taenia crassiceps* Tapeworm in Immunocompetent Woman, Germany**

- Serologic test results for echinococcosis were negative
  - crude and recombinant antigen
  - ELISAs and indirect hemagglutination test results were negative (11)
- Commercial Western blots for cysticercosis and echinococcosis showed weak atypical bands of ≈47 kDa and 30 kDa, respectively

**Cerebellar Cysticercosis Caused by Larval *Taenia crassiceps* Tapeworm in Immunocompetent Woman, Germany**

- The patient underwent neurosurgery
- Histology revealed structures typical for cestod larval infection
- Final diagnosis was made by cestode-specific PCRs selective for the parasite's mitochondrial 12S rRNA gene and mitochondrial cytochrome c oxidase subunit I gene
- After sequencing and comparison with genome-databases sequences showed 99% and 100% homology with the *T. crassiceps* tapeworm,

**Cerebellar Cysticercosis Caused by Larval *Taenia crassiceps* Tapeworm in Immunocompetent Woman, Germany**

- After surgery, the patient was given praziquantel (600mg bid) and albendazole (400 mg bid) for 3 months.
- postoperative course was uneventful,
- the patient recovered rapidly
- No clinical or radiographic signs of recurrence after a followup period of 18 months