Workshop for OIE National Focal Points for Animal Production Food Safety
Hammamet, Tunisia (4-6 April 2011)

Challenges in prevention and control of food-borne zoonotic parasites in Africa

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Outline

- **Introduction**
  - Endemic food-borne zoonotic parasites in Africa
  - Impact of food-borne zoonotic parasites in Africa
  - Current control and prevention strategies of food-borne zoonotic parasites in Africa
- **Challenges in Control and Prevention**

Introduction

Food-borne zoonotic parasites-considerable attention in the last decade or two

i. ***Cases have gone up in humans world-wide including Africa***

ii. ***Better diagnostic tools are now available-high prevalences***

iii. ***Improved communication-record keeping***

iv. ***HIV-AIDS pandemic in Sub-Saharan Africa***

v. ***Urban farming***

vi. ***Globalization of food supply***

vii. ***Changes in lifestyle***

Endemic food-borne zoonotic parasites in Africa

Parasite species	Source of human infection
*1. *Taenia solium*	i. Ingestion of cysts in raw or undercooked meat (pork) ii. Ingestion of eggs from contaminated food and uncooked vegetables and fruits iii. Autoinfection
2. Taenia saginata	i. Ingestion of cysts in raw/undercooked meat (beef)
*3. *Echinococcus granulosus*	i. Ingestion of eggs from contaminated food, fruits and uncooked vegetables
*4. *Trichinella species*	i. Ingestion of larvae in raw/undercooked meat (variety of meat)
5. Fasciola gigantica/hepatica	i. Ingestion of metacercariae in edible plants or from contaminated drinking water
6. Toxoplasma gondii	i. Ingestion of sporulated oocysts from contaminated fruits and uncooked vegetables fruits ii. Ingestion of cysts in meat (variety of meat)

***Disease caused by parasite is classified under “Neglected tropical diseases”**

Food-borne zoonotic parasites fulfill the criteria for “neglected tropical diseases”

- Constitutes some of the oldest diseases known to man
- Common in rural agricultural communities
- Of late in urban areas where people keep livestock and live in close contact with their animals
- Public health importance is often ignored
- True incidence is difficult to evaluate
- Severity of their health and socio-economic impact is often unclear
- Limited information in most countries on the spread of these diseases
- Poor people are more vulnerable to infection

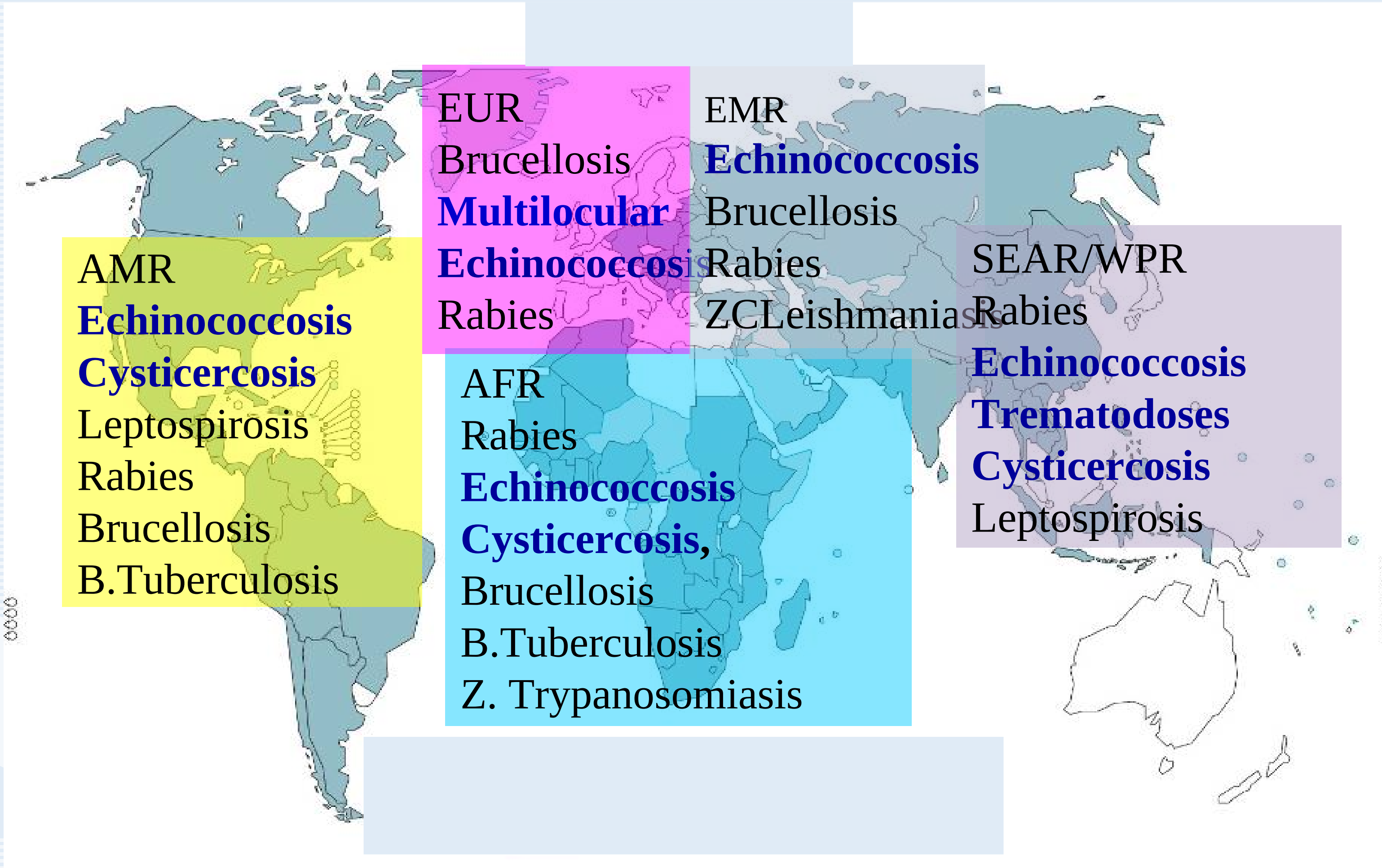
Why we only see tip of the iceberg of food-borne zoonotic parasites in Africa

- Global Burden of Disease is assessed using DALYs (disability adjusted life-years)
- This can be calculated only when the epidemiological information of the disease is known
- In most developing countries the incidences of these neglected parasitic diseases are completely unknown
- Underestimation leads to neglect due to lack of evidence for government and donor decision makers on the importance of these diseases

Impact of food-borne zoonotic parasites in Africa

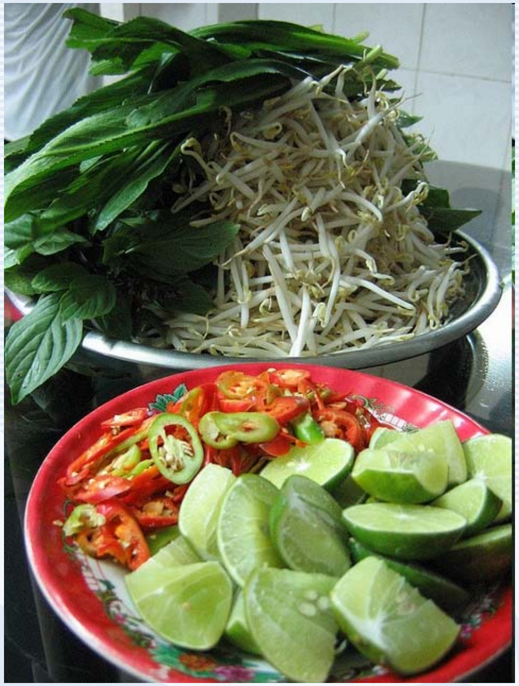
Parasite species	Economic and Social impact
1. Taenia solium	**i. Quality of pork affected** **ii. Reduced farmers' income** iii. Burden of disease in humans is hampered by lack of data iv. Cost of disease in humans estimated USD18-34 million in Eastern Cape Prov. S/Africa and USD13 million in southern Cameroon v. Taeniosis in humans
2. Taenia saginata	**i. Quality of beef is affected** **ii. Reduced farmers' income** iii. Taeniosis in humans
3. Echinococcus granulosus	**i. Quality of meat is affected** **ii. Reduced farmers' income** iii. Hydatidosis in humans
4. Trichinella species	**i. Hamper pork and game meat export** ii. Most human cases go unnoticed
5. Fasciola gigantica/hepatica	**i. Hampers animal production** **ii. Liver condemnations** iii. Human cases underestimated in Africa
6. Toxoplasma gondii	**i. Abortions mainly in sheep** ii. Congenital infection and abortions in humans iii. Detrimental effects in immuno-compromised individuals

Major neglected zoonoses and WHO Regions

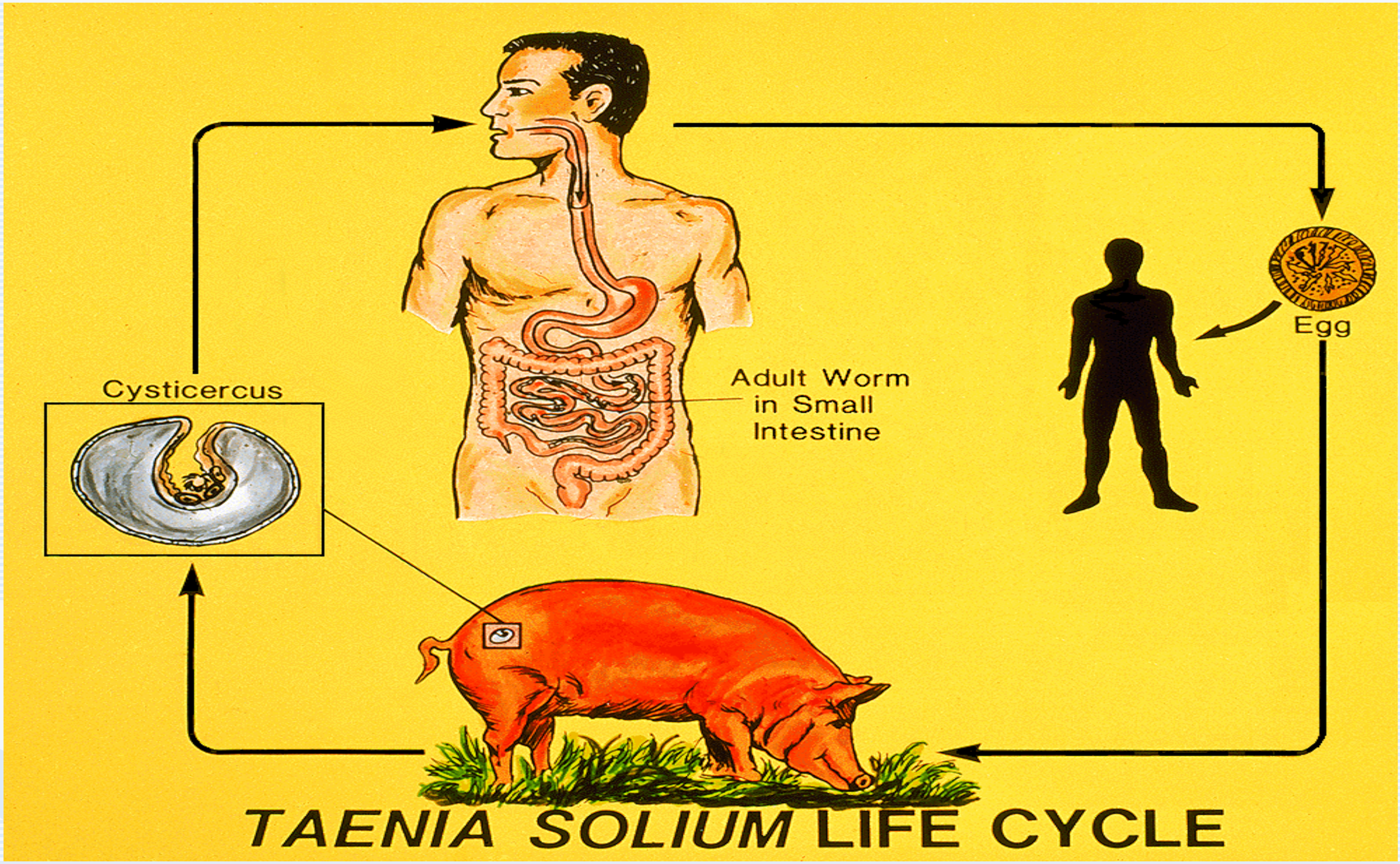


Human fascioliasis-what is known in Africa?

Traditionally high consumption of raw vegetables contaminated with metacercariae

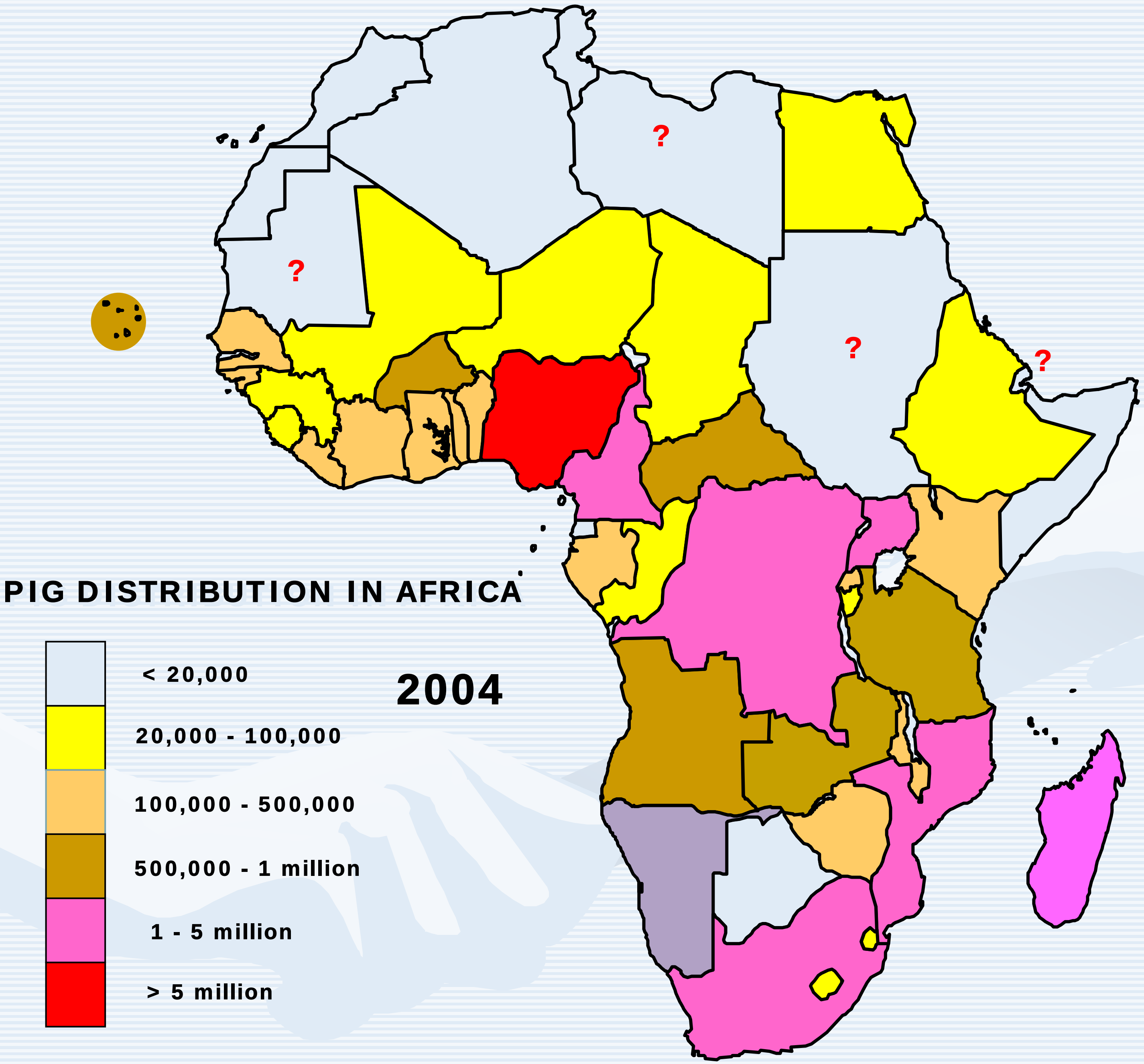


Taenia solium taeniosis/cysticercosis in eastern and southern Africa



Pig tapeworm has two hosts: Man- Taeniosis and cysticercosis

Pigs-Cysticercosis

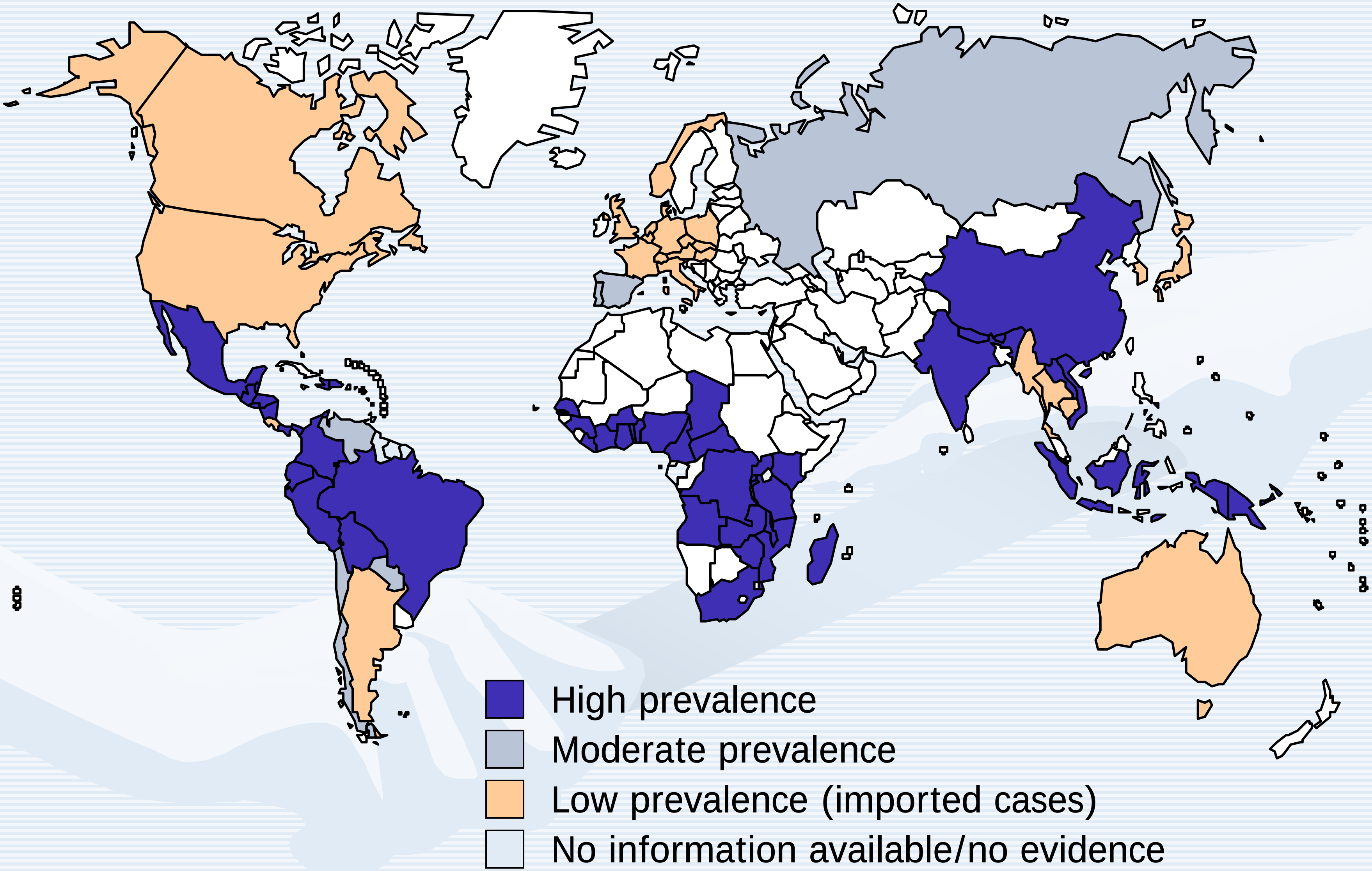

PIG DISTRIBUTION IN AFRICA
2004
< 20,000
20,000 - 100,000
100,000 - 500,000
500,000 - 1 million
1 - 5 million
> 5 million
?
?
?
?

Regional projections of total demand and consumption of pork (million tonnes)

PORK

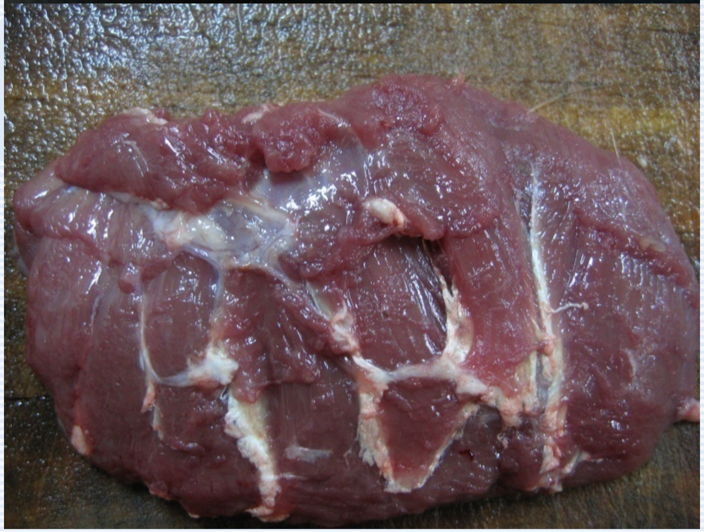
	1993	2020
Developed Region	38	41
Developing Region	39	81

Global distribution of *Taenia solium* cysticercosis / taeniosis



Taenia solium: Effects on pig production

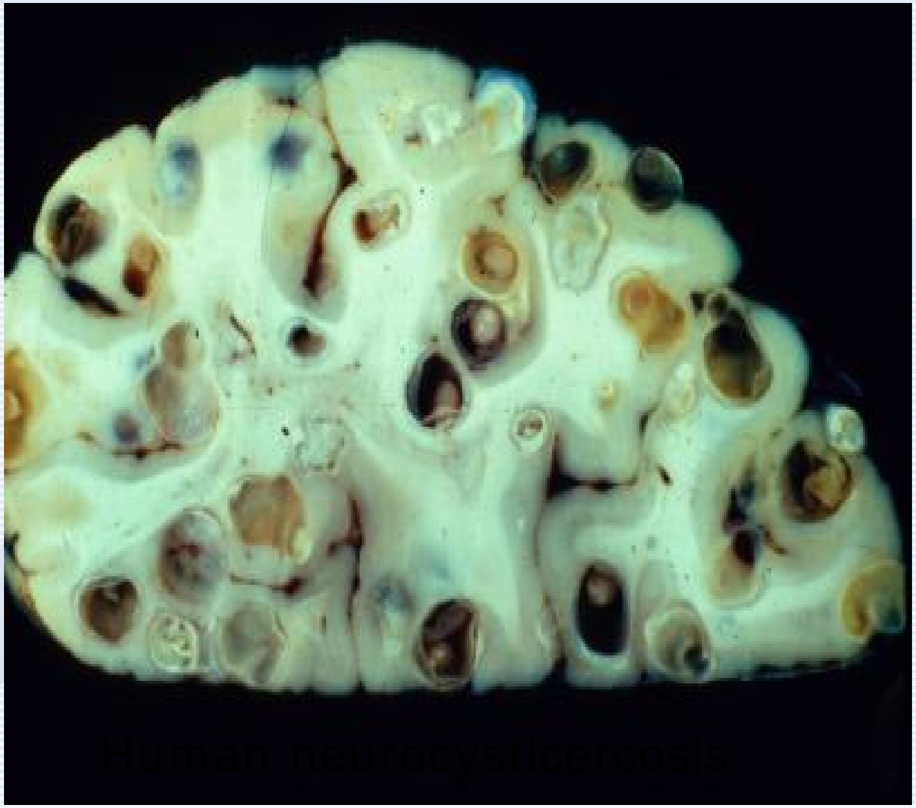
- Cysts greatly reduce market value
- Condemnation of pork
    - Loss of animal protein
    - Loss of income (producer)



Taenia solium: Effects on humans

Cysts in brain (Neurocysticercosis)

a. Epilepsy
b. Headache
c. Death



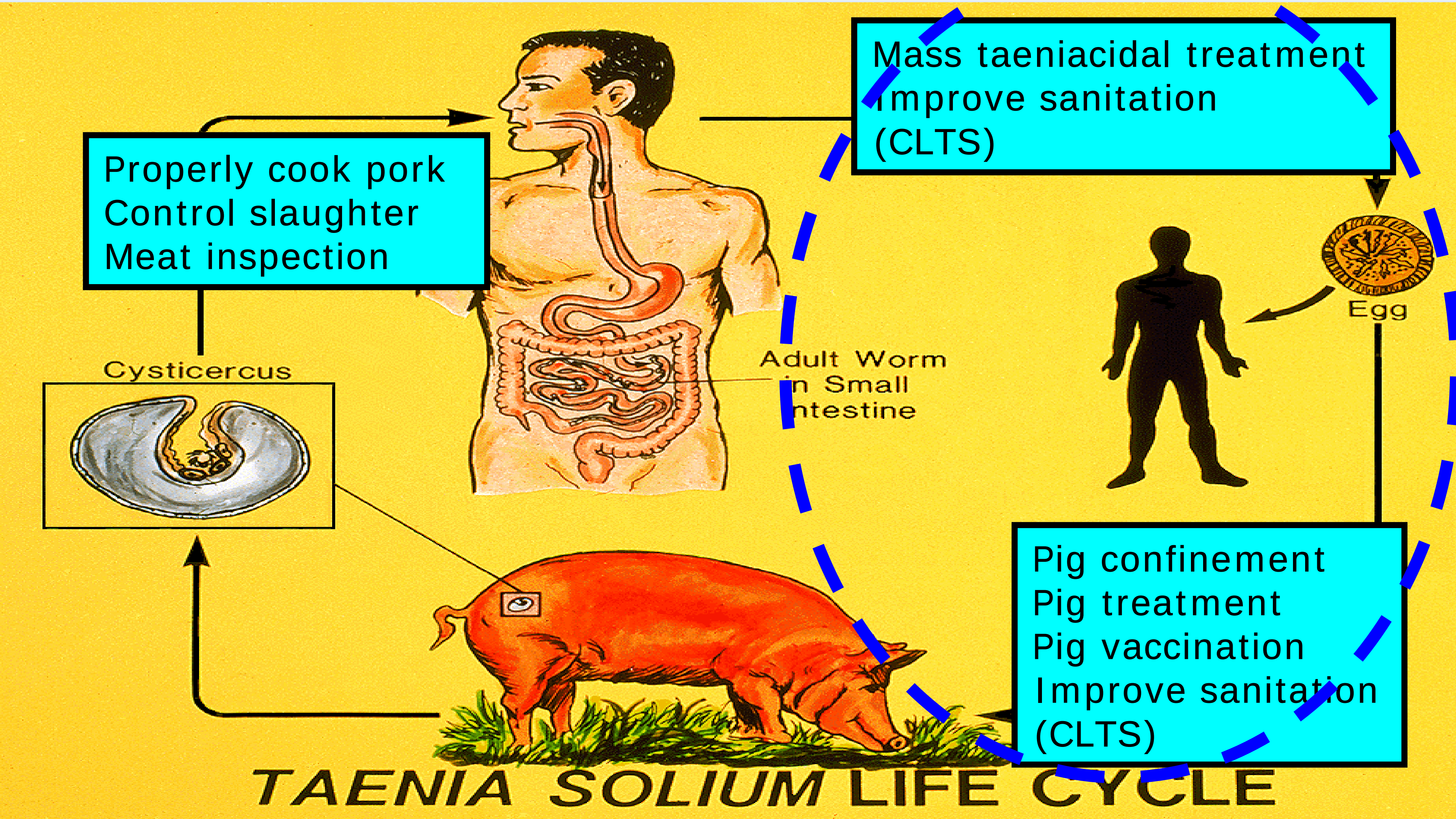
Economic effects:

a. Loss in man hours
b. Reduced labour force
c. Hospitalization cost

Social effects

a. Epileptics-stigmatised

Possible intervention strategies for control of cysticercosis



Results of prevalence studies on porcine cysticercosis conducted in ESA

Country	Porcine Cysticercosis Prevalence (%)	No. pigs surveyed	Type of survey	Area Surveyed	Reference
Tanzania	**0.04 - 4.9**	45,794	P	Mbulu District	Nsengwa, 1995[b]
	4.5 – 37.7	83	P	Northern highlands	Boa *et al.*, 1995
	3.2 – 46.7	770	L	Mbulu District	Ngowi, 1999
	0 – 26.9	1,789	L	Southern highlands	Boa, 2002
Kenya	**10.0 – 14.0**	407	L	Busia & South Nyanza Districts	Githigia *et al.*, 2002
Uganda	**33.7 – 44.5**	600	P	Moyo District	Anyanzo, 1999
	0 - 33.7[c]	297	P	Central & Northern Districts	Kisakye and Masaba, 2002

[a]P = post-mortem, L = lingual examination, S = serological;
[b]Survey conducted from 1985 – 1989
[c]Eight foetuses from a positive slaughtered pregnant sow were all found to be infected with cys

Results of prevalence studies on porcine cysticercosis conducted in ESA

Country	Porcine Cysticercosis Prevalence (%)	No. pigs surveyed	Type of survey	Area Surveyed	Reference
Zambia	**20.6 - 56.6**	1,316	S,P	Lusaka	Phiri *et al*., 2001
	8.2 - 20.8	249	L,S	Eastern & Southern Provinces	Phiri *et al*. 2002
Zimbabwe	**0.03 - 4.3**	1,000,000	P	National	Robinson, 1978
	2.7 - 28.6	99,525	P	Western Region	Matenga *et al*., 2002
Mozambique	**6.5 - 33.3**	387	S	Tete Province	Afonso *et al*., 2001
South Africa	**0.5 – 25.1**	> 100,000	P	National	Viljoen, 1937
	0 – 9.1	28,242	P	National	Heinz and MacNab, 1965

[a]P = post-mortem, L = lingual examination, S = serological

Main risk factors identified

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

The pig population in Africa increased 284% during the 20 year period 1980–1999 - far more than any other livestock species during that time and the trend continues.

Clandestine livestock market in downtown Lusaka – more than 20% of pigs are infected with *Taenia solium!*

ESA in general:

- Lack of official slaughtering facilities for pigs
- Lack of official pork inspection and control
- Inadequate pork inspection guidelines

Control and Surveillance of food-borne zoonotic parasites

Parasite species	Control and prevention options at farm and abattoir level
1. Taenia solium	i. Improvement in pig production systems ii. Meat inspection at abattoir level iii. Post-slaughter processing to inactivate larvae
2. Taenia saginata	i. Improvement in pig production systems ii. Meat inspection at abattoir level iii. Post-slaughter processing to inactivate larvae
3. Echinococcus granulosus	i. Meat inspection at abattoir level ii. Control of stray dogs and deworming of dogs
4. Trichinella species	i. Improvement in pig production systems ii. Meat inspection at abattoir level iii. Post-slaughter processing to inactivate larvae
5. Fasciola gigantica/hepatica	i. Anthelmintic treatment of ruminants ii. Meat inspection at abattoir level
6. Toxoplasma gondii	NP

Challenges in Control and Prevention

- Collapse in veterinary infrastructure and services of most African countries
- Lack of regulations or enforcement of regulations to prevent and control some of these parasites
- Lack of reliable epidemiological data on infection in humans and animals
- The diseases do not lead to large-scale international outbreaks and hence countries are not compelled to international notification
- Lack of awareness of the diseases and no coordinated approach by health/veterinary professionals

Challenges in Control and Prevention (ctd)

- Lack of research on the epidemiology of the diseases
  - Results in lack of accurate data on the incidence, sources and transmission routes
  - Do not fulfill a risk-based approach as proposed by Codex Alimentarius to implement risk based control programme

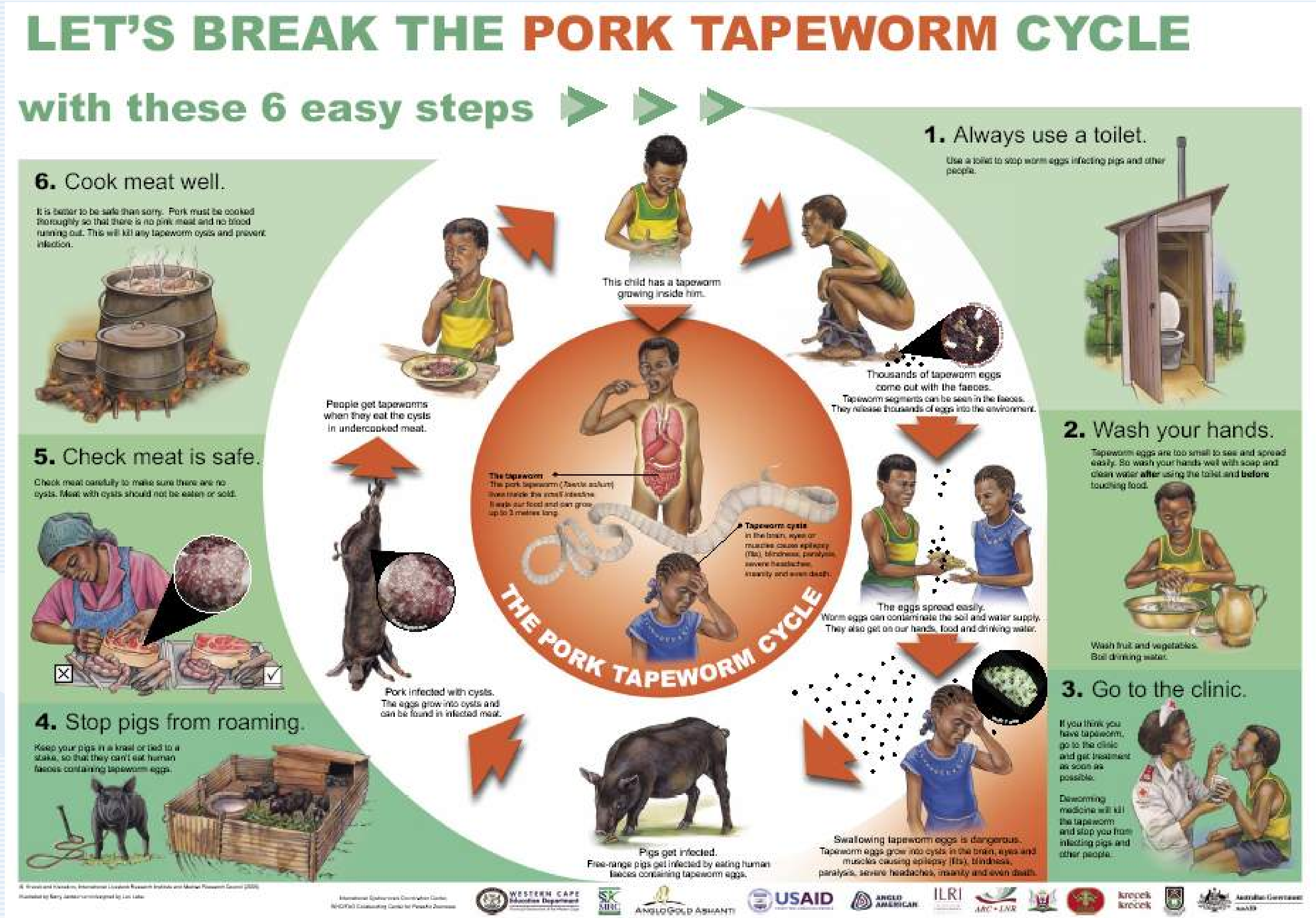
- Poverty (Lack of adequate sanitation in resource-poor communities, illiteracy and malnutrition)

- Under-diagnosis of diseases due to unavailable or inadequate laboratory equipment, methods and qualified staff

- Livestock rearing methods (mainly extensive, exposing animals to the parasite)

Cysticercosis Working Group in East and Southern Africa

- Tanzania
- Kenya
- Uganda
- Burundi
- Rwanda
- DR Congo
- Malawi
- Madagascar
- Mozambique
- South Africa
- Zimbabwe
- Zambia
- Angola



LET'S BREAK THE PORK TAPEWORM CYCLE
with these 6 easy steps
1. Always use a toilet.
Use a toilet to stop worm eggs infecting pigs and other people.
2. Wash your hands.
Tapeworm eggs are too small to see and spread easily. So wash your hands well with soap and clean water after using the toilet and before touching food.
Wash fruit and vegetables. Boil drinking water.
3. Go to the clinic.
If you think you have tapeworm, go to the clinic and get treatment as soon as possible.
Deworming medicine will kill the tapeworm and stop you from infecting pigs and other people.
4. Stop pigs from roaming.
Keep your pigs in a kraal or tied to a stake, so that they can't eat human faeces containing tapeworm eggs.
5. Check meat is safe.
Check meat carefully to make sure there are no cysts. Meat with cysts should not be eaten or sold.
6. Cook meat well.
It is better to be safe than sorry. Pork must be cooked thoroughly so that there is no pink meat and no blood running out. This will kill any tapeworm cysts and prevent infection.
This child has a tapeworm growing inside him.
Thousands of tapeworm eggs come out with the faeces.
Tapeworm segments can be seen in the faeces. They release thousands of eggs into the environment.
The eggs spread easily.
Worm eggs can contaminate the soil and water supply. They also get on our hands, food and drinking water.
Swallowing tapeworm eggs is dangerous.
Tapeworm eggs grow into cysts in the brain, eyes and muscles causing epilepsy (fits), blindness, paralysis, severe headaches, insanity and even death.
Pigs get infected.
Free-range pigs get infected by eating human faeces containing tapeworm eggs.
Pork infected with cysts.
The eggs grow into cysts and can be found in infected meat.
People get tapeworms when they eat the cysts in undercooked meat.
THE PORK TAPEWORM CYCLE
The tapeworm
The pork tapeworm (Taenia solium) lives inside the small intestine. It eats our food and can grow up to 3 metres long.
Tapeworm cysts
In the brain, eyes or muscles cause epilepsy (fits), blindness, paralysis, severe headaches, insanity and even death.
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TOOLS FOR DETECTION AND SURVEILLANCE OF SELECTED FOO-BORNE ZOONOTICS PARASITES

Background

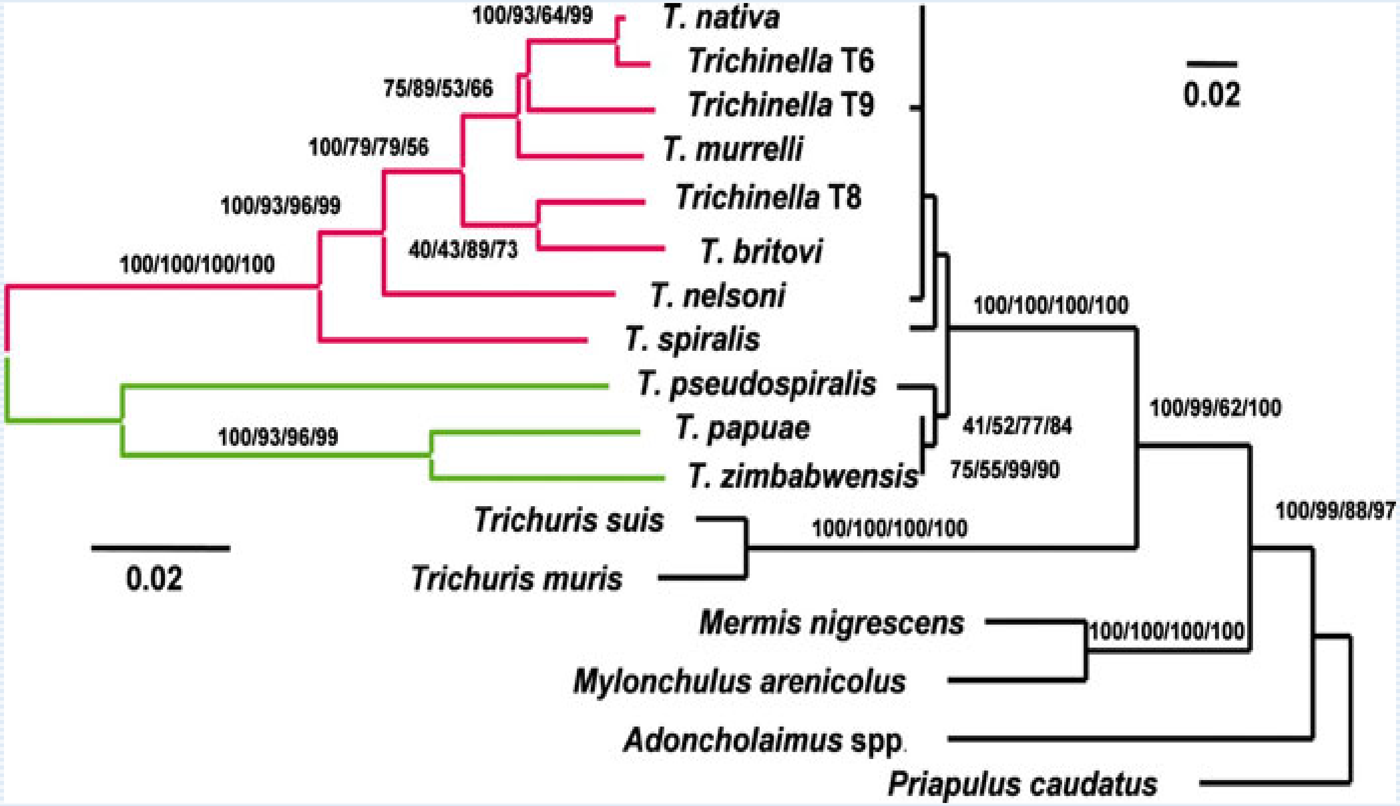
- Effective detection/diagnostic tools for zoonotic parasites are essential for ensuring food safety
- The diagnostic methods should be reliable (sensitive, specific and inexpensive)
- Traditional parasitological tools (accessible to most labs in developing countries, inexpensive, sensitivity +/-, specificity +, tedious as surveillance tools)
- Molecular tools (not readily accessible to most labs in developing countries, expensive to run, sensitivity ++, specificity ++, easy to run and require little material)
- Serological tools (commercial kits available for some parasites, sensitivity +, specificity +/-, easy to run and very useful as surveillance tool)

Trichinellosis

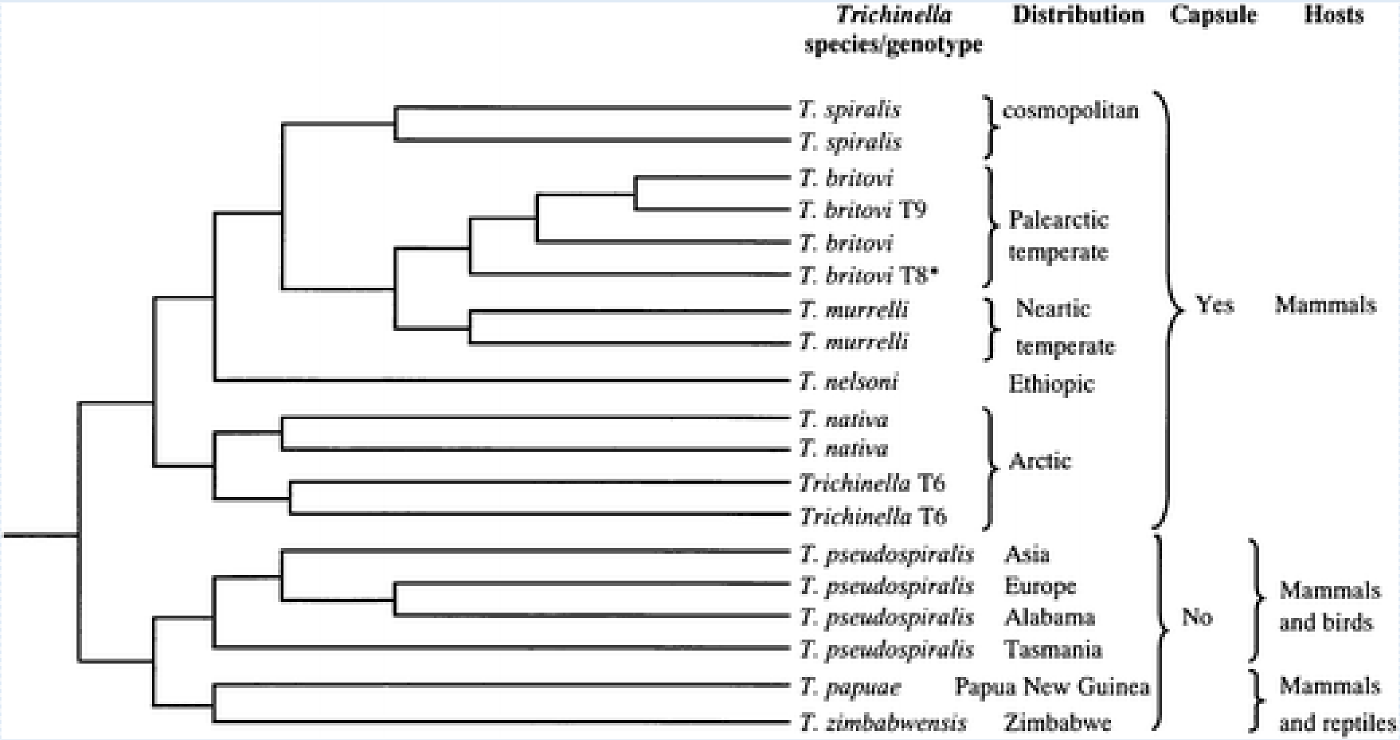
- All *Trichinella* species are presumed infective to man and a large variety of mammals
- Average incidence of the disease in humans worldwide is about 10,000 cases /year
- Mortality rate of about 0.2% (mostly in Europe and what about Africa?)
- Infection is underreported in many African countries due to lack of appropriate detection tests and knowledge of the disease on the part of physicians (Pozio, 2007).
- Direct life cycle (no exogenous stage)
- Broad host spectrum
- All species morphologically indistinguishable
- Two clades

i. Encapsulated species
ii. Non capsulated species

Encapsulated (red) and non-encapsulated (green) species and genotypes of *Trichinella* based on the variation in mitochondrial LSU and COI DNA (on the left) and SSU rDNA (on the right) ([Zarlenga et al. 2006)](#).



Geographical distribution of *Trichinella* genotypes

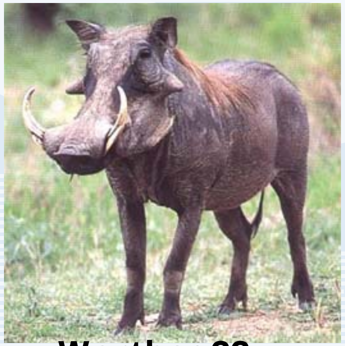


Sylvatic cycle in Africa (*Trichinella zimbawensis*)

Nile crocodile + +

Lion + +

Varan (monitor lizard) + +



Warthog??

Bush pig??

Domestic cycle of *Trichinella spiralis*

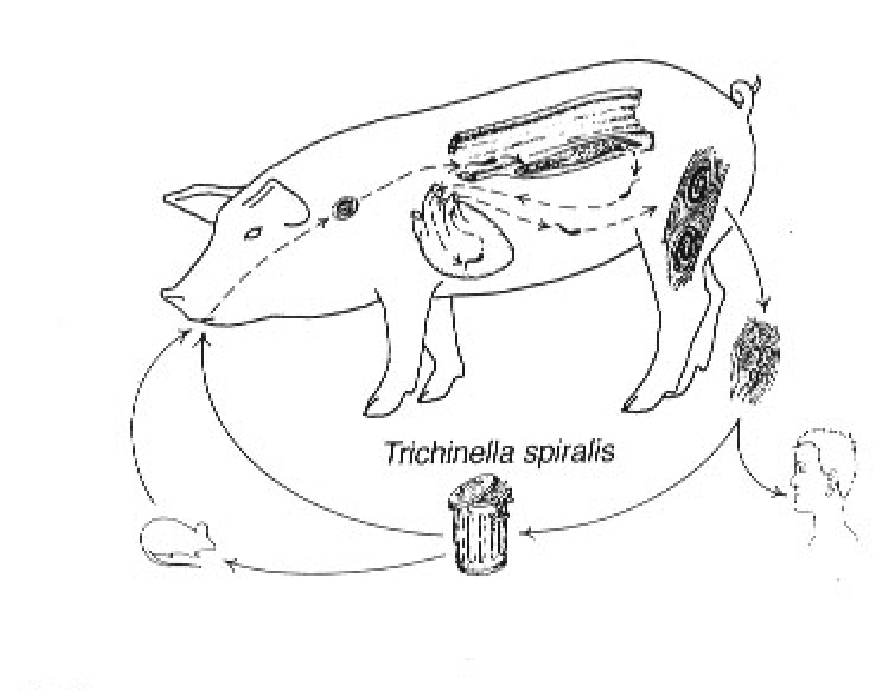


Fig. 176. *Trichinella spiralis*. Twenty days for larvae to be infective. Larvae to adult in 4 days.

Domestic pig + +

Monkeys + +

Table 1. Clinical manifestations of baboons and monkeys infected with *Trichinella zimbabwensis*

Animal code							
	SFB	SMB	BFB	BFM	SFM	SMM	BMM
Infective dose/kg	16 600	16 400	7 300	25 000	24 500	24 500	17 600
Clinical signs and symptoms	Day of the first manifestation pi						
Fever	9	11	16	14	13	18	10
Diarrhea	16	16	16	16	19	21	21
Depression	12	12	12	12	12	12	12
Periorbital edema	30	30	30	30	30	30	30
Muscular pain	30	30	30	30	30	30	30
Alopecia	26	26	26	26	26	26	26
Blindness	38	no	no	no	no	no	no
Death	49 dpi	50 dpi	no	30 dpi	no	36 dpi	no

Post-slaughter detection of Trichinella

Samples for Diagnosis of *Trichinella*

a. The detection of *Trichinella* larvae is mainly targeted to post-mortem inspection of pigs and wild animals which are consumed by humans.

b. Detection usually achieved through routine meat inspection

c. Sensitivity of existing methods is dependent on the muscle selected for sampling, sample size and quality assurance measures employed

d. Predilection sites for *Trichinella*
-Pigs (diaphragm pillars, tongue and masseter muscles
-Wild boars (forearm muscle, diaphragm pillars
-Crocodiles (tail and extremeties)
-unknown for the species (tongue)

Techniques	Tools	Advantages/Disadvantages
1. Observation of muscle larva	i. Trichinoscopy and microscope	**i. Ideal for field situations** **ii. Laborius and time consuming for individual carcasses** **iii. Low sensitivtiy** **iv. Not recommended for use in food and game animals intended for human consumption**
***2.* Artificial digestion of muscle** **i.Magnetic Stirrer method (Gold standard)** **ii.Stomacher method** *-Pooled samples* *-Individual samples*	i. Laboratory equipment and chemicals	**i. Need for retesting individual samples if the pooled sample is positive** **ii. Need for laboratory and equipment** **iii. Ideal for large samples**
3. Serological techniques **i.ELISA** **ii.Western Blot**	i. ELISA reader, plates and chemical reagents	**i. Unsuitable for the purposes of meat inspection** **ii. Useful for surveillance and epidemiological studies in animal populations** **iii. False negatives during early stages of infection** **iv. Techniques not tested in wild animals**

Geographical distribution of *T. zimbabwensis*

- Zimbabwe (commercialy reared crocodiles, wild crocodiles, varans)
- South Africa (commercialy reared crocodiles, wild crocodiles, lions)
- Mozambique (wild crocodiles)
- Ethiopia (wild crocodiles)

Serological detection of trichinellosis (Gajahdah et al., 2009)

Method	Antigen	Sensitivity	Specificity
ELISA	Crude	99% (pigs, humans)	60% (humans)
ELISA	Excretory/Secretory	98% (pigs, horses) 99% (humans)	98% (pigs)
ELISA	Beta tyvelose	<98% (pigs) <98% (horses)	>99% (pigs)
Western Blot	Crude antigen	98% (humans)	98% (humans)
Western Blot	ES antigen	Not available	98% (horses)

Porcine cysticercosis

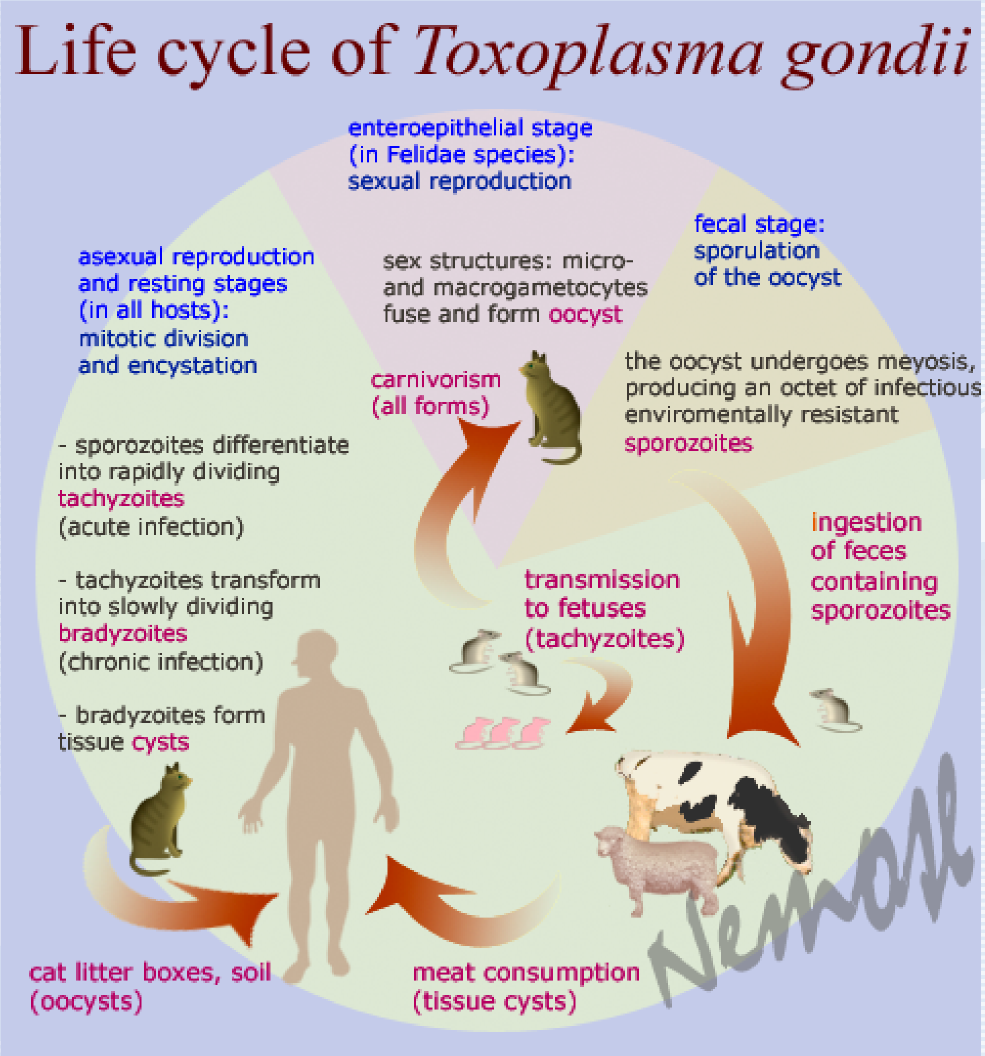
- Detection of porcine cysticercosis cases is vital for preventing human infections as well as for monitoring interventions programmes
- Detection methods are available for live animals as well as inspection of carcass at slaughter

Techniques	Tools	Advantages /Disadvantages
1. Lingual examination	i. Visual inspection and palpation for cysts on the ventral surface of tongue	**i. Inexpensive and quick method for farmers and pig traders** **ii. Specificity is very high** **iii. Useful for rapid assessment of sites and determination of "hot spots"** **iv. Sensitivity depends on the intensity of infection** **v. May underestimate prevalence of infection**
***2.* Pig carcass inspection**	i. Slaughter houses, equipment and official meat inspection guidelines	**i. Sensitivity is low in pigs with low intensity of infection** **ii. Underestimates the true prevalence** **iii. Useful for validating other diagnostic methods if conducted properly**
3. Serological techniques **i.Antigen-ELISA** **ii.Western Blot**	i. ELISA reader, plates and chemical reagents	**i. Useful for surveillance and epidemiological studies in animal populations** **ii. Cross-infection with *Taenia hydatigena***

Larval *Taenia solium* cysts on pig’s tongue

Toxoplasmosis in livestock

- Very few countries implement active surveillance programmes for toxoplasmosis
- Main challenge is the epidemiological versatility and complexity of *T. gondii*
- Practice of extensive farming of livestock adds a challenge for the detection of the parasite
- Unavailability of resources and technology in Africa limits the relevance of a single global control strategy



http://www.metapathogen.com/IMG/Tgo-lc.png

Methods for detection of *T. gondii*

Many methods are available but the reliability is unclear

a. Serological tests
b. Parasite isolation and identification
c. Polymerase chain reaction (PCR)

Use of properly validated assays in laboratories operating as part of a recognised quality assurance system is essential

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Wildlife products in Africa: what are the zoonotic parasites to look for?

Introduction

Factors to consider

- Role of wildlife as potential source of zoonotic paraites to human and domestic animals
- Growth rate of the global human population (demand for food)
- Expanding appetite for resources of all types
- Dissolution of many ecological barriers important in the natural control of parasitic zoonoses
- Human intrusions into many wildlife habitats and the reverse
- Shift in the interface between wildlife and people from often sporadic and fragile environments to more permanent and substantial opportunities for parasite transmission
- Change of life-style and eating habits

Wildlife Products likely to be source of infection

- Bush meat-(illegal and unsustainable trade in wildlife for meat and income)
- Wild meat- (legal and sustainable trade in wildlife for meat and income)
- Game meat-(legal and sustainable trade of farmed or ranched wildlife for meat and income

Cultural traditions for food preparation that do not affect parasite viability lead to transmission of parasites

Some statistics of bushmeat trade African countries

- More than 30 million poor rural and urban people in sub-saharan Africa are dependent on bushmeat as food, role in rituals or for trade
- In Central Africa, over 1 million metric tons of bushmeat is eaten each year — the equivalent of almost 4 million cattle
- Illegal trade in game meat runs into millions of USD every year

Reptiles and other wildlife are often captured for food or trade

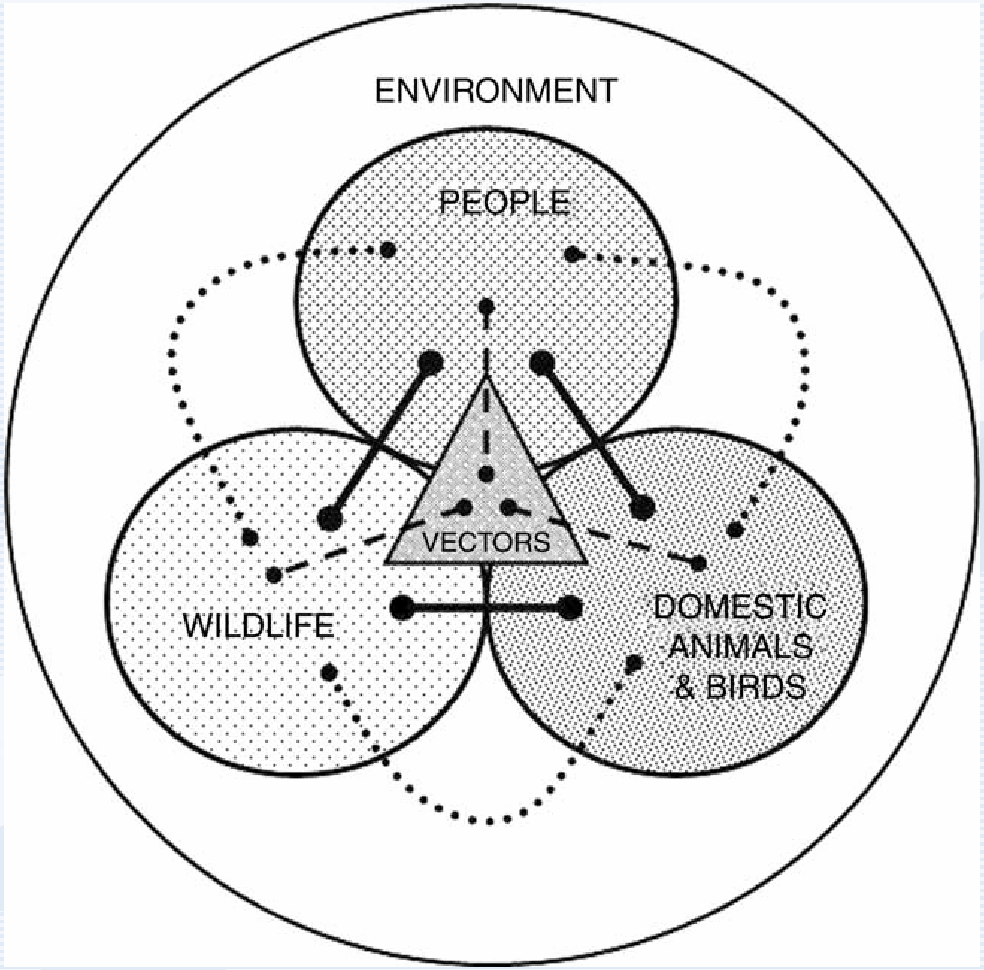
Achatina spp

Some zoonotic parasites of wildlife origin acquired by parasite flow through consumption of infected meat / tissue

Parasite	Wildlife host	Route(s) of human infection
1. *Trichinella* spp.	Carnivorous and omnivorous mammals, birds and reptiles	Infective larvae in meat which is raw or undercooked
2. Toxoplasma gondii	Mammals and birds	Bradyzoites or tachyzoites in intermediate hosts
3. *Angiostrongylus cantonensis*	Rodents	Infective larvae in gastropod intermediate hosts, snails, slugs, fish, crab or crayfish paratenic hosts, or on vegetables

Are these the only zoonotic parasites from wildlife?

Zoonotic parasites web comprising multiple possible routes of parasite flow (Polley, 2005)



Crocodile Farming in sub-saharan Africa

Croc tails meat ready for marketing

Trichinella zimbabwensis-infected crocodile farms in Zimbabwe

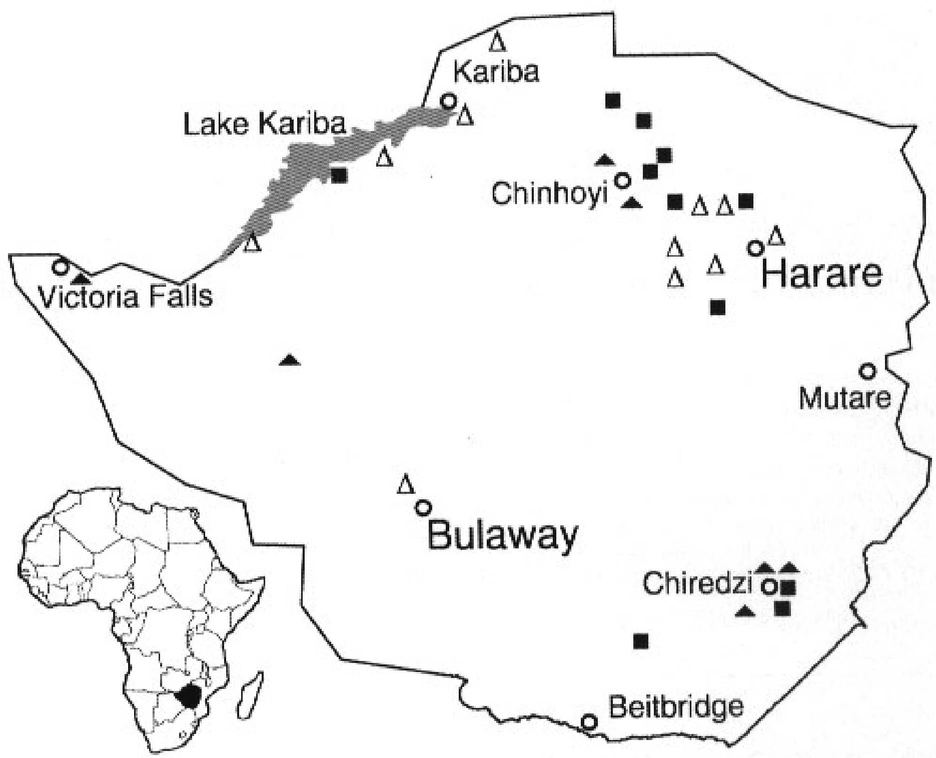
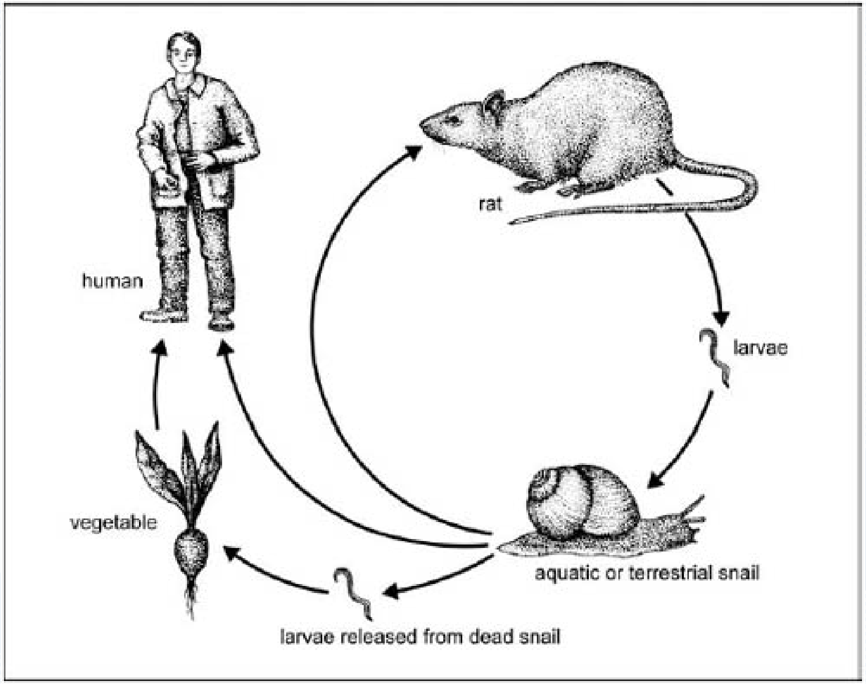


Fig. 1. Map of Zimbabwe showing the crocodile (*Crocodylus niloticus*) farms and their relative position (black area) in Africa. (△), Farms with no history of *Trichinella*-positive crocodiles; (▲), farms which had *Trichinella*-positive crocodiles in 1995 but not in 2002; ■, farms with *Trichinella*-positive crocodiles in 2002; ○, towns and cities.

The rat lung-worm *Angiostrongylus cantonensis* first report in South Africa (Archer et al 2011)



A. cantonensis *female*

A. cantonensis *egg*

A. cantonensis *larva*

Challenges in detecting zoonotic parasites in wildlife products

- Difficulties in accessing wildlife products for inspection (informal channels)
- Lack of information regarding the host and geographic distributions of the hosts and the zoonotic parasites.
- Lack of validation of some of the diagnostic tests used for these infections in wildlife, particularly those based on serology.
- Lack of national or regional monitoring/surveillance for wildlife zoonotic parasites in Africa

Thank you for your attention