

*ISOSPORA*  
***CYSTOISOSPORA***

## HETEROXENOUS COCCIDIA

Genera: **SARCOCYSTIS**, **BESNOITIA**, **TOXOPLASMA**,

**NEOSPORA, FRANKIELINA, HAMMONDIA, CARYOSPORA**  
– morphology, the main species, prevalence, the life cycle, epidemiology, the role of various host in transmission of sarcocystosis, pathogenesis and clinical signs, pathology, diagnosis, prevention and control.

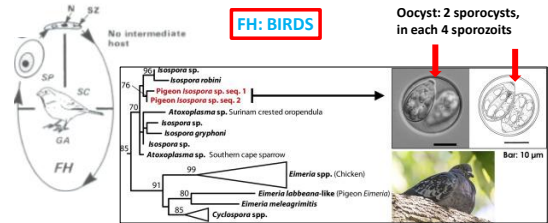
**ISOSPORA**

**Family: Eimeriidae**

- **monoxenous** (*I. canaria*, *I. serini*), sporocysts have Stieda body

**FH: BIRDS**

**Oocyst: 2 sporocysts,  
in each 4 sporozoits**



## HETEROXENOUS COCCIDIA

Order: EIMERIDA

Family: **Sarcocystidae**

*Besnoitia,*  
*Cystoisospora,*  
*Neospora,*  
*Sarcocystis,*  
*Toxoplasma*

**CYSTOISOSPORA**

- **heteroxenous** – without Stieda body, use in the life cycles of parathenic hosts

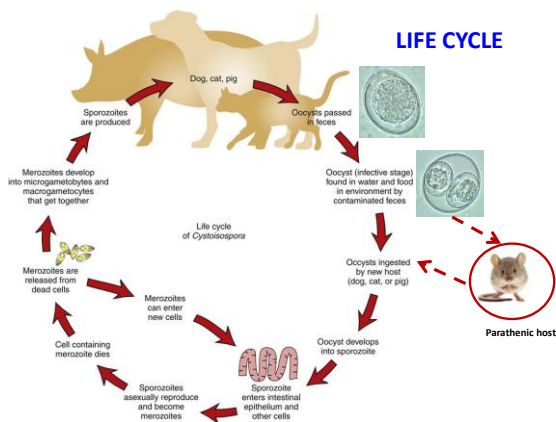
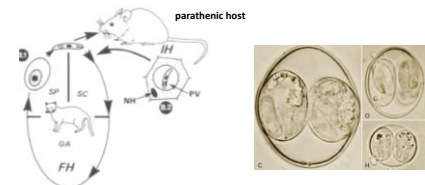
**Dog:** *Cystoisospora canis*, *C. ohioensis*, *C. bahiensis*, *C. burrowsi*

**Cat:** *C. felis*, *C. rivolta*

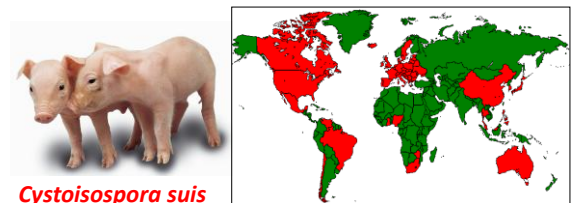
Pig: *C. suis*

Man: *C. belly*, *C. nathalensis*

*Cystoisospora* is not found in horses, ruminants and domestic poultry

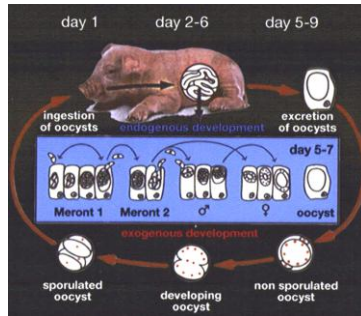


## Clinical coccidiosis in piglets – cystoisosporosis



## *Cystoisospora suis*

- Life cycle in the mucosa of piglet's small intestine;
- Asexual and sexual multiplication with formation and excretion of oocysts;
- Sporulation of oocysts in the environment;



- The sporulated oocysts contain two sporocysts with four sporozoites each.
- **Sporulation** is dependent upon humidity, temperature and oxygen.
- Once the oocysts are sporulated they are **resistant to most disinfectants**.

## Pathophysiology of Coccidiosis in Piglets

- villous atrophy and fusion;
- necrotic enteritis;
- enterocyte metaplasia;
- crypt hyperplasia;
- presence of *Cystoisospora suis* in different developmental stages in the cells of the intestinal epithelium;
- the lesions encourage the invasion of secondary pathogens since the protective function of the mucous is severely impaired;
- the intestinal mucous regenerates relative quickly, but the digestive function will be impaired for considerably longer than the clinical disease due to the fact that it will take time for the villi to grow back to their original size;

## Functions of the small intestine mucosa

Jejunum of piglets



Ileum of piglets

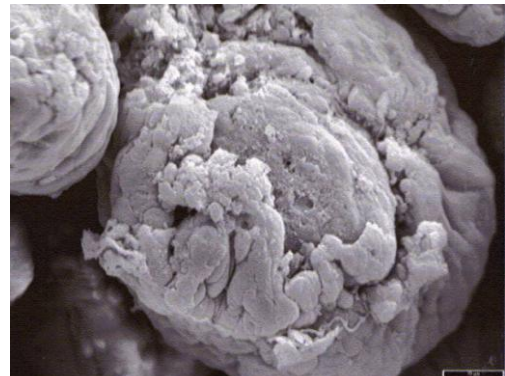


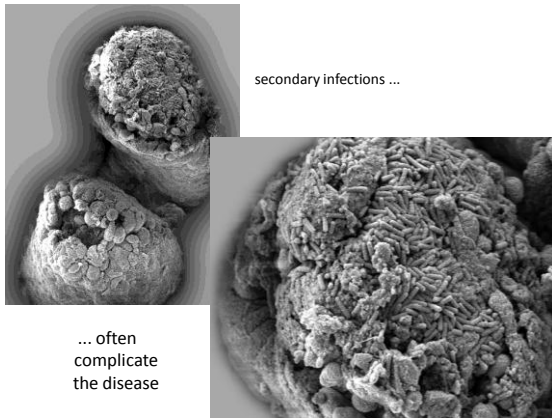
## Pathomorphology and economic significance

normal villous structure



epithelial desquamation





### Clinical picture and epizootiology



- Piglets have pasty to watery diarrhoea; yellowish to gray in colour, blood is never present;
- Gain less weight
- Often have secondary infections




### Important factors for the epizootiology

- Short development cycle of *C. suis*
- High susceptibility of young animals

### Suspected piglet coccidiosis

- **History:** Diarrhoea in the 2nd or 3rd week of life;
- **Clinical picture:** Pasty to watery faeces, white to yellow in colour;
- **Treatment:** Unresponsive to antibiotic treatment;
- **Pathomorphology of the small intestine:** Villous atrophy, crypt fusion and related inflammatory signs;
- **Differential diagnosis:** Exclusion of other enteropathogens (e.g. *E. coli*, rotaviruses, coronaviruses)

### Identification of the pathogen (detection of *Cystoisospora suis*)

In the intestine (necropsy)	In the faeces	
	qualitative / semiquantitative	quantitative
scraping of gut mucosa	direct examination of faecal smear	quantitation in McMaster counting chamber
contact preparation	accumulation and flotation of oocysts	
histology	autofluorescence microscopy	

### THERAPY

**TOLTRAZURIL 5 % suspension against neonatal coccidiosis in piglets due to *Cystoisospora suis*;**

- 20 mg/kg b.w., p.o.

➤ **PONAZURIL** 20 mg/kg

➤ **DICLAZURIL** 2 mg/kg

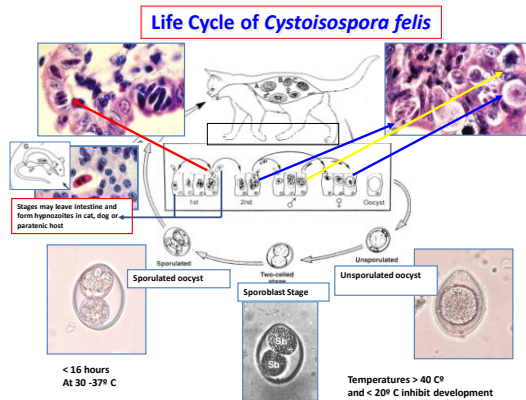
➤ **SULPHADIMIDINE** 200 mg/kg



## Dog cystoisosporosis

	<i>C. ohioensis</i>	<i>C. neurivolta</i>	<i>C. burrowsi</i>	<i>C. canis</i>
Localisation	Sm. intestine, caecum, colon	Posterior part of sm. intest.	Posterior part of sm. intest	Posterior part of sm. intest
Prep. period	5	6	6	9
Patent period	12-28	13-23	4-12	12-28
Oocysts (µm)	19 – 27 x 18 – 23	17-24 x 16-22	17 – 22 x 16 -19	34 – 40 x 28 - 32

### *Cystoisospora ohioensis* complex

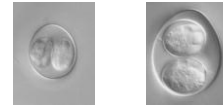


### Dg. flotation



## Cat cystoisosporosis

	<i>Cystoisospora rivolta</i>	<i>Cystoisospora felis</i>
Localisation	Sm. intestine	Sm. intestine
Prepatent period - days	4 - 7	7 - 11
Patent period - days	> 14	10 - 11
Oocysts (µm)	18 – 28 x 16 - 23	38 – 51 x 27 - 39



### Clinical signs

- Incubation for 5-7 days;
- **Weak infection is asymptomatic;**
- Severe infection (*C. canis*) especially at the age of 4 weeks to 3-4 months - diarrhoea (may also be blood);
- Vomits;
- Anorexia;
- Apathy;
- Growth lagging;
- Fever (sometimes);
- Dehydration
- Immunity - labile (for cats max. 2-5 months);
- Polyuria;
- Anemia;

### Treatment of Coccidiosis of Dogs and Cats

- **Sulfadimethoxine**
- **Sulfaguanidine**
- **Furazolidone**
- **Trimethoprim/Sulfonamide**
- **Sulfadimethoxine/Ormetoprim**
- **Quinacrine**
- **Amprolium**
- **Amprolium/Sulfadimethoxine**
- **Toltrazuril**
- **Diclazuril**
- **Ponazuril**
- 50-60 mg/kg daily for 5-20 days (D,C)
- 150 or 200 mg/kg daily for 6 days (D,C); 100-200 mg/kg every 8 hours for 5 days (D,C)
- 8-20 mg/kg once or twice daily for 5 days (D,C)
- Dose/length depends of sulfa; 30-60 mg/kg trimethoprim daily for 6 days in animals > 4 kg; or 15-30 mg/kg trimethoprim for 6 days in animals ≤ 4 kg
- 55 mg/kg of sulfadimethoxine and 11 mg/kg of ormetoprim for 7-23 days (D)
- 10 mg/kg daily for 5 day (C)
- 300 to 400 mg (total) for 5 days (D); 110-200 mg (total) daily for 7-12 days (D); 60-100 mg/kg (total) daily for 7 days (C); 1.5 tbsps (23 cc)/gal (sole water source) not to exceed 10 days (D)
- 150 mg/kg of amprolium and 25 mg/kg of sulfadimethoxine for 14 days (D)
- 10-30 mg/kg daily for 1-3 days (D)
- 25 mg/kg daily for 1 day (C)
- 20 mg/kg daily for 1-3 days (D,C)

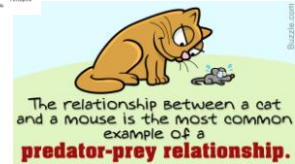
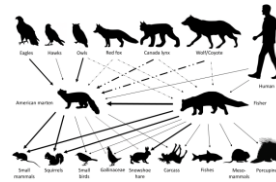
## HETEROXENOUS (TISSUE) COCCIDIA

Order: **EIMERIDA**

Family: **Sarcocystidae**

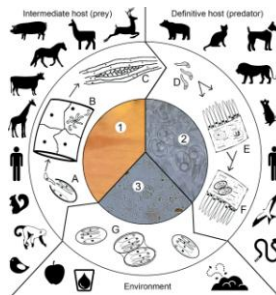
*Besnoitia*,  
*Cystoisospora*,  
*Neospora*,  
*Sarcocystis*,  
*Toxoplasma*

### *Sarcocystis* predator-prey life cycle



### *Sarcocystis*

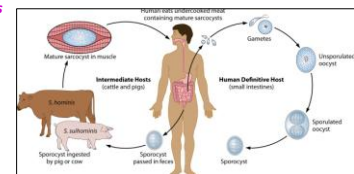
- Obligate heteroxenous life cycle
- **Asexual stages in prey species** - usual site of pathology;
- **Sexual stages in predator** - gametogony in intestinal tract only part of l.c. in definitive host - **sporogony** occurs within this host and infectious sporocysts containing 2 sporozoites (with 4 sporozoites each) shed in feces;
- **taxonomic confusion**
  - generally named after host species



### Significant species of the genus *Sarcocystis*

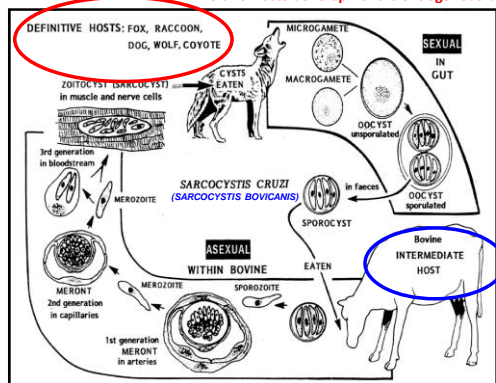
#### *Sarcocystis bovi/hominis*

*S. bovicanis* (*S. cruzi*)  
*S. bovisfelis* (*S. hirsuta*)  
*S. sui/hominis*  
*S. suicanis* (*S. miescheriana*)  
*S. Suifelis* (*S. porcifelis*)  
*S. ovicanis* (*S. tenella*)  
*S. ovifelis* (*S. gigantea*)  
*S. arieticanis*  
*S. capracanis*  
*S. hircicanis*  
*S. equicanis*  
*S. bertrami*  
*S. neurona*  
...



***Sarcocystis* with FH dog or cats are not zoonotic!**

The two-hosts development is endogenous !



### *Sarcocystis cruzi* (*S. bovicanis*)

- Dog, wolf, coyote, raccoon, fox and hyenas (**Final host**)
- Cattle (**Intermediate host**)
- **No pathology in definitive host** – dogs, cats;
- Asymptomatic;
- Diarrhoea (rarely);
- Species transmitted by dogs are generally more pathogenic to IH than those released by cats;



### Intermediate hosts – acute and subacute sarcocystiosis

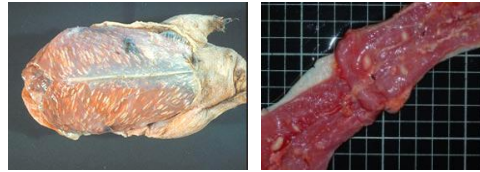
#### Symptoms:

- Fever;
- Apathy;
- Anorexia, pyrexia, anemia, weight loss, decreased milk production, generalized lymphadenopathy, abortion;

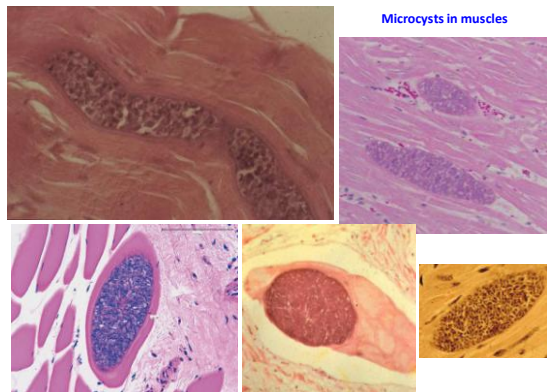
### Intermediate hosts – chronic sarcocystiosis

- Clinically inconspicuous;
- Generalized myositis;
- Degenerating cysts – enclosed by granulomas and mononuclear infiltrations;

### *Sarcocystis* spp. pathology



Macrocysts of *Sarcocystis* spp.



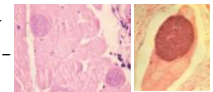
Microcysts in muscles

### Diagnosis, Therapy and Control (Prevention)

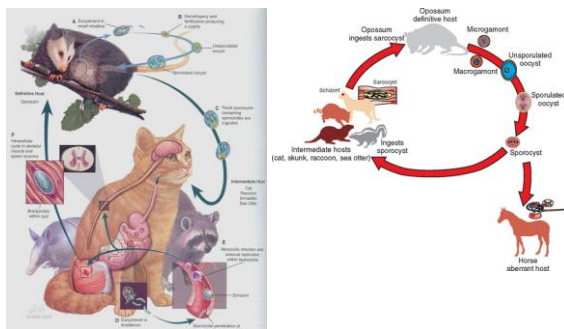
- FH – coproscopic detection of oocysts/sporocysts in faeces;
- Morphological species identification is not possible;
- Serological tests – detecting specific antibodies – FH, IH;
- IH – post mortem – detection of cysts in muscles – **digestive method** – microcysts;
- Macrocysts – meat inspection;
- No therapy for IH and FH;
- Do not allow dogs to feed on raw meat - most common where home slaughter occurs;
- Prevent contamination of feed with dog feces containing sporocysts;



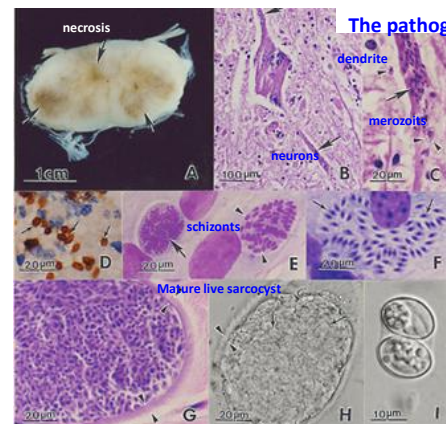
(8-13 x 6-11 μm)



### *SARCOCYSTIS NEURONA* (EPM - equine protozoan myeloencephalitis)



### The pathogenesis



## EPM - (CLINICAL SIGNS)



## EPM - DIAGNOSIS

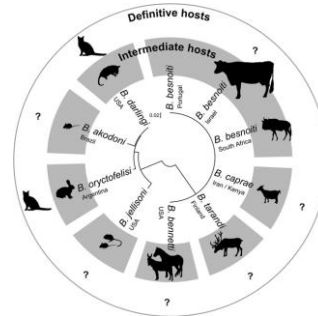
- Clinical presentation
- Serology, Western blot-cerebrospinal fluid (CSF) is required for the diagnosis
- Polymerase Chain Reaction (PCR)
- Seroprevalence apparently high (~50%) - latency, subclinical infection ??

## Prevention and control

- During 4-12 weeks administered **trimethoprim/sulfadiazine** of 15 mg/kg twice daily in combination with 0.25 mg/kg per day in the feed **pyrimethamine**.
- The therapy can result in side effects such as leukopenia, therefore, it should be given the **vitamin B complex**.
- More recently, also served **diclazuril**, **toltrazuril** and **Ponazuril®**.
- Anti-inflammatory drugs and vitamin E.

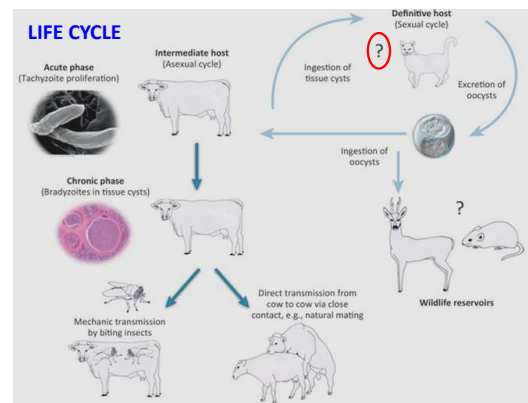
## BESNOITIA / BESNOITIOSIS

- An acute to chronic infectious disease of animals



Phylogenetic tree of the genus *Besnoitia*. Eight out of 10 named *Besnoitia* species and their known natural host types are shown.

- **heteroxebous life cycle;**
- final and intermediate hosts are known for four species
  - *Besnoitia wallacei*: cat/rat
  - *B. darlingi*: cat/opossum
  - *B. oryctofelis*: cat/rabbit
  - *B. neotomofelis*: cat/woodrat
- oocysts of *Besnoitia* spp. have not been found in cat faeces in Europe !
- but the most important species - ***Besnoitia besnoiti*** – severe diseases in cattle !
- *B. caprae* (goat)
- *B. tarandi* (reindeer)
- *B. benetti* (horse, donkey)



## Clinical Findings



Detail of the thickening and wrinkling with patchy alopecia of the skin of the tarsal region of the hind limbs of a six-year-old bull with bovine besnoitiosis.

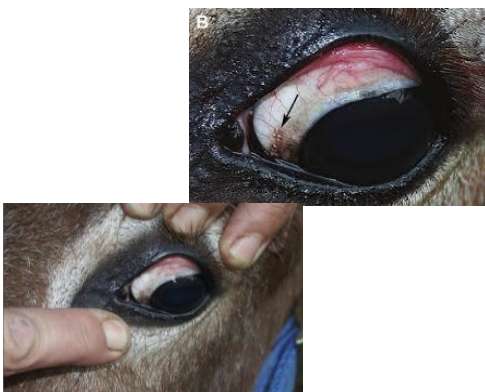


## Equine besnoitiosis

- Besnoitiosis in donkeys and horses is caused by *Besnoitia bennetti*, a coccidian parasite (a single-celled obligate intracellular parasite) that infects the animal, growing within tiny cysts in the connective tissue of the skin, muscles and other organs and even the eyes of affected animals;
- *Besnoitia* is thought to be transmitted mainly by hematophagous insects (Tabanids = horse flies).
- Characteristic thick-walled tissue cysts containing many thousands of bradyzoites are mainly found in cutis, subcutis, conjunctiva, genital and respiratory mucosa, fasciae and blood vessels, and may be macroscopically evident due to their size of up to 600 µm diameter;



Perineal Lesions of *Besnoitia bennetti*



Scleral Lesions of *Besnoitia bennetti*







### Diagnosis

- Identification of *Besnoitia* cysts within a [skin biopsy](#) sample;
- Upper airway [endoscopy](#) of affected animals might reveal extensive involvement of the nasal mucosa, pharynx, and larynx;
- We can detect antibodies to *B. bennetti* via [Western blot and indirect fluorescent antibody testing](#) (IFAT);
- history, clinical signs, histopathology, serology, immunohistochemistry, PCR.

### Differential diagnosis

- [Sarcoptic mange](#), [Dermatophytosis](#), [Insect bites](#);
- Photosensitization (Dermatitis: solar) [Urticaria](#), Bacterial dermatitis
- Streptothrichosis (*Dermatophilus congolensis* infection) ([Dermatophilosis](#))
- Sweating sickness Lumpy skin disease

### Treatment

- **No known effective** besnoitiosis treatments;
- Trimethoprim and sulfamethoxazole. **Stopping cyst formation has been very difficult.**

➤ Further investigations are needed to gain a better understanding of disease transmission, treatment, and ultimately prevention.