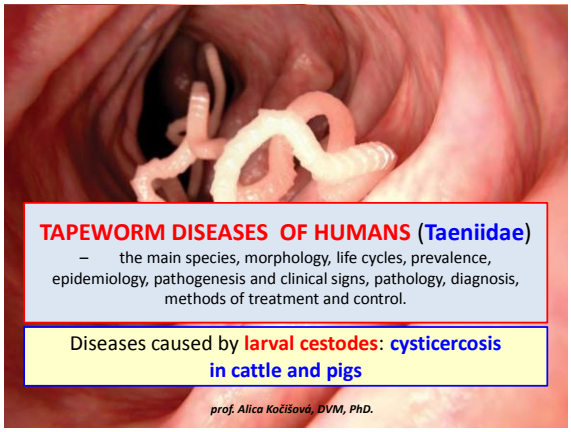


TAPEWORM DISEASES OF HUMANS (Taeniidae)

– the main species, morphology, life cycles, prevalence, epidemiology, pathogenesis and clinical signs, pathology, diagnosis, methods of treatment and control.

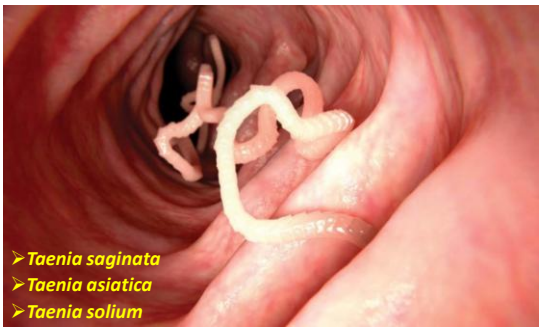
Diseases caused by **larval cestodes: cysticercosis in cattle and pigs**

prof. Alica Kočišová, DVM, PhD.

Taeniidae

Taenia	
Taenia hydatigena	**- cysticercus tenuicollis**
T. multiceps	**- coenurus cerebralis**
T. ovis	**- cysticecus ovis**
T. pisiformis	**- cysticercus pisiformis**
T. serialis	**- coenurus serialis**
T. cervi	**- cysticercus cervi**
T. krabbei	**- cysticercus tarandi**
T. taeniaeformis	**- cysticercus fasciolaris**
T. saginata	**- cysticercus bovis**
T. solium	**- cystircus celulosae; cysticercus racemosus**
Echinococcus	
Echinococcus granulosus	**- echinococcus**
E. multilocularis	**- alveococcus**

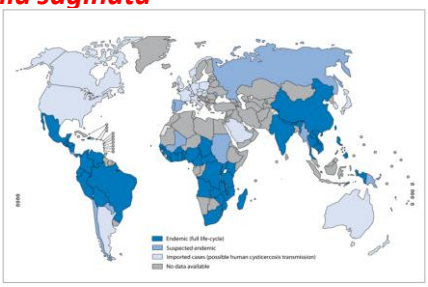
TAPEWORM DISEASES OF HUMANS
Taeniidae



- ***Taenia saginata***
- ***Taenia asiatica***
- ***Taenia solium***

Species/lenght	Distribution	Location/Prepatency	IH/Metacestodes
Taenia saginata Up to 10 m	Worldwide	Small intestine 12-14 weeks	Cattle, buffalo; **Cysticercus bovis** (striated muscles)
Taenia asiatica 4-8 m	East and South-East Asia	Small intestine 11 weeks	Pig, rarely cattle **Cysticercus viscerotropicus** (liver)
Taenia solium 3-4 m	Latin America, India, South East Asia, Sub-Saharan Africa, rare in Europe	Small intestine 9-10 weeks	Domestic and wild pig **Cysticercus cellulosae** (striated muscles, subcutis, CNS, eye and other organs)

Taenia saginata



Epidemiology

- Developed states around 1% of animals
- Developing countries up to 60%;
- WHO approximately 50 million people yearly infected

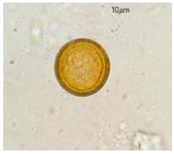
Taenia saginata
„The Beef Tapeworm"

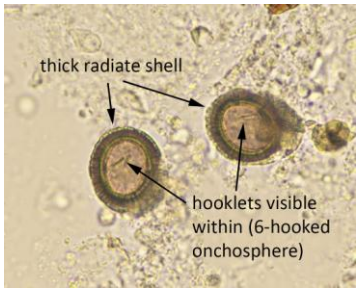
- Commonest Taenia infection
- **Adult**: 4 – 10 m (rarely up to 25 m)
- Scolex 4 suckers no hooks

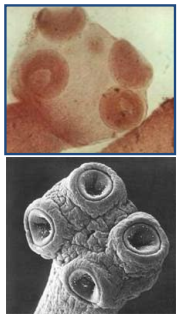
- Gravid proglottids (lateral uterine branches 14 - 32) and **leave the host spontaneously !** (6 – 9 proglottids within a short time)
- Each segment contains about 80 000 eggs

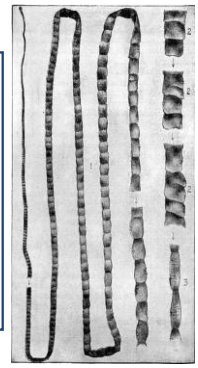
Egg

- Identical between species, spherical, 35 – 45 µm, gelatinous outer coat, thick striated embryophore, oncosphere inside egg with hooklets

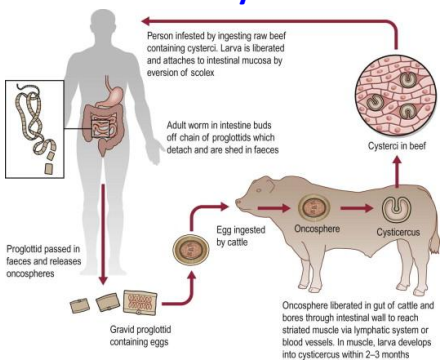








Life cycle



Epizootiology / Epidemiology

- **Eggs tend to be dispersed widely and can survive for a half to one year under favorable conditions !!**
- **They remain infectious for 71 days in liquid manure,**
- **16 days in city sewage,**
- **33 days in river water and**
- **159 days on pastures**
- **After beeing ingested by IH *Cysticercus bovis* develops in 10 to 12 weeks**
- **FH is infected by ingestion of raw or poorly cooked beef**

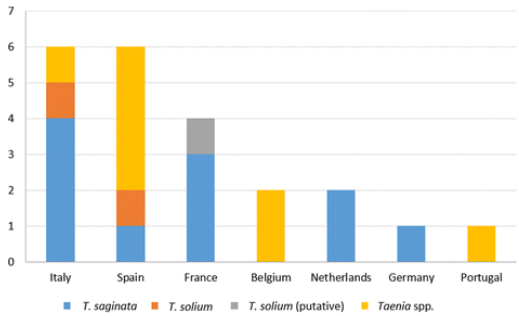
- **Human infection highest in areas of world where beef is a major source of food and sanitation is poor.**
- **In developing nations, there is ample opportunity for cows to eat the eggs of the tapeworm, and for people to eat infected meat.**
- **Customs may have effect on infection rates.**
- **Despite good sanitation systems in any country, it is possible for cattle to be exposed to *T. saginata* eggs.**

- Cysticerci are **susceptible to high temperatures**,
- Freezing at <5 °C for more than 4 days destroys cysticerci; (-10 °C in 10 days or -18 °C in 5 days)

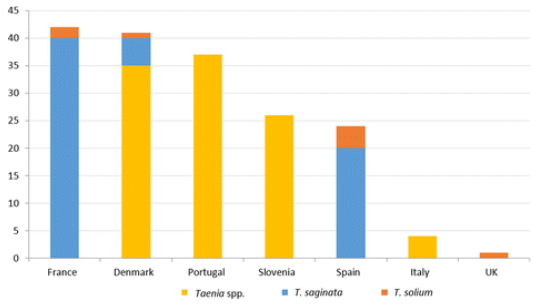
- In spite of the EU directives that regulate meat inspection for bovine cysticercosis, *Taenia saginata* is **still present in Europe** and causes economic losses due to condemnation, refrigeration and downgrading of infected carcasses.
- The main reasons for this persistence include the low sensitivity of current meat inspection protocols, the dissemination and survival of eggs in the environment and cattle husbandry systems, which allow grazing on pastures and drinking from water streams.
- It is assumed that water streams and surface water are potentially contaminated with *T. saginata* eggs. Furthermore, current wastewater management not only fails to halt, but rather contributes to the dissemination of eggs in the environment.
- **Taeniosis is not a notifiable disease.**

Number of identified taeniosis cases in case reports in western Europe (1990–2015)

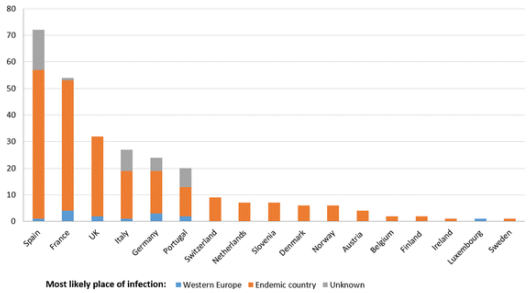
(Laranjo-González et al. Parasites & Vectors (2017).



Number of aggregated taeniosis cases reported at hospital/laboratory level in western Europe (1990–2015).
(Laranjo-González et al. Parasites & Vectors (2017).



Number of identified human cysticercosis cases in case reports in western Europe (1990–2015)
(Laranjo-González et al. Parasites & Vectors (2017).



Pathogenesis

Symptoms include:

- **Disease characteristics of *T. saginata* infection are similar to those of infection by any large tapeworm.**
- **Most are asymptomatic or mild-moderate symptoms.**
- **Dizziness, abdominal pain, diarrhea, headache, localized sensitivity to touch, and nausea.**
- **Delirium is rare, but can occur.**
- **Intestinal obstruction with need for surgical intervention sometimes occurs.**
- **Hunger pains, universally accepted by lay people as a symptom of tapeworm infection, are uncommon.**
- **Loss of appetite is very common.**

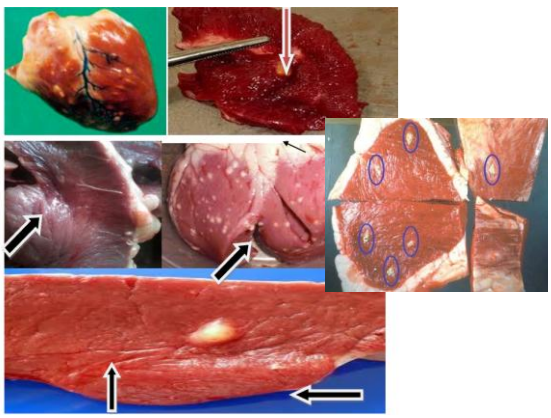
Pathogenesis

More symptoms

- **Worms release antigens, which can cause allergic reactions.**
- **It is hard to estimate psychological effects on an infected person of observing nonstop passage of proglottids out of the anus.**

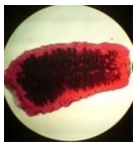
Bovine cysticercosis

- Cestodosis characterized by **myositis** and cysticeroid formation;
- Cysticecus bovis (***Taenia saginata***) MH - striated muscles of HD (masticatory muscles, tongue, intercostal muscles and heart), buffalo, how, zebra, sheep, goat and man;
- Cysticercosis - no symptoms, severe infection - triage disorder, weakness, diarrhoea, movement pain, cardiac disorder;
- In man - without symptoms, probably epigastric pain, anorexia, diarrhoea, waiting for poverty Therapy: -



Diagnosis

- Microscopic identification of eggs and proglottids in feces is diagnostic for taeniasis, but is not possible during the first 3 months following infection, prior to development of adult tapeworms.
- Microscopic identification of gravid proglottids (or, more rarely, examination of the scolex) allows species determination.
- Repeated examination and concentration techniques will increase the likelihood of detecting light infections. *Ag-ELISA*



Treatment

- Niclosamide and praziquantel are the drugs of choice.

Praziquantel

- Novel antihelmintic, board range of activity against trematodes (*Schistosomes*), cestodes but not nematodes.

MOA:

Rapidly taken by the susceptible worms and causes leakage of intracellular calcium → contracture and paralysis →Loss of intestinal mucosal grip→expelled.

ADRS:

- Bitter taste, nausea, abdominal pain
- Headache, dizziness and sedation.

Uses:

- Tapeworm infestations
- Neurocysticercosis
- Schistosomes
- DOC for all flukes except liver fluke.

Control and Prevention

- One infected person who defecates in a pasture where cattle feed, can quickly infect the entire herd.
  - Using night soil fertilizer has the same effect.
- Shelled eggs can remain viable in liquid manure for 71 days, in untreated sewage for 16 days, and on grass for 159 days.
- Cattle are coprophagous, and will often eat human feces, wherever they can find it.

Prevention is easy:

- Cook meat until well done (i.e. NO pink), because cysticerci are killed at 56 °C
- Meat is also safe to eat if it has been frozen at -10 °C for at least a week.
- Avoid using night soil as fertilizer in cow pastures.
- Avoid defecating in cow pastures as well.

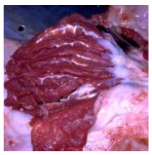
Meat inspection at slaughter houses

Predilection location:

- Masseters, cardiac muscle, diaphragm,muscles of the trunk
- For prophylaxis beef should be eaten after sufficient heating (over 60 °C) or freezing (- 10 °C for 10 days or -18 °C for 5 days)

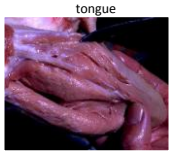
Meat inspection

neck

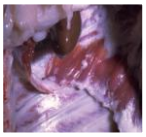


heart

tongue



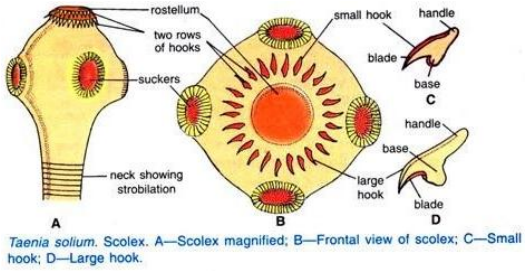
diaphragma



esophagus

Taenia solium

"The Pork Tapeworm"



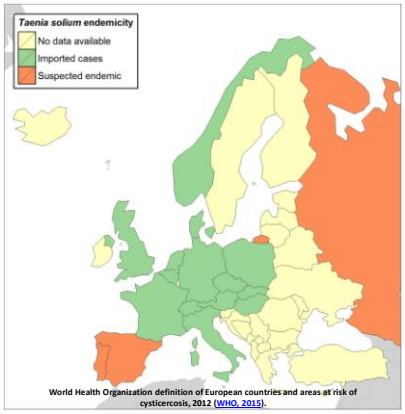
Taenia solium. Scolex. A—Scolex magnified; B—Frontal view of scolex; C—Small hook; D—Large hook.

Taenia solium

Pork Tapeworm

- Recognised since biblical times
- Adult: 3 – 8 m long
- Less than 1000 proglottids
- Gravid proglottids – uterus 7 – 16 lateral branches
- Each segment contains cca 40 000 eggs, they do not leave the host spontaneously

- Matures in 5-12 weeks
- Usually long lived (25 years) single worm

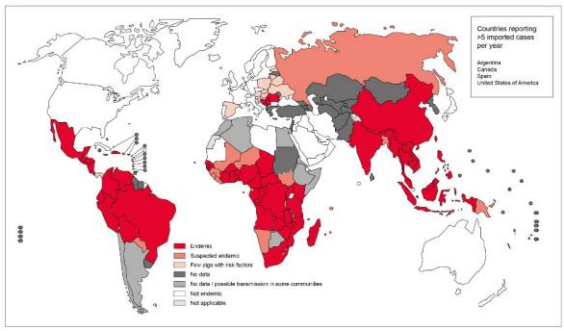


World Health Organization definition of European countries and areas at risk of cysticercosis, 2012 (WHO, 2015).

Porcine cysticercosis cases reported to the World Organisation for Animal Health from 2005 onwards (sorted by period).

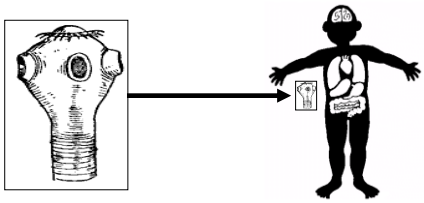
Country	Region	Period	Number of cases
Slovakia	Banska Bystrica	Jun 2014	1
Slovakia	Banska Bystrica	Nov 2013	1
Romania	Ialomita	Dec 2013	3
Spain	Catalonia	Jan–Jun 2013	5
Romania	Satu Mare	Mar 2011	1
Romania	Satu Mare	Feb 2011	1
Serbia	Whole country	Jul–Dec 2009	65
Bulgaria	Whole country	Jan–Jun 2009	3
Spain	Andalusia	Jan–Jun 2009	7
Spain	Andalusia	Jul–Dec 2008	1
Bulgaria	Whole country	Jan–Jun 2008	12
Spain	Catalonia	Jan–Jun 2008	1
Spain	Madrid	Jan–Jun 2008	47
Bulgaria	Whole country	Jul–Dec 2007	3
Spain	Catalonia	Jul–Dec 2007	233
Slovenia	Maribor	Nov 2007	1
Bulgaria	Whole country	Jan–Jun 2007	30
Bulgaria	Whole country	Jul–Dec 2006	152
Serbia and Montenegro	Whole country	Jul–Dec 2006	4
Spain	Catalonia	Jan–Jun 2006	37
Bulgaria	Whole country	Jan–Jun 2006	316
Slovenia	Maribor	Jan 2006	1
Bulgaria	Whole country	Jul–Dec 2005	205
Bulgaria	Whole country	Jan–Jun 2005	136

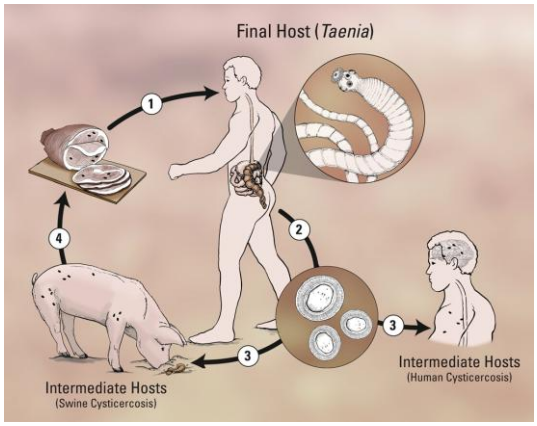
Endemicity of *Taenia solium*, 2015



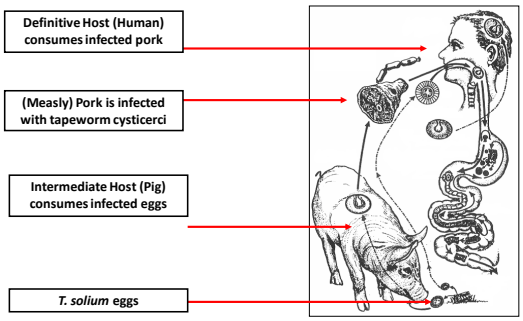
Hosts to *T. solium*

- **Humans are the only definitive host for *T. solium* (absolute host specifity).**



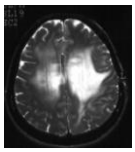


Definitive Host - Humans

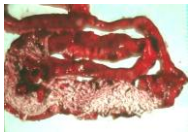


Taenia solium causes two different diseases…

1. **CYSTICEROSIS** – muscle tissues
   - Eggs cross digestive tract, enter circulation, and lodge in muscle tissues
   - If it's in the brain it's *neurocysticerosis*



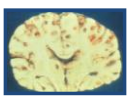
2. TAENIASIS – digestive tract
   - Develops when adult tapeworm infects human intestine
   - Asymptomatic but continuous source of eggs in the feces



Affects in the Human - Larva

Affects C.N.S. and brain

- severe pain, paralysis, and epileptic convulsions
- swelling of the brain (hydrocephalus)
- loss of consciousness or even death!



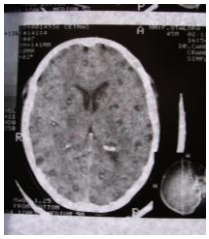
Other Muscle Tissue

- May feel lumps
- Asymptomatic unless involving ocular tissue, then…
- Great discomfort and possible detachment of retina

The annual mortality rate is approximately 50,000 cases worldwide!

Clinical manifestations of Cysticercosis

- **NEUROCYSTICERCOSIS**
  - **Severe headaches**
  - **Encephalitis**
  - **Increase in emergency**
- **Ocular form of cysticercosis**
- **Muscular form of cysticercosis**
- The symptoms are related to the site of infection.
- The patients may manifest headache, nausea, vomiting, epilepsy, paralysis, weakness in limbs, diplopia, dizziness, mental disorder.
- Epilepsy is the most frequent symptoms of brain cysticercosis.



cysticercus in the tongue

Subcutaneous and muscular form of cysticercosis

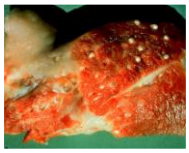
- **The subcutaneous nodules are usually found in head, limbs, neck, abdomen and back.**
- **They are movable and painless.**

X-ray arms with many *Taenia solium* cysticerci

X-ray legs with many calcified *Taenia solium* cysticerci

Pig cysticercosis

- ***Cysticercus cellulosae***



Life Cycle in the Human - Adults

- However, sometimes there are non-specific symptoms that form such as constipation or diarrhoea.
- Occasionally, appendicitis can result from migrating proglottids.
- Very rarely is there perforation of the intestinal wall - peritonitis.
- 25% of cysticercosis infections are acquired by the **autoinfection**.

Diagnosis and Treatment

Diagnosis of taeniosis

- Taeniasis - eggs occur in stool 8-12 weeks after infection.
- finding gravid proglottides
- Stool samples can diagnose both cysticercosis and teniasis but is not possible during the first 3 months following infection.

Treatment

- Treatment is simple and very effective.
- Praziquantel is the drug of choice.
- Appropriate drug therapy seems to be the only treatment. There is no immunization available at this time.

Diagnosis and Treatment

Diagnosis of cysticercosis

- Biopsy of subcutaneous nodules,
- ophthalmoscope examination is used for ocular form.
- surgical removal
  - X ray - calcified larvae
  - CT scan or MRI for brain lesions
  - Fine needle aspirate
  - Serology/PCR

Therapy

- Surgical removal is required for ocular and superficial cysticercoses.
- Praziquantel

Prevention

Try to keep stable, sanitary conditions in impoverished areas.

Ensure that pork is cooked thoroughly before eaten.

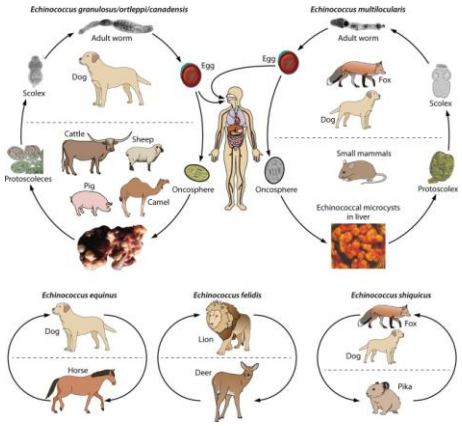
- **Health education**
- **Avoid eating raw bean-pork.**
- **Avoid pigs eating human stool.**
- **Sanitary inspection of slaughter and sanitary disposal of night soil.**

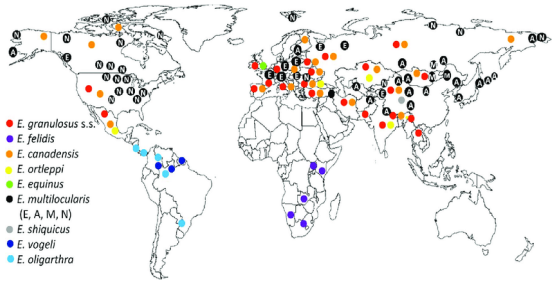
Echinococcus

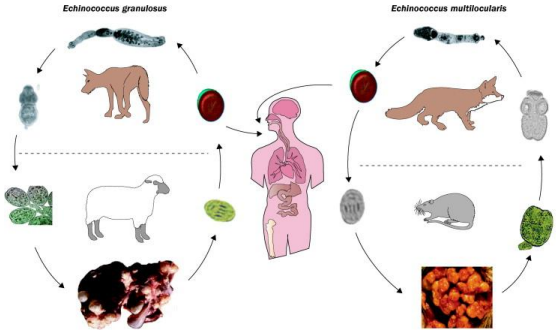
- ***Echinococcus granulosus s.s.***
- ***Echinococcus multilocularis***
- ***Echinococcus equinus***

- *Echinococcus ortleppi*
- *Echinococcus intermedius*
- *Echinococcus canadensis*
- *Echinococcus felidis*
- *Echinococcus vogeli*
- *Echinococcus oligarthrus*
- *Echinococcus shiquicus*

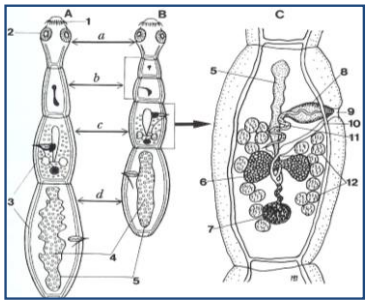
According to Directive 2003/99 / EC of the European Parliament and of the Council on the monitoring of zoonoses and zoonotic agents, Echinococcosis has been included in group "A" requiring continuous monitoring of its occurrence in all EU Member States.

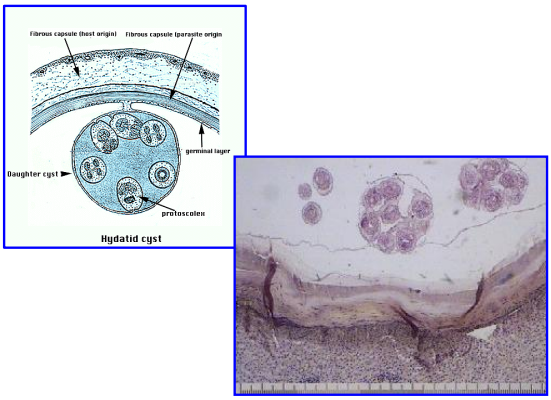


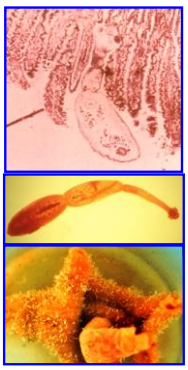




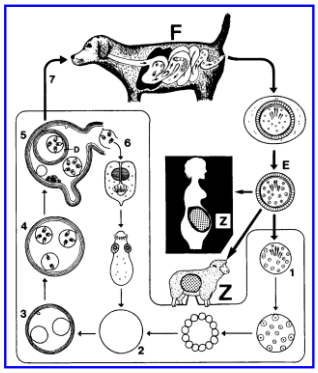
Echinococcus granulosus
Echinococcus multilocularis







Echinococcus granulosus

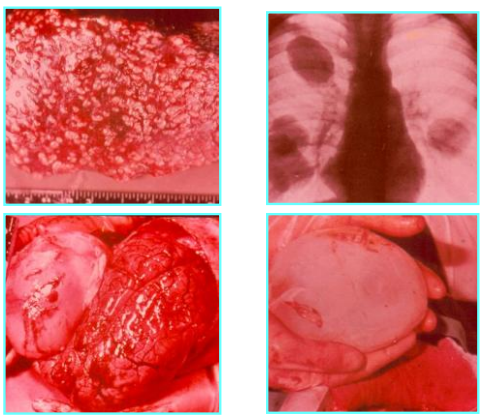


Clinical Features:

- *Echinococcus granulosus* infections remain silent for years before the enlarging cysts cause symptoms in the affected organs. Hepatic involvement can result in abdominal pain, a mass in the hepatic area, and biliary duct obstruction.
- Pulmonary involvement can produce chest pain, cough, and hemoptysis.
- Rupture of the cysts can produce fever, urticaria, eosinophilia, and anaphylactic shock, as well as cyst dissemination. In addition to the liver and lungs, other organs (brain, bone, heart) can also be involved, with resulting symptoms.

Echinococcus granulosus

Hydatid cyst in the brain



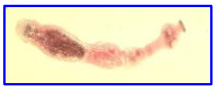
Laboratory Diagnosis

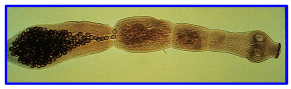
- The diagnosis of echinococcosis relies mainly on findings by ultrasonography and/or other imaging techniques supported by positive serologic tests.
- In seronegative patients with hepatic image findings compatible with echinococcosis, ultrasound guided fine needle biopsy may be useful for confirmation of diagnosis; during such procedures precautions must be taken to control allergic reactions or prevent secondary recurrence in the event of leakage of hydatid fluid or protoscolices.
- **Diagnostic findings**
- Microscopy
- Antibody detection

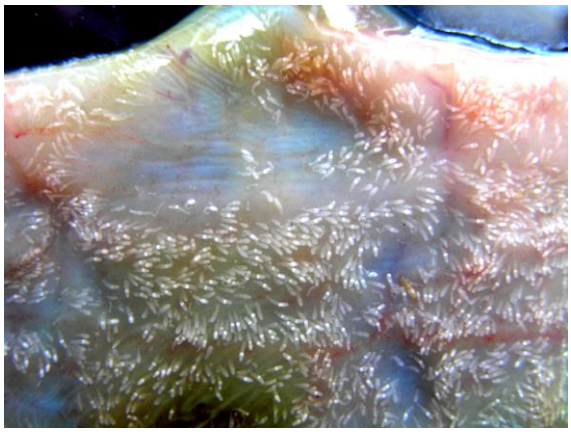
Treatment

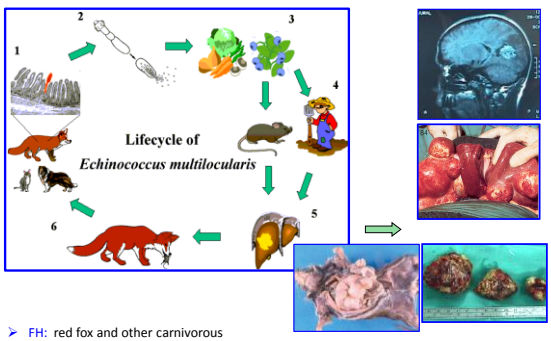
- Surgery is the most common form of treatment for echinococcosis, although removal of the parasite mass is not usually 100% effective.
- After surgery, medication may be necessary to keep the cyst from recurring.
- The drug of choice for treatment echinococcosis is albendazole (*Echinococcus granulosus*).

Echinococcus multilocularis





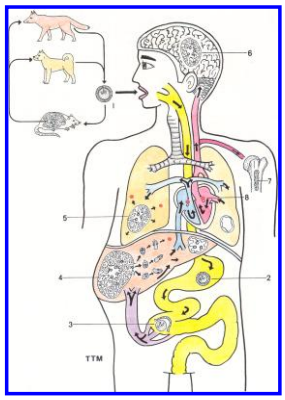




- FH: red fox and other carnivorous
- IH: small rodents (***Arvicola terrestris***), human, pig, ruminants

Prepatent periode: < 26 days

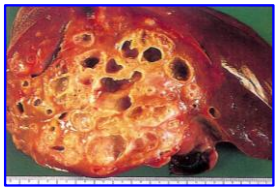
Patent periode: 1.5 – 4 monthes



Liver from healthy rodent (right) and rodent with *Echinococcus multilocularis* (left).

Clinical Features

- *Echinococcus multilocularis* affects the liver as a slow growing, destructive tumor, with abdominal pain, biliary obstruction, and occasionally metastatic lesions into the lungs and brain.
- *Echinococcus vogeli* affects mainly the liver, where it acts as a slow growing tumor; secondary cystic development is common.



Multilocular hydatid cyst in the human liver.

Diagnosis

***Post mortem*:**

- **IST (intestinal scraping technique)**
- **SCT (sedimentation and counting technique**

- **Detection of coproantigenes**
- **PCR**

Treatment and prevention

Carnivorous:

praziquantel
epsiprantel

Human:

- **Surgical removing**
- **Long lasting chemotherapy**

mebendazol a albendazol