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Survey of the Prevalence of *Trichinella* in Local Authority Supervised Pig Slaughterhouses

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INDEX

SUMMARY

Trichinellosis is a zoonotic disease caused by the nematode worm *Trichinella.* Humans and animals contract the disease by eating infected muscle (meat) that is inadequately cooked. The most common sources of human infection are pigmeat, wild game and horse meat.

There are at least eight recognised species of *Trichinella*; the most commonly isolated species is *Trichinella spiralis*.

The last native case of human trichinellosis reported in Ireland was in 1968. In 2008, there were two cases of Trichinellosis in Ireland. Following investigation, it was established that both cases acquired infection outside of Ireland. In Europe, the prevalence of human trichinellosis varies considerably between countries. In 2008, the highest numbers of cases were recorded in Romania, Bulgaria and Lithuania (35). In 2007, Denmark received recognition from the EU Commission and Member States as a region where the risk of *Trichinella* in domestic swine is officially recognised as negligible. There has been no report of trichinellosis in animals in Ireland since 1968 (7).

Until 2006, all pigs destined for third countries, slaughtered in Department of Agriculture, Fisheries and Food (DAFF) supervised meat export plants were examined for *Trichinella* in accordance with Directive 64/433 EC. This Directive applied only to DAFF supervised exporting slaughterhouses. It did not apply to the local authority supervised slaughterhouses that traditionally supplied the domestic market only. The testing carried out represented approximately 50% of all pigs slaughtered in Ireland (32).

Since 2006, all slaughterhouses approved under Regulation (EC) 853/2004 can export meat within the European Union. Regulation (EC) 2075/2005 applies within all approved slaughterhouses. The Regulation lays down specific rules on official controls for *Trichinella* in meat. All domestic pigs and horses slaughtered for human consumption must be sampled for *Trichinella* as part of the *post-mortem* inspection.

All horses slaughtered in Ireland are tested for *Trichinella.* Consumption of horsemeat in Ireland is low; much of the horsemeat produced in Ireland is exported to France and Belgium.

Wildlife surveys conducted in Ireland show that the sylvatic or wildlife cycle of *Trichinella* continues in Ireland, independent of the domestic pig cycle. Outdoor or extensively reared pigs that may be exposed to wildlife are at a greater risk of contracting Trichinellosis from wildlife sources (6).

The Food Safety Authority of Ireland (FSAI) conducted a survey to investigate the prevalence of *Trichinella* in pigs slaughtered in low throughput pig slaughterhouses. Many of these slaughterhouses source pigs from extensive or “backyard” pig production systems. The FSAI targeted this “high-risk” sub-population by focusing the survey on low throughput slaughterhouses.

From August 2007 to January 2009, a total of 10,247 samples were taken and analysed for *Trichinella* in thirty-three slaughterhouses supervised by the local authority veterinary service. There were no positive samples detected during the survey.

This survey shows that over an 18 month period there were no positive samples of *Trichinella* in a domestic pig sub-population which is most vulnerable to exposure to *Trichinella* infested animals and birds.

Ireland may apply to the European Commission to implement a derogation from the systematic sampling of swine carcasses for domestic swine kept solely for fattening where these animals come from a holding that has been officially recognised by DAFF as free from *Trichinella* in accordance with Regulation (EC) 2075/2005. These holdings will be audited to verify compliance with biosecurity measures. Fattening pigs from these holdings will be exempt from mandatory *Trichinella* testing.

Ireland is required to submit an annual report to the European Commission (EC) on the results of monitoring in domestic and indicator animals following the implementation of a derogation provided for in Regulation (EC) 2075/2005. Ireland submitted its initial report to the EC in June 2009.

Since the conclusion of the FSAI *Trichinella* survey, *Trichinella* sampling and analysis have continued in local authority supervised slaughterhouses.

INTRODUCTION

Trichinellosis is the term used for the human zoonotic disease caused by nematode worms belonging to the genus *Trichinella*. *Trichinella* are one of the most widespread zoonotic pathogens in the world (2). The parasite has a wide range of mammalian host species, including man. Human trichinellosis has been documented in 55 countries around the world (2).

Trichinella, first identified as a human pathogen by Owen in 1835, is now comprised of eight species (*Trichinella spiralis, Trichinella nativa, Trichinella britovi, Trichinella murelli, Trichinella nelsoni, Trichinella pseudospiralis, Trichinella papuae and Trichinella zimbabwensis*) and three additional genotypic variants (*Trichinella T6, Trichinella T8* and *Trichinella T9*) that have yet to be taxonomically defined. There are two main clades (a clade is a group consisting of a single common ancestor) recognised in the genus *Trichinella.* The first describes species that encapsulate in host muscle tissue and the second does not encapsulate in host muscle (1).

Trichinella spiralis is the etiological agent of most of the human *Trichinella* infections and deaths around the world (4). Humans typically acquire the infection by eating raw or inadequately cooked meat contaminated with infective larvae. The most common sources of human infection are pig meat, wild boar meat and game meat. Other animal meats have also transmitted the infection, e.g. horses and dogs (35). The severity of the disease is proportionate to the number of larvae ingested. Symptoms include fever, eye swelling, breathing difficulties and muscle pains. Often, mild cases of trichinellosis are never specifically diagnosed and are assumed to be the flu or other common illnesses.

In Europe, the majority of infections are caused by *T. spiralis, T. britovi* and *T. nativa* while a few cases caused by *T. pseudospiralis* and *T. murelli* have also been described (35). In Ireland, *Trichinella spiralis* is the only reported species in animals or man (1). The distribution area of *Trichinella spiralis* has been strongly influenced by the passive introduction of this pathogen by domestic pigs and intermediate (synanthropic) rats on different continents, followed by the transmission to wildlife (3)

LIFE CYCLE

The life cycle of *Trichinella* spiralis consists of a sylvatic and domestic life cycle. It is generally accepted that the sylvatic or wildlife cycle operates independently of man although it may serve as a source of human infection. Generally, sylvatic trichinellosis affects carnivores with cannibalistic and scavenger behaviour (9).

The domestic cycle refers to the transmission pattern occurring in swine herds. Pigs can acquire infection by eating the infected flesh of other pigs or rats (11).

In most EU countries, the reservoir for the parasite is the red fox (vulpes vulpes) although in Finland the raccoon dog (Nyctereutes procyonoides) is also a reservoir.
(See Annex II)

HUMAN INFECTION AND CLINICAL SIGNS

Humans typically acquire the infection by eating raw or inadequately cooked meat contaminated with infective larvae. The most common sources of human infection are pig meat, wild boar meat and game meat. Other animal meats have also transmitted the infection, e.g. horses and dogs (35). Since 1975, the consumption of horse meat has accounted for 52.8% of total cases (n=6250) of human Trichinellosis in the European Union (10).

The clinical signs of acute trichinellosis in humans are characterised by two phases. The first phase of trichinellosis symptoms may include nausea, diarrhoea, vomiting, fatigue, fever and abdominal discomfort. However, this phase is often asymptomatic. Headaches, fevers, chills, cough, eye swelling, aching joints and muscle pains, itchy skin, diarrhoea, or constipation follow the first symptoms. If the infection is heavy, patients may experience difficulty coordinating movements, and have heart and breathing problems. In severe cases, death can occur; severity of the disease is proportionate to the number of larvae ingested (17). In the case of mild to moderate infections, most symptoms subside within a few months. Fatigue, weakness, and diarrhoea may last for months. Abdominal symptoms can occur one to two days after infection. Further symptoms usually start two to eight weeks after eating contaminated meat. Symptoms, the severity of which relates to the number of infectious worms consumed in meat, may range from very mild to severe (see Annex III). Often, mild cases of trichinellosis are never specifically diagnosed and are assumed to be the flu or other common illnesses.

Treatment of trichinellosis involves the administration of Benzimidazoles as well as symptomatic treatment. Although most infections are self-limiting, serious complications or death may result from invasion of the heart, lungs or central nervous system.

Symptoms such as myalgia and neuromuscular disturbances may persist long after the acute stage of disease has ended. (37)

TRICHINELLA IN EUROPE

In 1998, a paper on Trichinellosis in the EU claimed that Trichinellosis is still endemic in most countries of the European Union (6).

Figure 1: The Distribution of domestic and sylvatic trichinellosis in EU countries (1998)

(White areas = *Trichinella*-free regions; black areas = both domestic and sylvatic cycles still occur; hatched areas = only the sylvatic cycle is present, but where *Trichinella spiralis* is also present in wildlife, because the domestic cycle existed formerly; cross-hatched areas = only the sylvatic cycle is present;? = countries where further epidemiological surveys are needed to obtain more reliable estimates) (6)

Since Figure 3 was published, the EU has expanded considerably and a number of the new EU Member States have significant levels of reported human cases. The number of reported trichinellosis cases in humans is presented in Table 2 (35)

Table 2: Reported cases of trichinellosis in humans (35)

Table TR2. Reported cases of trichinellosis in humans 2004-2008[1], and notification rate for confirmed cases, 2008

Country	2008				2007	2006	2005	2004
	Report Type[2]	Cases	Confirmed cases (Imported)	Confirmed cases per 100,000	Confirmed cases (Imported)			Cases (Imported)
Austria	U	0	0	0	0	0	0	0
Belgium	A	5	5	<0.1	3	-	0	0
Bulgaria[3]	A	67	67	0.9	62	180	-	-
Cyprus	U	0	0	0	0		0	0
Czech Republic	U	0	0	0	0	-	0	0
Denmark	–[4]	-	-	-	–	-	-	9 (9)
Estonia	U	0	0	0	0		1	0
Finland	U	0	0	0	0	-	0	0
France	C	3	3	<0.1	1 (1)	10	20 (20)	3 (3)
Germany	C	1	1 (1)	<0.1	10 (7)	22 (1)	0	5 (4)
Greece	U	0	0	0	0	-	-	0
Hungary	C	5	5 (3)	<0.1	2 (2)	-	0	0
Ireland	C	0	0	0	2 (2)	0	0	0
Italy	U	0	0	0	1	-	-	0
Latvia	C	4	4	0.2	4	11	62	24
Lithuania	A	41	31	0.9	8	20	13	22
Luxembourg	U	0	0	0	–	-	0	-
Malta	U	0	0	0	0	-	0	-
Netherlands	C	1	1 (1)	<0.1	0	-	0	0
Poland	C	4	4	<0.1	217	89	70	163
Portugal	U	0	0	0	0	-	0	-
Romania[3]	C	503	503	2.3	432	350	-	-
Slovakia	C	18	18	0.3	8	5	0	1
Slovenia	C	1	1 (1)	<0.1	0	1	0	0
Spain	C	27	27	0.1	29	18	9 (3)	33 (1)
Sweden	U	0	0	0	1	-	0	1 (1)
United Kingdom	U	0	0	0	0	0	0	0
EU Total		**680**	**670 (6)**	**0.1**	**780 (12)**	**706 (1)**	**175 (23)**	**261 (18)**
Iceland	–[4]	-	-	-	-	-	0	-
Liechtenstein	–[4]	-	-	-	-	-	-	-
Norway	U	0	0	0	0	-	0	0

Note: in Switzerland no surveillance system exists for humans.
1. Number of confirmed cases for 2005-2008 and number of total cases for 2004.
2. A: aggregated data report; C: case based report; —: No report; U: Unspecified.
3. EU membership began in 2007.
4. No surveillance system exists.

In 2008, 670 confirmed cases of trichinellosis were reported by Member States. The highest numbers of cases were recorded in Romania, Bulgaria and Lithuania. (35)

Table 3: Trichinella detections in animals (35)

Table TR3. Number of Trichinella positive animal samples, 2008

Country	Pigs		Wild boar farmed		Wild boar non-farmed		Foxes		Bears		Raccoon dogs		Other wildlife[1]	
	N	Pos	N	Pos	N	Pos	N	Pos	N	Pos	N	Pos	N	Pos
Austria	5,491,872	0	546	0	11,555	0	-	-	-	-	-	-	-	-
Belgium	11,547,720	0	-	-	15,177	0	61	0	-	-	-	-	-	-
Bulgaria	342,942	12	22,884	1	4,307	34	94	3	-	-	-	-	-	-
Czech Republic	3,401,215	0	-	-	78,911	0	-	-	-	-	-	-	-	-
Denmark	18,935,880	0	1,946	0	-	-	122	0	-	-	-	-	193	2
Estonia	474,859	0	-	-	4,255	12	-	-	50	5	-	-	-	-
Finland	4,872,522	0	118	0	-	-	445	100	45	4	280	92	186	77
France	16,548,576	2	1,083	0	44,708	0	40	3	-	-	-	-	-	-
Germany	9,358,968	3	-	-	-	-	4,221	2	-	-	-	-	-	-
Greece	848,620	0	790	0	-	-	-	-	-	-	-	-	-	-
Hungary	-	-	-	-	-	-	1,046	25	-	-	-	-	-	-
Ireland	2,561,293	0	-	-	-	-	452	2	-	-	-	-	445	0
Italy	9,786,611	0	2,813	0	7,978	29	551	2	-	-	-	-	934	0
Latvia	405,460	0	-	-	2,040	17	45	35	-	-	56	40	-	-
Lithuania	688,603	9	-	-	18,150	62	-	-	-	-	-	-	-	-
Luxembourg	2,305	0	-	-	877	0	-	-	-	-	-	-	-	-
Netherlands[2]	13,999,301	0	27	0	3,585	0	-	-	-	-	-	-	338	7
Poland	20,027,092	69	-	-	103,612	524	-	-	-	-	-	-	-	-
Portugal	78,369	0	-	-	2,152	0	-	-	-	-	-	-	-	-
Romania	3,030,926	1,005	-	-	7,313	27	-	-	164	22	-	-	-	-
Slovakia	1,124,256	2	-	-	12,960	2	-	-	-	-	-	-	-	-
Slovenia	385,195	0	-	-	1,496	1	-	-	49	0	-	-	-	-
Spain	38,897,604	77	-	-	81,248	182	-	-	-	-	-	-	121,655	8
Sweden[3]	3,015,835	0	-	-	27,131	1	348	1	167	0	-	-	149	7
United Kingdom	1,673,775	0	1,567	0	31	0	600	0	-	-	-	-	44	0
EU Total	**167,499,799**	**1,179**	**31,774**	**1**	**427,486**	**891**	**8,025**	**173**	**475**	**31**	**336**	**132**	**123,944**	**101**
Norway	1,497,200	0	-	-	-	-	-	-	-	-	-	-	-	-
Switzerland[2]	2,360,000	0	-	-	1,458	3	-	-	-	-	-	-	-	-

Note: Data are only presented for sample size ≥25.

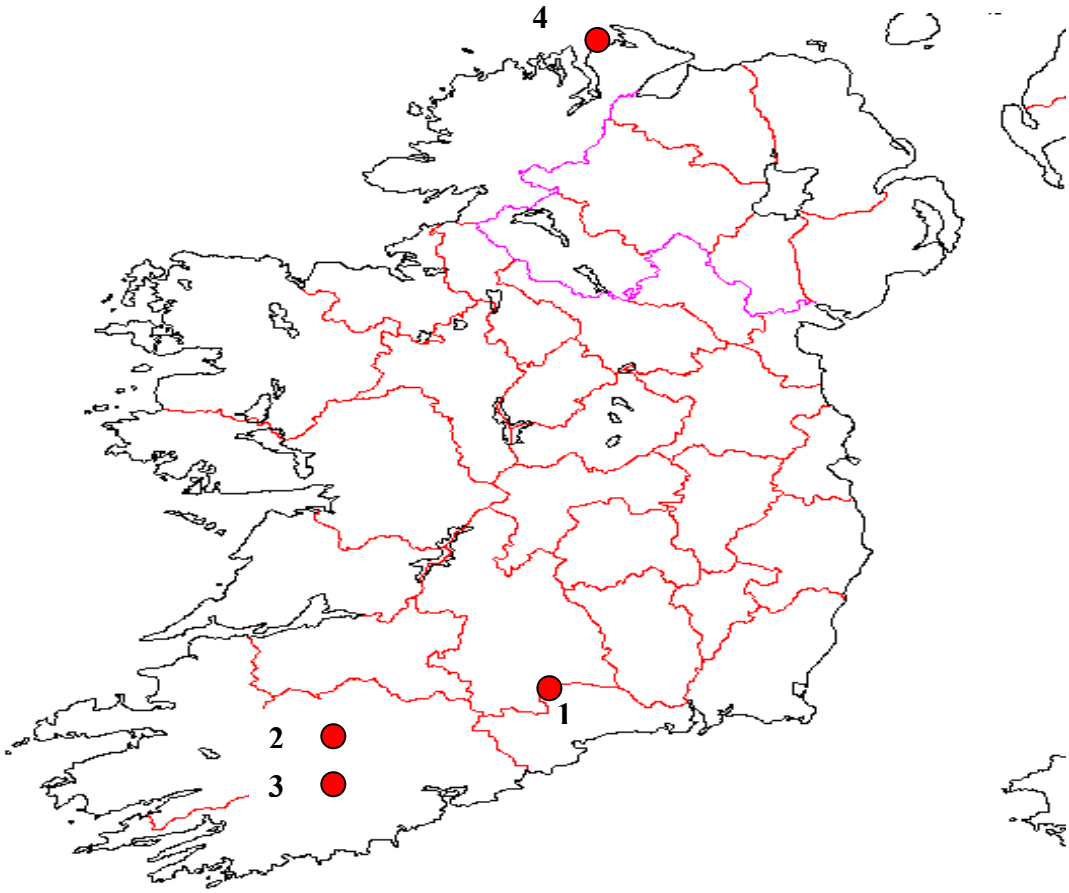
1. Other wildlife include lynxes, wolves, martens, wild birds, badgers, wild minks, otters, wild polecats, deer, stray dogs, squirrels, beavers, hedgehogs, rodents.
2. In the Netherlands and Switzerland, samples from other wildlife and wild boar (non-farmed) are based on serological tests, respectively.
3. The number on wild boars sampled includes both farmed and non-farmed. Data only covers the samples tested at the National Veterinary Institute (SVA).

In the 1990s in Eastern Europe, a re-emergence of the domestic cycle of *Trichinella spiralis* was described with a prevalence of up to 50% in swine herds in some villages. The rise was attributed to a breakdown of Government veterinary services, economic problems and war (34).

TRICHINELLA IN IRELAND

The last reported autochthonous (native) case of trichinellosis in Ireland was in 1968 (32). This led researchers to believe that the parasite had been eradicated. A study conducted in 2002 to examine foxes in Ireland for the presence of *Trichinella* found 4 of 454 foxes collected and tested were positive for *Trichinella spiralis.*

Figure 2. *Trichinella* Fox Survey, 2002, location of positive foxes in Ireland



1) Portlaw, Co Waterford, 2) Cookstown, Co Cork, 3) Templemartin, Co Cork, 4) Castlecarey, Co Donegal.

This study concluded that the sylvatic cycle of *Trichinella* still exists in Ireland and the study also confirmed that the sylvatic cycle can exist for decades independently of whether or not infection among domestic animals or humans has been demonstrated (7).

This persistence of *Trichinella* in foxes is thought to be, in part, as a result of hunters leaving carcasses/parts of carcasses in the field after skinning (7).

In 2005, 52 of the badgers captured under the Bovine Tuberculosis eradication scheme were randomly selected for *Trichinella* testing. All tested negative for *Trichinella* (31).

In 2008, DAFF carried out a fox survey. Five hundred and ten foxes were collected from multiple locations throughout the country and delivered to each of the six regional veterinary laboratories. Of the 510 foxes examined, *Trichinella* larvae were found in two (18).

In 2007, there were two confirmed human cases of trichinellosis in Ireland. Following an investigation by the Health Protection Surveillance Centre (HPSC), both cases were confirmed as imported cases – i.e. trichinellosis was contracted outside Ireland.

Both cases were Polish nationals who ate smoked pork sausages while on a visit to Poland. They both developed symptoms of infection upon their return to Ireland (8).

ON-FARM CONTROL

It has been demonstrated that the domestic life cycle of *Trichinella* will not occur in modern farming systems based on the absence of risks for transmission to pigs (12).

The principal risk factors include feeding raw waste products or animal carcasses and exposure to infected rodents and wildlife. (21)

The International Commission on Trichinellosis established minimum requirements, based on husbandry, which must be achieved for swine to be considered *Trichinella*-free.

These include:

- Architectural and environmental barriers (buildings should be rodent proof, air vents should be gridded, surrounding areas should be free from debris and rodent harborage)
- Feed and feed storage (this should be rodent proof also, suppliers should be approved and waste food should be handled according to animal by-product legislation)
- Rodent control (a documented program should be maintained by a recognised pest control provider)
- Farm hygiene (disposal of dead animals should be swift and in accordance with animal by-product legislation)
- New animals (should originate from *Trichinella* free farms or quarantine and serologically tested after three weeks) (13)

EU legislation adopts many of the above recommendations in its detailed conditions for *Trichinella* free holdings and regions with negligible risk.

TRICHINELLA IN HORSES

In 1975, the first human trichinellosis outbreak associated with eating horsemeat was recorded. The outbreak, which occurred in Northern Italy, affected 89 people (26). From 1975 to 2005, horse meat has been implicated in 15 outbreaks (involving 3334 people) in France and Italy (4). The reason for the higher incidence in these countries compared to, e.g. Belgium where the consumption of horse meat is higher per capita, is attributed to the habit of consuming raw or undercooked meat including steak *tartare* (27).

Studies have shown that horses, considered herbivores, will, in some cases eat meat products when offered (28). No epidemiological evidence exists to explain how *Trichinella* is transmitted to horses. Two hypotheses have been proposed: 1. grazing pastures contaminated with infected rodent carcasses or pork scraps. 2. by ingesting infected flesh from pigs and wild carnivores (10). Horse meat outbreaks have important consequences for public health because of the high number of infected people resulting from consumption of meat from a single horse.

In Ireland, the consumption of horse meat is very low. Prior to 2006, two slaughterhouses were approved to slaughter horses in Ireland. Between 2006 and 2008 only one approved horse slaughterhouse was operational. In 2009, a slaughterhouse under local authority supervision was approved for the slaughter of horses. The majority of the horse meat produced in these slaughter houses is exported to France and Belgium. All horses slaughtered are tested for *Trichinella* according to Regulation (EC) 2075/2005. No positive result has been reported to date. See Table 4 for numbers tested (31).

Table 4: Number of horses slaughtered and *Trichinella* samples tested 2001-2008

Year	Number Slaughtered	Number Tested	% Tested
2001	2,805	2,805	100%
2002	3,618	3,618	100%
2003	2,968	2,968	100%
2004	1,445	1,445	100%
2005	783	783	100%
2006	822	822	100%
2007	1,400	1,400	100%
2008	2,002	2,002	100%

LEGISLATION

Directive 2003/99 EC

This Directive identified *Trichinella Spiralis* as well as a number of other zoonoses as public health priorities. The Directive requires the monitoring of zoonoses, zoonotic agents and related antimicrobial resistance and proper epidemiological investigation of foodborne outbreaks. The information collected is used to evaluate trends and identify sources of zoonoses. Directive 2003/99 EC was transposed into Irish law by S.I. No.154 of 2004.

S.I. No. 707 of 2003

This Statutory Instrument is an amendment to the Infectious Diseases Regulations, 1981 and listed trichinellosis among the conditions which are notifiable to the Department of Health and Children.

Directive 64/433 EEC

Prior to 2006, this Council Directive required that fresh meat derived from domestic swine, destined for third countries be examined for *Trichinella.*

Regulation (EC) no. 2075/2005

This Regulation lays down specific rules on official controls for *Trichinella* in meat.
These rules are laid down in addition to Regulations (EC) no. 853/2004; (EC) no 854/2004 and (EC) no 882/2004 and are more specific requirements for *Trichinella*. [1]

Sampling of carcasses

Carcasses of domestic swine, horses, wild boar and other farmed and wild animal species susceptible to *Trichinella* infestation are required by the Regulation to be systematically sampled in slaughterhouses as part of the *post-mortem* examination.

The samples must be taken from predilection sites outlined in the Regulation and examined for *Trichinella* in a designated laboratory using the reference method or an equivalent method.

Derogations from requirement to sample

There are a number of derogations from the requirement to sample outlined in the Regulation:

- Meat of domestic swine which has undergone a freezing treatment in accordance with Annex II under competent authority supervision is exempt from *Trichinella* examination.

- Carcasses and meat of domestic swine kept for fattening which comes from a holding or category of holding that is recognised as officially *Trichinella* free or if the animals come from a region where the risk of *Trichinella* is officially recognised as negligible, these carcasses are not required to be examined for the presence of *Trichinella*.

The derogation from sampling according to categories of freedom does not apply to the carcasses of sows and boars these carcasses must be sampled at *post-mortem*.

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2005R2075:20071114:EN:PDF

Methods of detection

Testing methods for the detection of *Trichinella* infection in pigs and other species may be divided into procedures which are based on 1.direct detection of the parasite or 2.Indirect detection of the parasite by detecting antibodies using serological methods.

All procedures outlined in Regulation 2075/2005 for *Trichinella* inspection are based on direct detection of the parasite larval stages in muscle tissue. The magnetic stirrer method for pooled-sample digestion is recommended as a reliable method for routine use. (Annex I)

Trichinoscopy is permitted to be used only during the transitional period until 31st December, 2009. Meat tested by this method must be placed only on the market in the Member State in which it originated. Trichinoscopic examination fails to detect non-encapsulated *Trichinella* species infecting domestic and sylvatic animals and humans and is no longer suitable as a detection method for standard use.

Digestion methods have a theoretical detection limit of 1 larva per gram muscle tissue (LPG) (14). A number of published studies have demonstrated that the sensitivity of the recommended methods is lower than stated (15) (16).

Serological tests are not suitable for detecting *Trichinella* infestation in individual animals intended for human consumption (13). This is because of the slow rate of antibody production which means that an infected animal cannot be detected for several weeks (3-5) after exposure. Serological responses in pigs persist for at least six months after infection with no decline (24; 22). In horses however, antibody levels have been reported to decline within a few months following infection, even though infective larvae may persist in the musculature for at least one year (25). Serology is considered suitable for surveillance and epidemiological investigations in animal populations, where the prevalence of infection is high (13b). The ELISA method is the most commonly used method for the detection of *Trichinella* infection because it is economical, reliable, readily standardised and provides an acceptable balance of sensitivity and specificity (23).

All positive samples must be forwarded to the National Reference Laboratory or the Community Reference Laboratory for determination of the *Trichinella* species involved.

Contingency plans

The Regulation requires competent authorities of the Member States to prepare a contingency plan outlining action to be taken in the case of a positive result.

Recognition of officially *Trichinella*-free holdings, categories of holdings or regions with negligible risk

The competent authority of a Member State may recognise holdings or categories of holdings as *Trichinella* free where detailed requirements laid down in the Regulation are complied with.

More stringent requirements apply to Member States who wish to claim negligible risk status. Currently, Denmark is the only Member State to claim it is a region of negligible risk in accordance with Article 3 of Regulation 2075/2005.

TRICHINELLA FREE STATUS IN IRELAND

It is Ireland's intention to implement a derogation as outlined in Article 3 of Regulation (EC) 2075/2005 whereby carcasses and meat of domestic swine kept solely for fattening and slaughter shall be exempt from *Trichinella* examination where the animals come from a holding that has been officially recognised by the competent authority (DAFF) as free from *Trichinella.* Until the derogation is implemented, Ireland will continue to sample all carcasses of domestic swine for *Trichinella* infection.

A Member State that implements derogation from systematic sampling of porcine carcasses for *Trichinella* is obliged to submit initial and subsequent annual reports to the Commission. These reports must contain information referred to in Chapter II (D) of Annex IV of Regulation (EC) 2075/2005. Ireland submitted an initial report in June 2009.

The pig holdings involved will be required to fulfill a number of good farming practices as outlined in Chapter 1, Annex IV of Regulation (EC) 2075/2005. Inspections of these holdings will be conducted to verify adequate biosecurity measures are in place.

Ireland intends to conduct risk-based wildlife epidemiological studies on an ongoing annual basis (31).

TRICHINELLA SURVEY

In Ireland, prior to the introduction of Regulation (EC) 2075/2005, the majority of *Trichinella* testing conducted was by private laboratories in pig slaughtering plants.

Trichinella testing was a requirement for those plants supplying the Russian market. Figures compiled for 2003 and 2004 from DAFF state that 48% of pigs were tested during this period.

Since the introduction of Regulation (EC) 2075/2005 all domestic swine must now be systematically sampled as part of *post-mortem* examination.

There are 440 commercial pig production units in Ireland. These consist of 51 breeding-only units producing piglets, 102 pig fattening units and 287 integrated units accommodating both breeding and fattening pigs. The sow population is 153,000 with an average of 452 sows per farm.

Table 5: Summary of Irish pig slaughtering for years 2005-2008 (39)

Year	**2005**	**2006**	**2007**	**2008**
Total number of pigs slaughtered	2,647,000	2,658,000	2,614,000	2,577,700

DAFF supervised exporting slaughter plants source their pigs, in general, from large intensive pig producing farms. Pig rearing on these farms is carried out in a controlled environment. Biosecurity measures are put in place to control a number of diseases. These biosecurity measures also help to minimise any potential transmission of *Trichinella* from sylvatic animals to domestic pigs.

A number of the larger pig slaughterhouses have in-house laboratories that carry out *Trichinella* testing.

The local authority veterinary service supervises 220 slaughterhouses. Forty-five of these slaughterhouses are approved to slaughter pigs. Many of these have a very low throughput and slaughter pigs infrequently. The pig producers supplying these slaughterhouses vary from controlled intensive production systems to small extensive systems including “backyard” herds and outdoor pig rearing.

The following table shows the number of pigs slaughtered in local authority supervised slaughterhouses from 2005-2008 as a percentage of the national slaughter figure:

Table 6: Number of pigs slaughtered in local authority supervised slaughterhouses as a percentage of the total number slaughtered in Ireland

Year	Number of Pigs Slaughtered in Local Authority Slaughterhouses	% of Total no. Slaughtered (IE)
2005	26,220	1.0%
2006	37,918	1.4%
2007	49,425	1.9%
2008	47,811	1.9%

The numbers slaughtered in local authority supervised slaughterhouses are a small proportion of the total number slaughtered in Ireland. They are however, an important population to investigate because of their varied production systems. This includes “backyard” herds which are often reared with minimal biosecurity measures in place and are consequently at higher risk of contracting trichinellosis from sylvatic animals. These animals are, therefore, important indicators of disease.

In 2007, the FSAI undertook a survey of the levels of *Trichinella* in pigs slaughtered in local authority supervised slaughterhouses. A tendering process for analysis of samples was conducted prior to commencing the survey. En-Force Laboratories Ltd. Cork was awarded the contract for analysis. Thirty-three local authority slaughterhouses participated in the survey which began in August 2007 and was completed in January 2009. The slaughterhouses were located in 16 counties. All the pigs slaughtered in that period were sampled.

Two slaughterhouses in Cavan and Meath were not included in the survey because their throughput was much greater than the other local authority supervised slaughterhouses and they sourced their pigs, in general from larger intensive farms.

Ten local authority supervised slaughterhouses did not participate in the survey for operational reasons. The majority of these slaughterhouses did not slaughter pigs for the duration of the survey.

Table 7: Number of local authority slaughterhouses participating in the survey by county

Local Authority	Number of Establishments Slaughtering Pigs
Carlow CC	1
Cork CC	10
Donegal CC	5
Kerry CC	2
Kildare CC	1
Kilkenny CC	1
Laois CC	1
Leitrim CC	2
Limerick CC	2
Mayo CC	1
Offaly CC	1
Sligo CC	1
South Dublin CC	1
Tipperary (SR) CC	2
Westmeath CC	1
Wexford CC	1

Figure 3: Distribution of slaughterhouses participating in the survey

The frequency of pig slaughtering varied widely between the slaughterhouses participating in the survey.

Methodology

A standard operating procedure for taking of samples was developed by the FSAI and circulated to the participating local authorities. Sampling was carried out by trained food business operators. One specimen was taken from each porcine carcase.

In the case of whole carcasses of domestic swine a 1 gram specimen was taken from the pillar of the diaphragm. In the case of breeding sows and boars, a larger sample of 2 grams was taken at the pillar of the diaphragm.

In the absence of diaphragm pillars, a specimen of twice the size 2 grams (or 4 grams in the case of breeding sows and boars) was taken from the rib part or the breastbone part of the diaphragm, or from the jaw muscle, tongue or abdominal muscles. The samples were then dispatched in suitable packaging by swift post to En-Force Laboratories Ltd. for analysis.

The laboratory analysed the samples according to the magnetic stirrer method for pooled sample digestion as outlined in Regulation (EC) 2075/2005(Annex I). The magnetic stirrer method is considered the gold standard because it is a method specifically designed for pooled samples and it has been subjected to validation studies (31). This widely used magnetic stirrer method for pooled samples can be employed in a variety of circumstances with a minimum of equipment (24). This method is used as the reference method and is considered satisfactory if the limit of three larvae per 100 grams of meat is achieved in the 75% of tests.

The individual animal samples submitted from each slaughterhouse from a day of slaughtering were analysed together as a composite sample. The laboratory method used could analyse up to 100 individual 1 gram samples as one composite sample. The numbers of individual samples comprising a composite sample were often very low ranging from 1 pig up to 41 pigs in a composite sample

Collation of Data

Results of the analysis were reported to the food business operator and the local authority veterinary inspector by fax and hard copy within the agreed time of 48 hours. A system of sending computer generated text messages was also in place for those food business operators who could not be contacted by fax.

The protocol in the event of a positive sample being detected was to send the sample to the Central Meat Control Laboratory which is the National Reference Laboratory for *Trichinella.* There were no positive samples detected during the survey.

Results

Over the course of the survey 10,247 samples or 1030 composite samples were taken and submitted to En-Force Laboratories Ltd. *Trichinella* was not detected in any sample analysed during the survey.

Figure 4: Number of pigs sampled per county for the duration of the survey (August 2007-January 2009)

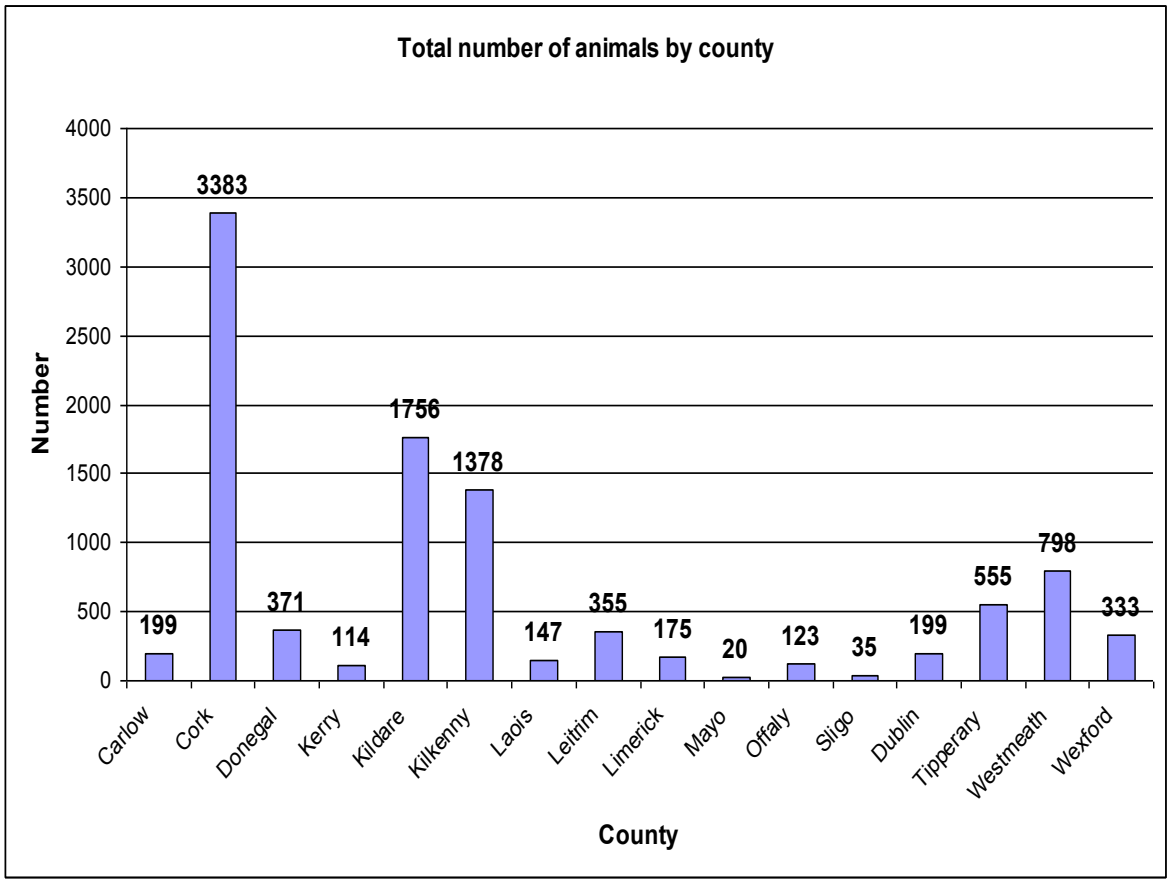
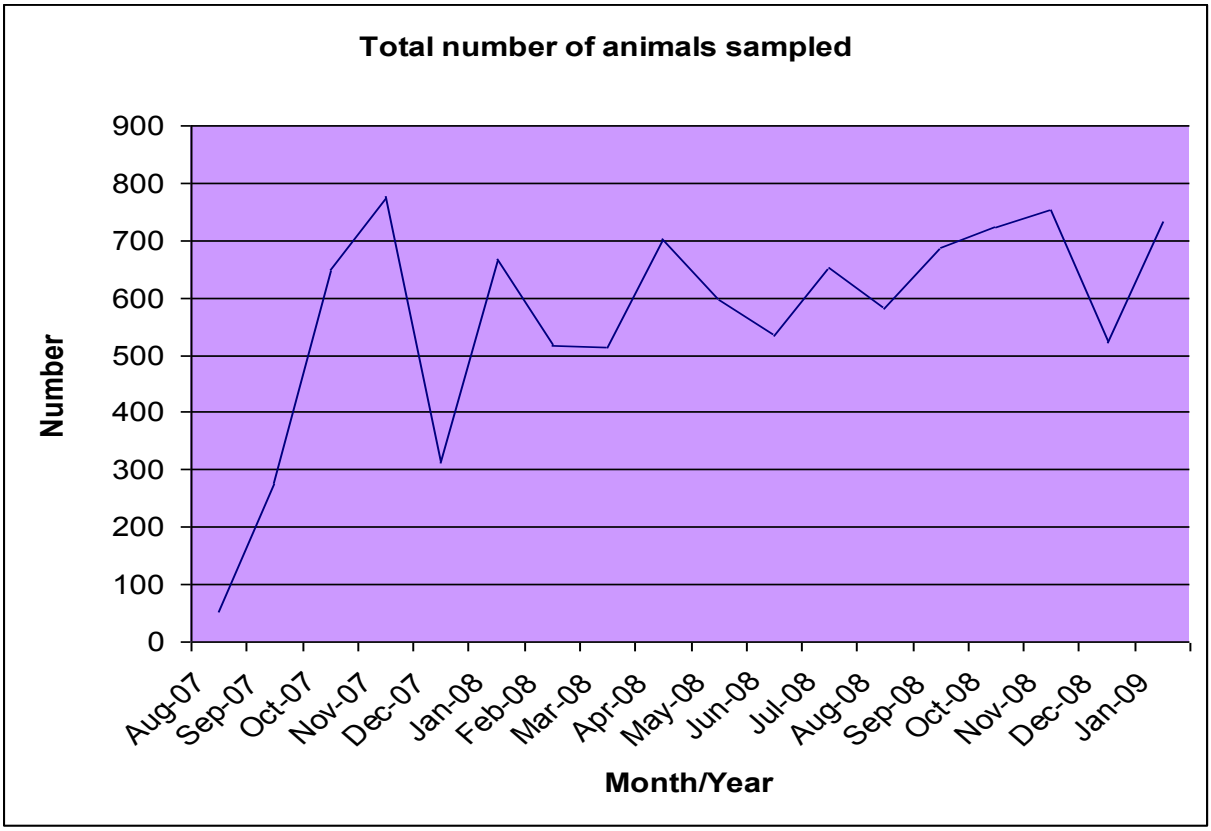


Figure 5: Number of pigs sampled during the survey (August 2007-January 2009)



CHANGES IN *TRICHINELLA* TESTING PROCEDURES

Since the completion of the survey in January 2009, participating food business operators have continued to sample all pig carcasses slaughtered in their establishments for *Trichinella*. It is a legal requirement under Regulation (EC) 2075/2005 that all pigmeat placed on the market must be tested for *Trichinella*. The cost of analysis of one pig is equivalent to the cost of analyzing 100 pigs; therefore food business operators slaughtering small numbers of pigs incur significant costs per pig compared to higher throughput food businesses.

The FSAI and the local authority veterinary service coordinated a system for analysis of *Trichinella* samples. The system requires each slaughterhouse to submit samples on the day of slaughter. These samples are analysed as a composite sample in the laboratory. The results are then forwarded to the food business operators and the relevant local authority veterinary inspector. This system significantly reduces the average cost per pig slaughtered and fulfills the legal requirement for all pigs to be sampled for *Trichinella* analysis.

Each food business operator must have a contingency plan in place detailing action to be taken in the event of a positive result. The contingency plan requires the food business operator to detain all pig carcasses pending a negative result. A procedure for re-sampling carcasses from a positive sampling pool is outlined and in the case of a carcase which is confirmed positive this carcase must be declared as unfit for human consumption and disposed of appropriately.

CONCLUSION

Trichinellosis is a zoonotic disease caused by the nematode *Trichinella*. It is a significant cause of foodborne illness in many European Union Member States.

In 2007, the FSAI funded a *Trichinella* survey in 33 local authority supervised slaughterhouses. The survey targeted low throughput slaughterhouses that sourced their pigs from extensive pig production systems including “back-yard” production systems. These extensive pig production systems were highlighted as high-risk production systems due to the potential for domestic pigs to encounter infected wildlife.

The survey was conducted over 18 months.1,030 composite samples were analysed from 10,247 pigs and there were no positive samples reported. All pigs slaughtered in Ireland continue to be sampled for *Trichinella* and to date; there have been no reported positives.

RECOMMENDATIONS

- Thorough cooking of meat is good practice to avoid many foodborne illnesses. Education of consumers regarding the risks of undercooking meat will help to prevent clinical trichinellosis in the event of contaminated meat being consumed.
- Education of consumers should be targeted in particular at those groups or nationalities who traditionally consume raw or undercooked meats.
- Provision of information to the consumer regarding the potential risks associated with consuming pig meat from animals slaughtered on their own farm which have not been tested for *Trichinella* is required.
- Education of hunters regarding good hunting practices and proper disposal of carcasses and offal will help to control this mode of *Trichinella* transmission among wildlife.
- Ireland is legally obliged to conduct a risk-based wildlife monitoring programme. Currently, this programme includes analysis of prevalence in foxes and badgers. The programme could be expanded to identify the prevalence in all susceptible wildlife species in Ireland.

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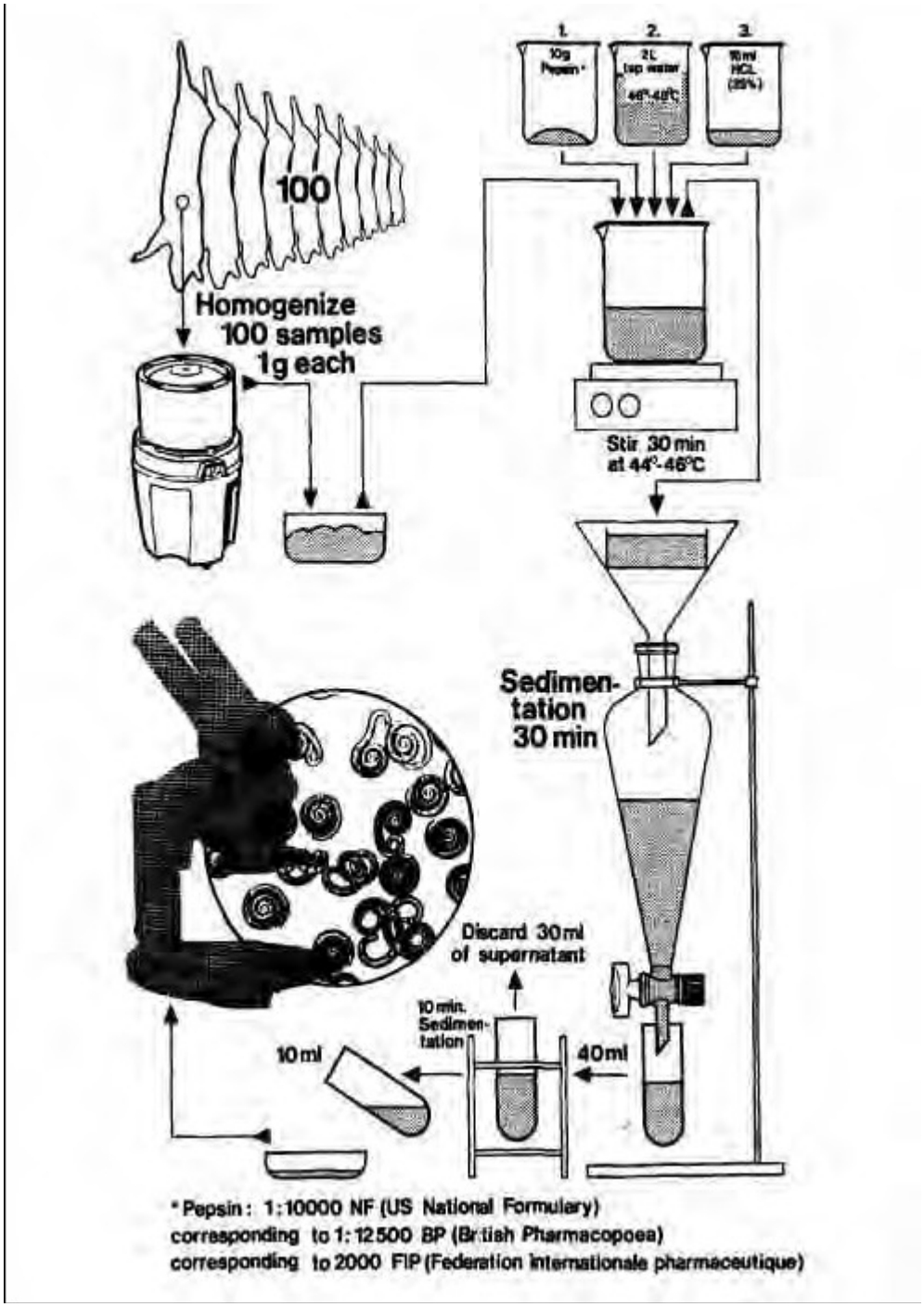
ANNEX I

Figure 6: Outline of the artificial digestion technique (Magnetic stirrer method)



For the magnetic stirrer method (Figure 9) the essentials are: A maximum of 100 g of pooled samples of muscle tissue from prescribed predilection sites of the animals under inspection.

The sample pool is digested using 2 l of artificial digestive fluid consisting of 0.5% pepsin (1:10,000 USA National Formulary) and 25% HCI to achieve a final normality of 0.06N.

The digest is stirred for 30 min at 44°C to 46°C in a 3 1 glass beaker using a heated plate magnetic stirrer. During this process, the *Trichinella* larvae are released from the muscle. The digestion fluid is then poured through a sieve (mesh size 180 urn), which retains any undigested tissues, but allows the passage of *Trichinella* larvae, into a 2 l separatory funnel.

Following sedimentation for 30 min, a 40 ml sample of the sediment is quickly released into a 50 ml tube. After a further 10 min of sedimentation to clarify the suspension, 30 ml of supernatant is withdrawn and the remaining 10 ml of sediment is poured into a gridded Petri dish.

The 50 ml tube is rinsed with 10 ml of tap-water, shaken, and this is added to the gridded Petri dish. The sample in the petri dish is then examined by either trichinoscope or stereo-microscope (15 to 40 x magnification) for the presence of *Trichinella* larvae (38).

A detailed protocol for this magnetic stirrer method for detection of *Trichinella* muscle larvae in pork is described in Regulation (EC) No 2075/2005.

ANNEX II - LIFE-CYCLE OF *TRICHINELLA*

Morphology

The adult female worm is about 2-3mm long and 90μm in diameter. The male is smaller measuring 1.2mm long by 60μm in diameter

Figure 7: Male and Female morphology (5)

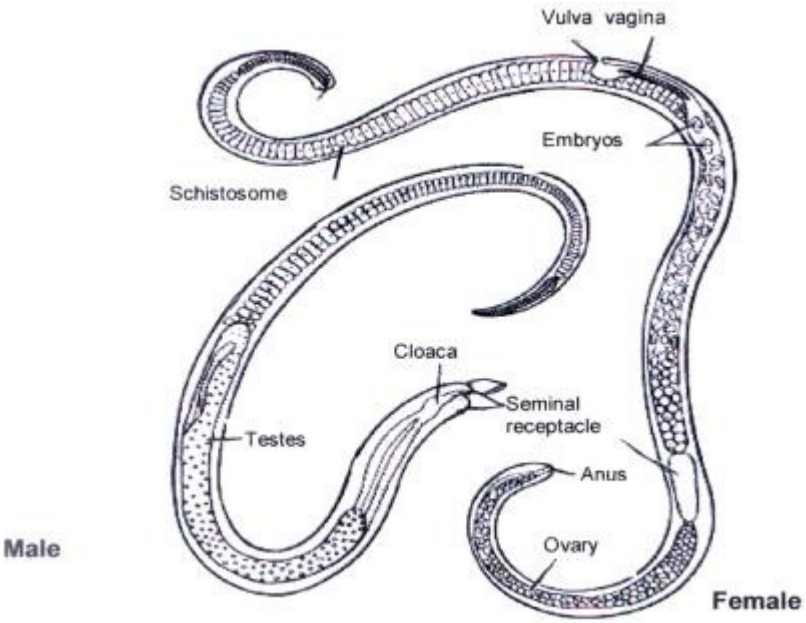
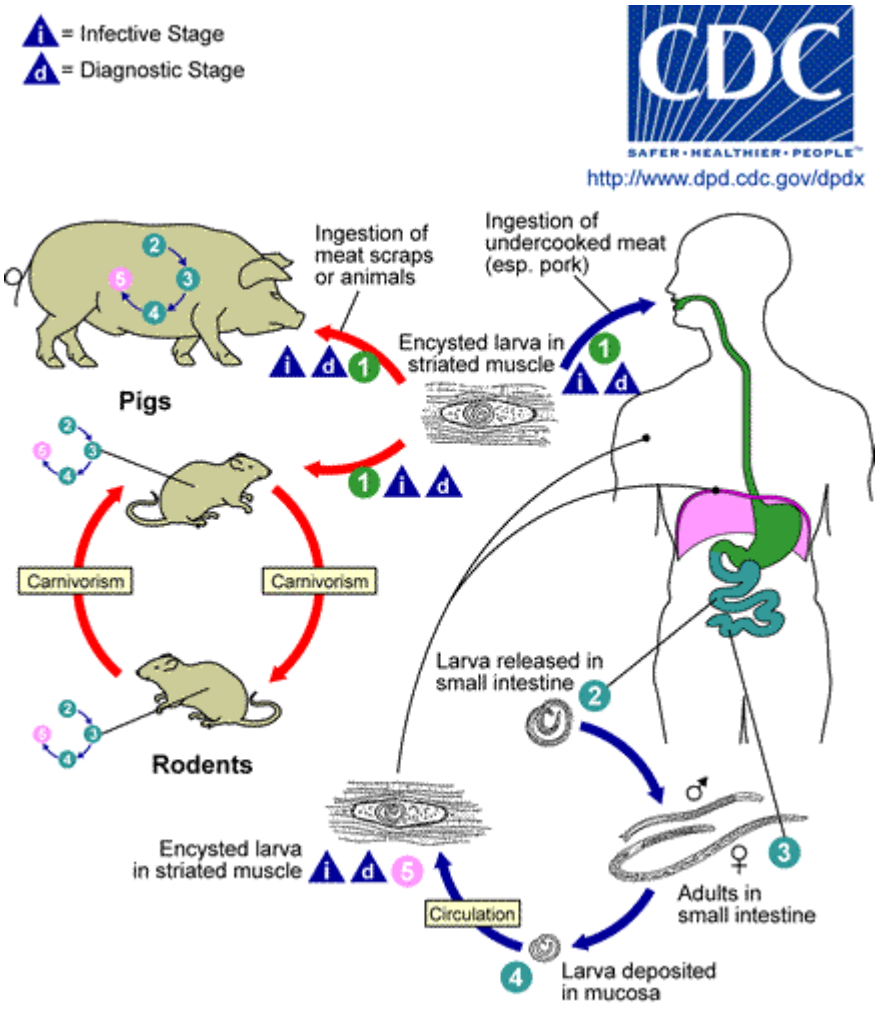


Figure 8: Life cycle of *Trichinella* (35)



Source: Centers for Disease Control and Prevention

Trichinellosis is acquired by ingesting meat containing cysts (encysted larvae) (1 Figure 2) of *Trichinella*. After exposure to gastric acid and pepsin, the larvae are released (2 Figure 2) from the cysts and invade the small bowel mucosa where they develop into adult worms (3 Figure 2) (female 2.2 mm in length, males 1.2 mm; life span in the small bowel: four weeks). After one week, the females release larvae (4 Figure 2) that migrate to the striated muscles where they encyst (5 Figure 2). *Trichinella pseudospiralis*, however, does not encyst.

Encystment is completed in four to five weeks and the encysted larvae may remain viable but dormant for several years. Ingestion of the encysted larvae perpetuates the cycle. Rats and rodents are primarily responsible for maintaining the endemicity of this infection. Carnivorous/omnivorous animals, such as pigs or bears, feed on infected rodents or meat from other animals. Different animal hosts are implicated in the life cycle of the different species of *Trichinella*. Humans are accidentally infected when eating improperly cooked meat of these carnivorous/omnivorous animals (or eating food contaminated with such meat).

ANNEX III - HUMAN INFECTION AND CLINICAL SIGNS

Table 1: Clinical signs of trichinellosis

First Phase	Second Phase
Nausea	Headaches
Diarrhea	Fever
Vomiting	Chills
Fatigue	Cough
Fever	Per orbital oedema (eye swelling)
Abdominal discomfort	Aching joints
	Muscle pains
	Itchy skin
	Diarrhoea
	Constipation
	Organ Damage –Central Nervous system Heart Lungs

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