

All-island Animal Disease Surveillance Report 2013

A joint AFBI / DAFM Veterinary Laboratories publication



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Table of Contents

Introduction	4
Animal demographics and the weather	5
Cattle and sheep demographics	5
Weather	5
Diseases of Cattle	6
Neonatal Calves	6
Calves	8
Weanlings (6-12 months old)	10
Adult cattle	11
Clostridial disease in Cattle	13
Bovine Neonatal Enteritis	16
Zinc Sulphate Turbidity Test	19
Bovine Abortion	20
Hereditary and developmental abnormalities	23
Bovine mastitis	24
Bovine respiratory disease	27
Farm diagnostic investigations	31

The National Bovine Viral Diarrhoea (BVD) Eradication programmes	32
Fatal poisonings	35
Cattle	35
Sheep	38
Horses	38
Dogs	38
Wild birds	39
Schmallenberg Virus	39
Diseases of sheep	41
Parasitic disease in sheep	42
Clostridial disease in sheep	45
Ovine Abortion	46
Diseases of pigs	47
Pneumonia in pigs	47
<i>Escherichia coli</i> infections	48
Streptococcal infections	48
Reproductive diseases	49
Notifiable Diseases	49
Other diagnosis	49
Diseases of poultry	51
Diseases of horses	54
The Irish Equine Centre	54
AFBI and DAFM Laboratories	56
Diseases of Aquatic Animals	57
Statutory testing	57
Diagnostic testing	57
Research	59
Scientific publications	60
Parasitic diseases	60
Liver and rumen fluke infections	60

Strongyles	61		
Coccidiosis	61		
Sheep scab	62		
Clinical chemistry	63		
Copper analyses	63		
Selenium analyses	63		
Iodine analyses	64		
Cobalt	65		
Haematology	65		
Anthelmintic resistance	66		
Wildlife surveillance	68		
<i>Echinococcus</i> surveillance of wild foxes	68		
Trichinella surveillance of wild foxes	68		
Post-mortem of two True's Beaked Whales	69		
Wildlife Crime	70		
Proficiency testing	71		
Zoonoses	72		
Toxoplasmosis	72		
Campylobacteriosis	73		
Listeriosis	73		
Cryptosporidiosis	74		
Q fever	74		
Salmonellosis	74		
Leptospirosis	75		
Surveillance of epizootic diseases	76		
Bluetongue	76		
Avian Influenza	77		
Newcastle disease	77		
Bovine spongiform encephalopathy (BSE)	77		
Scrapie	77		
		A selection of abstracts from published scientific papers	78
		Pre-calving and calving management practices in dairy herds with a history of high or low bovine perinatal mortality	78
		An international delphi study of the causes of death and the criteria used to assign cause of death in bovine perinatal mortality	78
		<i>Fasciola hepatica</i> : Histological demonstration of apoptosis in the reproductive organs of flukes of triclabendazole-sensitive and triclabendazole-resistant isolates, and in field-derived flukes from triclabendazole-treated hosts, using in situ hybridisation to visualise endonuclease-generated DNA strand breaks	79
		Anthelmintic resistance in Northern Ireland (I): Prevalence of resistance in ovine gastrointestinal nematodes, as determined through faecal egg count reduction testing	80
		Anthelmintic resistance in Northern Ireland (II): Variations in nematode control practices between lowland and upland sheep flocks	81

Introduction

“Taking some of the gamble out of risk”

Animal disease does not respect political boundaries and the main purpose of this, the 2013 All-Island Animal Disease Surveillance Report, is to summarise the results of disease surveillance carried out in 2013 on the island of Ireland which is in effect a single epidemiological unit. The report contains a summary of the findings from the six regional veterinary laboratories operated by the Dept of Agriculture, Food, and the Marine, the two analogous AFBI laboratories based in Northern Ireland, the Marine Institute and the Irish Equine Centre. In each case, scanning surveillance seeks to monitor and measure trends and patterns of disease, optimize methods and activities to detect novel emerging and exotic disease, and retain a live and dynamic link to the farm animal sectors we are seeking to observe. The breadth of coverage reflected in the list of contributors reflects the increasing recognition of the concept known as the ‘surveillance footprint’. In order for surveillance to be meaningful and provide for early warning, it is important to retain a substantial footprint in respect of both geographic coverage and various livestock sectors and production systems.

In the case of the pig and poultry sectors, which have traditionally been more self-reliant in terms of their diagnostic service needs than other sectors, the laboratory services in both jurisdictions are striving to maintain and if possible increase caseload. A significant reason for doing so presents itself at the time of writing, given that African swine fever has evidently breached the biosecurity defences of the EU, and is spreading in the Baltic States. This disease has the potential to cause significant damage to our pig industry, north and south, and our challenge is to ensure we remain free, or in the event that we fail in that endeavour, to strive

to detect and diagnose it as early as possible, to facilitate control and eradication.

Enhancing and expanding both the scale and the resolution of the surveillance footprint is an abiding pre-occupation of those who provide animal disease surveillance systems. In difficult economic circumstances, and working within fixed, and often shrinking resources, this requires prioritisation. Any such prioritisation must be based on an element of forecasting, and therefore contains inherent risks if an unforeseen threat materialises. The process of prioritisation must be founded on reliable description and a shared understanding of the myriad of theoretical risks faced by our livestock sectors. Typically, this comes from two sources, ‘hard data’ and ‘soft intelligence’. This report collates the former, and is a unique collection of hard data in respect of many agents and disease syndromes. Optimizing the latter requires that the contributors to this report continue to build and enhance close links with their respective geographic areas and with key players within the sectors at all levels: farmers, veterinary practitioners, processors, advisers to inform our own priorities, and those of policy makers in both parts of this shared island.

Animal demographics and the weather

Cattle and sheep demographics

The national cattle herds in Ireland and Northern Ireland showed divergent trends during 2013. Ireland recorded a minor increase compared to 2012 (+0.89 *per cent*) in the national herd to 6.31 million cattle while Northern Ireland witnessed a contraction of 2.32 *per cent* to 1.59 million cattle during the same time period (Figure 1). The rise in cattle numbers in Ireland, while modest, represents the continuation of a trend which began in 2011.

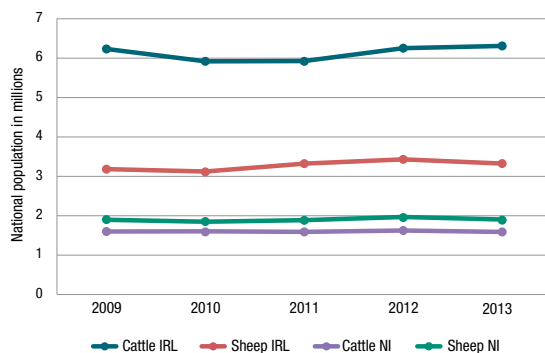


Figure 1: Trends in the national cattle and sheep populations in Ireland and Northern Ireland from 2009 to 2013. (Source: Central Statistics Office www.cso.ie for Ireland data; www.dardni.gov.uk/index/statistics.htm for Northern Ireland data)

The national sheep flocks in both Ireland and Northern Ireland contracted by approximately three *per cent* during 2013 compared to 2012 data. In Northern Ireland this contraction appears to have resulted from a drop in ewe numbers nationwide. Comparing the results of the last 5 years, a peak in sheep number was experienced in 2012 in both jurisdictions. The 2013 sheep populations represent a decrease from this peak and a return to the national flock sizes recorded during 2011 in both jurisdictions.

Weather

While the abiding memory of 2013 is of an exceptionally dry and warm summer, the annual rainfall was only marginally lower than the thirty-year average which reflects a year of marked contrasts. The year began wetter than normal, contributing to a very harsh winter for livestock. Submissions to the veterinary laboratories in both Ireland and Northern Ireland experienced a surge during the spring of 2013 as a combination of poor fodder, fodder shortages and inclement weather led to poor herd and flock health on many farms. Relief arrived in the form of six drier months (with the exception of April (Figure 2)), all of which led to animals regaining much of their lost condition following their release to pasture.

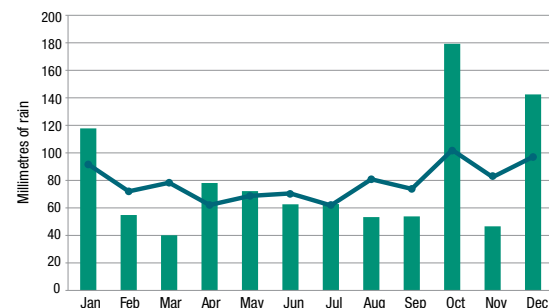


Figure 2: The monthly rainfall recorded during 2013 in Mullingar compared to the 30-year monthly average rainfall (blue line). (Source: www.met.ie)

Late autumn proved to be markedly wetter than normal with flooding experienced in many areas. In those areas where animals were housed as a result of flooding, the favourable summer had led to sufficient fodder reserves to cope with the prolonged housing period.

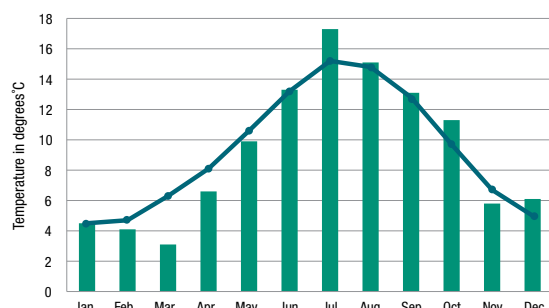


Figure 3: The monthly average temperature as recorded in Mullingar during 2013 compared to the 30-year average temperature (blue line). (Source: www.met.ie)

The average annual temperature for 2013 was the same as 2012 although the average monthly temperature recorded during July was well above the 30-year average (Figure 3). This led to occasional reports of heat stress among cattle in some areas, a problem which had not been recorded for many years. The combination of the heavy rainfall witnessed in late autumn and the warmer than average temperatures recorded in both October and December provided favourable conditions for the over-wintering of rumen and liver fluke on pasture, which may be a problem for 2014.

Diseases of Cattle

This section presents the most commonly diagnosed causes of death in cattle presented for examination at the laboratories of the Agri-Food and Bioscience Institute (AFBI) and the Department of Agriculture, Food and the Marine (DAFM). The range of diagnoses varies according to the age of the animal, thus results in this section are presented by age category. In an effort to rationalize the presentation of results, age categorisation has been standardized for AFBI and DAFM. Thus, results are presented for neonatal calves (under one month of age), calves (one to five months of age), weanlings (six to twelve months of age), and adult cattle.

In order to facilitate presentation and comparison with previous reports, conditions which affect given systems have been grouped together. Occasionally, specific details relating to some individual conditions are included in other sections of the report.

Neonatal Calves

Animals less than one month-old are included in the category of neonatal calves.

Gastroenteric infections have consistently been the most commonly diagnosed cause of mortality in previous reports in this age category and the trend continued in 2013, accounting for 38 *per cent* of neonatal deaths in Northern Ireland (Figure 6) and 27.6 *per cent* in Ireland (Figure 4). Gastroenteric infections are further discussed in the bovine neonatal enteritis section.

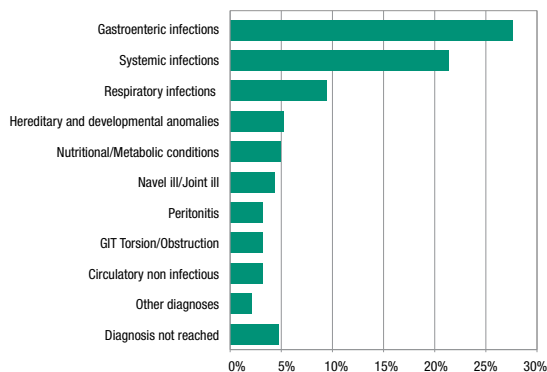


Figure 4: The conditions most frequently diagnosed on *post mortem* examination of neonatal (less than one-month-old) calves in Ireland during 2013 (n=1366). GIT=Gastrointestinal tract.

The second most commonly diagnosed cause of mortality in neonatal calves during 2013 on the island of Ireland was respiratory tract infections, accounting for 14 and 9.4 *per cent* of cases in Northern Ireland (Figure 6) and Ireland (Figure 4), respectively. *Mannheimia haemolytica* was the most frequently recovered respiratory pathogen in neonatal calves (16 and 9.3 *per cent* in Northern Ireland and Ireland, respectively). Bovine viral diarrhoea (BVD) virus was detected in two and three cases of respiratory tract infection in Northern Ireland and Ireland, respectively (Figure 5). More information can be found in the bovine respiratory diseases section.



Figure 5: Cerebellar hypoplasia (arrow) in a neonatal calf affected with bovine viral diarrhoea virus. (Photo: Cosme Sánchez-Miguel)

Colisepticaemia was the most common diagnosis in the septicæmia/toxaemia group, accounting for 56 and 24 *per cent* of cases in this group in Northern Ireland and Ireland, respectively. Hypogammaglobulinaemia was again the most frequently recorded nutritional/metabolic condition in neonatal calves during 2013, accounting for 68 and 46 *per cent* of cases in Northern Ireland and Ireland, respectively. Incorrect application of stomach tubes for ruminal feeding (10 cases out of 1134 *post mortem* calves studied) was the second most frequently recorded diagnosis in this group in Northern Ireland.

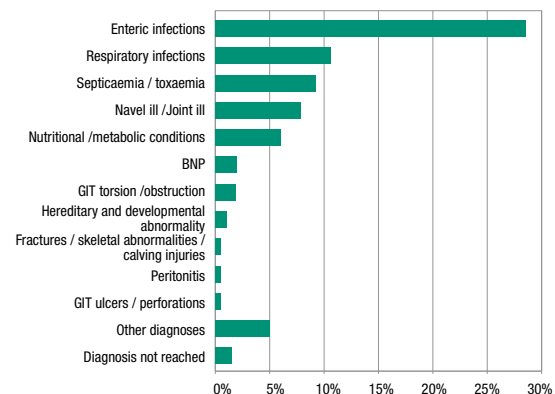


Figure 6: The conditions most frequently diagnosed on *post mortem* examination of neonatal (less than one-month-old) calves in Northern Ireland during 2013 (n=1134). GIT=Gastrointestinal tract; BNP=Bovine neonatal pancytopenia.

Bovine neonatal pancytopenia was diagnosed in 1.0 and 2.9 *per cent* of carcasses in Ireland and Northern Ireland respectively. Hereditary and developmental abnormalities were responsible for mortality in approximately 5 *per cent* of bovine neonates in Ireland during 2012. In Northern Ireland, the number of deaths due to similar conditions was recorded at 1.8 *per cent*. In Ireland, circulatory defects were the most frequently observed fatal developmental anomalies with 14 cases recorded during 2012. Congenital joint laxity and dwarfism accounted for the second most common cause of death in this category (10 cases), followed by atresia coli (9 cases) and atresia jejunum (7 cases).

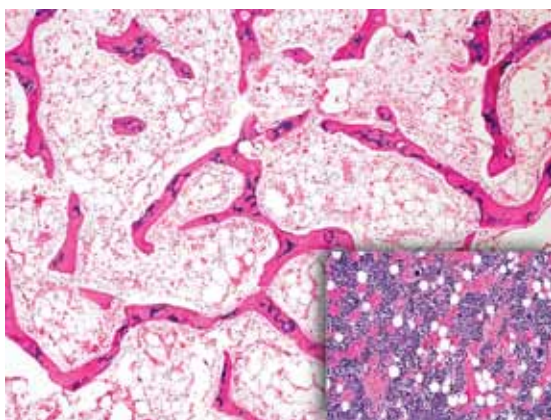


Figure 7: Photomicrograph showing characteristic bone marrow aplasia in a neonatal calf affected by bovine neonatal pancytopenia, compared to a normal bone marrow picture in the bottom left-hand side. (Photo: Cosme Sánchez-Miguel)

Salmonellosis is also discussed in the section on bovine neonatal enteritis. Of a total of 43 *Salmonella* isolates found in Northern Ireland, 38 were classified as *Salmonella* Dublin (88.4 per cent), two as *S. Typhimurium* (4.6 per cent) and three *Salmonella* isolates were classified as untyped Serogroup B (7.0 per cent). In Ireland, *Salmonella* spp. “were isolated from 58 neonatal calves (4.2 per cent) following *post mortem* examination, and it was associated with enteritis, septicaemia, pneumonia and navel ill. *S. Dublin* was again the most commonly isolated serotype, being found in 55 out of a total of 1366 neonatal calves examined (4.0 per cent), and *Salmonella* Typhimurium was isolated in three occasions (0.2 per cent).”

Another significant finding in the veterinary laboratories in Ireland was the isolation of *Mycoplasma bovis* on one occasion from a calf with arthritis.

Calves

This age category includes cattle of one to five months of age.

In this group, respiratory infections were the most frequent cause of death in the island of Ireland (38 and 29.5 per cent of cases in Northern Ireland and Ireland, respectively), following the same pattern as in previous years (Figure 9 and Figure 8).

In Ireland, respiratory infections in calves were diagnosed in 232 out of 786 animals examined (Figure 8). The most frequently diagnosed bacterial pathogen in respiratory infections was *Pasteurella multocida*, followed by *Mannheimia haemolytica*, *Trueperella pyogenes* and *Mycoplasma bovis* (16.4, 10.8, 7.8 and 5.6 per cent of the total respiratory diagnosed cases respectively). The most common viral pathogens detected in one to five-month-old calves showing respiratory infection were bovine respiratory syncytial virus (6.5 per cent), bovine herpesvirus one (BHV-1), the causal agent of infectious bovine rhinotracheitis (IBR) amongst other clinical syndromes, (2.1 per cent) and BVDV, (2.1 per cent). In addition, parasitic bronchitis caused by *Dictyocaulus viviparus* (hoose) was diagnosed in 9.1 per cent of the carcasses diagnosed with respiratory diseases.

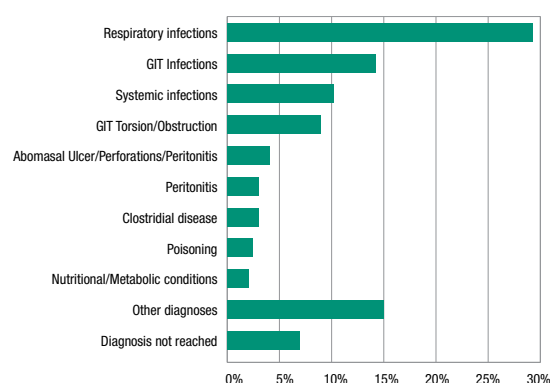


Figure 8: The conditions most frequently diagnosed on *post mortem* examination of one to five-months-old calves in Ireland during 2013 (n = 786). GIT=Gastro intestinal tract.

During 2013, respiratory infections were the most frequently diagnosed pathology in *post mortem* examination in one to five month-old calves in Northern Ireland (Figure 9), and they were most frequently associated with bacterial pathogens. In Northern Ireland a total of 184 cases of respiratory disease were diagnosed following *post mortem* examination of 488 one to five month-old calves and *Mycoplasma bovis* was the most frequent bacterial isolate with 35 cases, followed by *Pasteurella multocida* (26 cases), *Mannheimia haemolytica* (25 cases), *Trueperella pyogenes* (18 cases) and *Haemophilus somni* (10 cases). Hoose (parasitic bronchitis) was the most frequently diagnosed non-bacterial cause of pneumonia (8 cases).

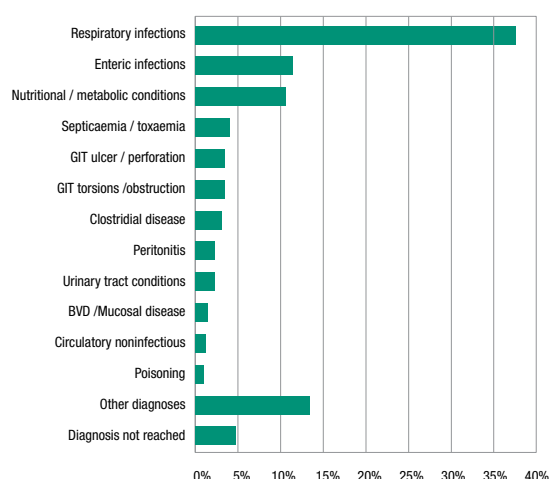


Figure 9: The conditions most frequently diagnosed on *post mortem* examination of one to five months-old calves in Northern Ireland during 2013 (n=488). GIT=Gastro intestinal tract.

Enteric infections were diagnosed in 11 *per cent* of examined calves in this age category in Northern Ireland and 14.4 *per cent* in Ireland during 2013 (Figure 9 and Figure 8). Coccidiosis was recorded as the causative agent in 18.0 and 17.7 *per cent* of the enteric infections in Northern Ireland and Ireland respectively. In the enteric infections group, *Cryptosporidium* spp, BVD/mucosal disease and parasitic gastroenteritis were each diagnosed in six occasions, representing an 11 *per cent* each

of all enteric disease diagnoses in Northern Ireland. In Ireland, the most frequent conditions diagnosed in the gastro-enteric infections group were parasitic gastroenteritis (9 cases, eight *per cent* of gastro-enteric infections) and *Salmonella* Dublin was recorded in three carcasses (2.7 *per cent*).

Nutritional and metabolic conditions were diagnosed in 52 calves (11 *per cent*) in Northern Ireland during 2013, similar to 2012 when 57 cases of nutritional and metabolic conditions were diagnosed. The most frequent cause of mortality in this group was ruminal acidosis (23 cases), followed by malnutrition (15 cases). In Ireland, nutritional and metabolic conditions were diagnosed in 16 cases, two *per cent* of the total, and the most frequent conditions in this group were ruminal acidosis, bloat, malnutrition and impaction of the rumen with seven, three, two and two cases respectively.

During 2013, *Salmonella* spp. “was associated with enteritis, septicaemia and pneumonia in this age category. In Ireland, *Salmonella* Dublin was isolated from 13 calves on *post mortem* examination, one of these cases was associated with a spinal abscess in a seven week-old calf. *Salmonella* Typhimurium was isolated from one calf examined *post mortem* in Ireland.”

Gastrointestinal ulceration/perforation leading to peritonitis is a common cause of death in one to five-month-old calves, and it was diagnosed on 17 and 32 occasions in Northern Ireland and Ireland respectively during 2013. The majority of these ulcers are perforated leading to spillage of intestinal contents and to peritonitis. Also, gastrointestinal torsion/obstruction was recorded in 71 cases in one to five-month-old calves in Ireland during 2013, 61 of these were intestinal/mesenteric torsions (Figure 10).



Figure 10: Large intestinal torsion in a two month-old calf. (Photo: Seán Fee)

Weanlings

In Ireland and Northern Ireland's veterinary surveillance laboratories, cattle between six and 12 months of age are categorised as weanlings, and findings in this age category are presented in this section.

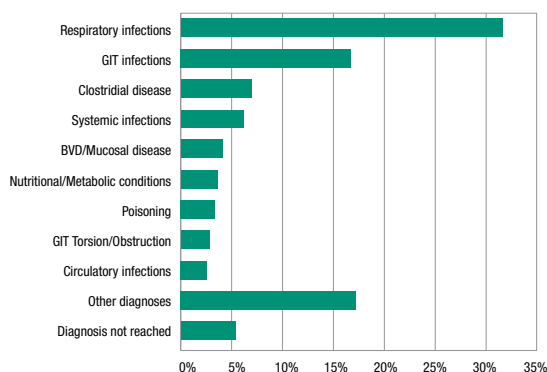


Figure 11: The conditions most frequently diagnosed by *post mortem* examination of weanlings (six to twelve month-olds) in Ireland during 2013 (n=391). GIT=Gastrointestinal tract.

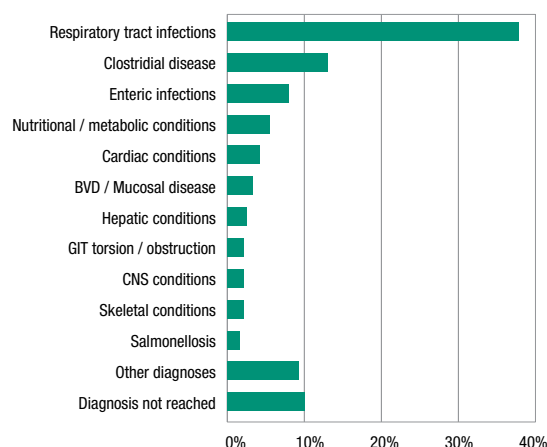


Figure 12: The conditions most frequently diagnosed by *post mortem* examination of weanlings (six to twelve month-olds) in Northern Ireland during 2013 (n=242). GIT=Gastrointestinal tract; CNS=Central nervous system.

As in previous years, respiratory tract infections were identified as the most common cause of mortality in weanlings in Northern Ireland and Ireland, accounting for 37 and 31.5 *per cent* of deaths respectively during 2013, overall a slight decline from 2012 and 2011 results in Northern Ireland (40 *per cent* in both years), and decreasing from 2012 and increasing from 2011 in Ireland (35.5 and 25 *per cent* in 2012 and 2011 respectively). Bacterial infections were the most frequent cause of respiratory tract infections. *Mycoplasma bovis* (Figure 13) was the most common pathogen detected in Northern Ireland (21 cases) and the second most common in Ireland (eight cases), while *Pasteurella multocida* was the most common pathogen detected in Ireland (18 cases) and the second most common in Northern Ireland (11 cases). Other common bacterial pathogens isolated were *Mannheimia haemolytica* (nine and six cases in Northern Ireland and Ireland, respectively), *Trueperella pyogenes* (four and five cases in Northern Ireland and Ireland, respectively), and *Histophilus somni* (two cases in Northern Ireland). Among the viral pathogens isolated in cases of respiratory diseases, bovine respiratory syncytial virus in six and seven cases, BHV-1 in

two and five cases and BVDV in two and four cases were detected in Northern Ireland and Ireland respectively during 2013. Parasitic pneumonia (hoose) caused by *Dictyocaulus viviparus* was detected in 14 and 31 cases in Northern Ireland and Ireland respectively. In Northern Ireland, all cases of hoose were diagnosed in weanlings between July and November with a peak in September. In Ireland there was one case diagnosed in April with cases every month from June to November, the greatest number of cases being in November.

Clostridial diseases were the second most important cause of death in weanlings in Northern Ireland (13 *per cent*) and the third in Ireland (6.9 *per cent*). Blackleg occurred most commonly in this age group and was diagnosed in 19 cases in Northern Ireland and in 20 cases in Ireland. In Northern Ireland there were also four cases of black disease and four cases of botulism, while in Ireland malignant oedema (three cases), black disease (two cases) and emphysematous abomasitis (two cases) were also diagnosed.

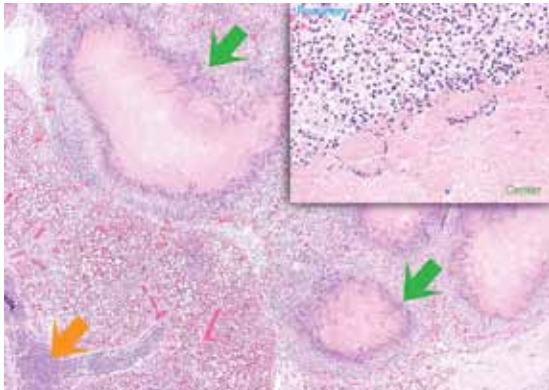


Figure 13: Photomicrograph of a lung section with well-demarcated foci of caseous necrosis (green arrows), with central accumulation of necrotic eosinophilic debris surrounded by leukocytes, and suppurative bronchitis (orange arrow) in a weanling calf diagnosed with *Mycoplasma bovis* pneumonia. Inset: caseous necrosis (centre) surrounded by a band of necrotic neutrophils, lymphocytes and fewer neutrophils (periphery). (Photo: Cosme Sánchez-Miguel)

Enteric infections were the second most common cause of mortality in weanlings in Ireland during 2013, and the third in Northern Ireland, maintaining the ranking of 2012. During 2013, parasitic gastroenteritis accounted for 21 and 43 *per cent* of enteric infections and coccidiosis accounted for 16 and 6.2 *per cent* of enteric infections in Northern Ireland and Ireland respectively.

Salmonella Dublin was diagnosed in four weanlings in Northern Ireland. In Ireland, salmonellosis was diagnosed in five weanlings. *Salmonella* Typhimurium was isolated in two cases, while *Salmonella* Dublin was isolated from the remaining three. Each of the five cases submitted was from a different herd.

Nutritional and metabolic conditions represented 5.0 and 3.6 *per cent* of cases in weanlings in Northern Ireland and Ireland respectively. In this category, ruminal acidosis was found in six and three animals in Northern Ireland and Ireland respectively and cachexia was the cause of death in 4 and 6 animals in Northern Ireland and Ireland respectively.

In Northern Ireland, BVDV/mucosal disease was diagnosed as the cause of death in 3 *per cent* of weanlings (eight cases) during 2013, similar to the ten cases diagnosed during 2012. In Ireland BVDV/mucosal disease was diagnosed in 4.1 *per cent* (16 cases) of the weanlings examined during 2013.

Adult cattle

The category “adult cattle” includes cattle older than 12 months of age.

As in previous years, respiratory infections were the most frequently diagnosed condition in this age category in Northern Ireland (13 *per cent* of total cases, Figure 15) and Ireland (13.6 *per cent* of total cases, Figure 14) during 2013. The most frequent pathogens found were bacteria, with *Mycoplasma bovis* most frequently detected (10 cases),

followed by *Mannheimia haemolytica* (nine cases), *Trueperella pyogenes* (nine cases), *Pasteurella multocida* (five cases) and *Histophilus somni* (three cases). In the viruses category, BVDV was detected in two cases of pneumonia and one case of BHV-1 infection was recorded. In Ireland, bacterial agents detected were *Mannheimia haemolytica*, *Pasteurella multocida*, *Trueperella pyogenes* and *Mycoplasma bovis* (six, five, four, and three cases respectively). Viral agents detected were BHV-1 (nine cases) and BRSV (four cases). BHV-1 was detected on five animals where the main pathological finding was pneumonia and on four occasions where the main pathological finding was tracheitis. Also within the respiratory conditions, 12 and 22 cases of hoose were recorded in adult cattle in Northern Ireland and Ireland respectively. Significantly fifteen of these cases throughout the island of Ireland were recorded in cattle more than two years old highlighting the increasing trend toward clinical outbreaks of hoose in older cattle.

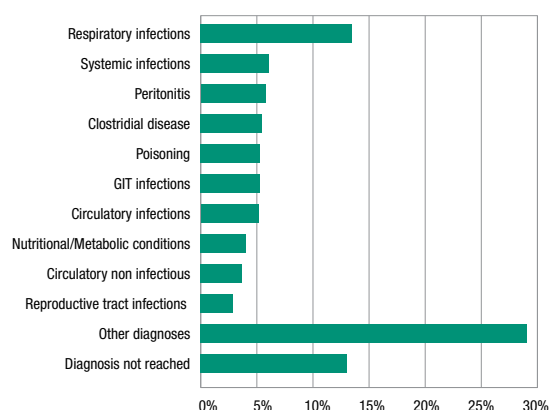


Figure 14: The conditions most frequently diagnosed on *post mortem* examination of adult cattle in Ireland during 2013 (n=618). GIT=Gastrointestinal tract.

Clostridial diseases were responsible for 12 *per cent* of deaths in adult cattle examined in Northern Ireland (Figure 15) (increasing from 8.9 *per cent* during 2012) and 5.5 *per cent* in Ireland (Figure 14). Black disease was the most commonly diagnosed clostridial disease in Northern Ireland with 28 cases, representing 33 *per cent* of the total clostridial diagnoses, followed by botulism with 26 cases,

a 30 *per cent* of the total clostridial diagnoses in adult cattle. Blackleg accounted for only two cases. In Ireland, there were 10 cases of botulism, nine of blackleg and eight of black disease.

Within the nutritional and metabolic conditions category, hypomagnesaemia was the most common cause of death in Northern Ireland during 2013 (13 cases representing 30 *per cent* of the diagnoses in this category), followed by cachexia (nine cases representing 20 *per cent* of the diagnoses in this category), ruminal acidosis (eight cases representing 18 *per cent* of the diagnoses in this category) and ketosis /fatty liver (six cases representing 14 *per cent* of diagnoses in this category). In Ireland hypomagnesaemia (eight cases) and ruminal acidosis (six cases) were the most frequently diagnosed conditions.

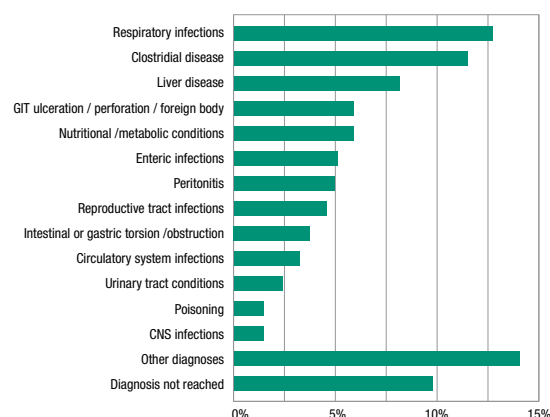


Figure 15: The conditions most frequently diagnosed on *post mortem* examination of adult cattle in Northern Ireland during 2013 (n=709). GIT=Gastrointestinal tract; CNS=Central nervous system.

Gastrointestinal disease due to ulceration, perforation or foreign bodies (Figure 16) was the fifth most commonly diagnosed category in Northern Ireland (Figure 15). Abomasal ulceration and/or perforation accounted for 22 cases (50 *per cent* of the diagnoses in this category) while reticulitis/foreign body reticulitis accounted for 13 cases (30 *per cent* of the diagnoses in this category).



Figure 16: Abscess in the mid-oesophagus of a 14 month-old bullock associated with the presence of a 5 cm long wire. (Photo: Alan Johnson)

Liver disease was the third most common cause of mortality in Northern Ireland in adult cattle during 2013 (Figure 15), accounting for nine *per cent* of adult cattle. In this category, liver fluke infestation was the most common diagnosis (19 cases) followed by liver abscessation (eight cases, Figure 17). In Ireland chronic fascioliasis remains at a low percentage (1.9 *per cent*, 12 cases in total) of the total number of deaths in adult cattle during 2013, similar to 2012 (1.4 *per cent*) and 2011 (2.0 *per cent*), and down significantly from 2009 (9.0 *per cent*) and 2010 (6.6 *per cent*).



Figure 17: Hepatic abscess discharging into posterior vena cava in an adult cow. (Photo: Seán Fee)

Other findings in adult cattle during 2013 in Ireland included eight cases of parasitic gastroenteritis, five diagnosed cases of Johnes disease, with *Mycobacterium paratuberculosis* subsp *avium* (MAP) isolated from four of them. Louping ill was diagnosed on one occasion, following histopathological examination of a four year-old cow which had shown clinical nervous signs, and malignant catarrhal fever was diagnosed on one occasion in a 2.5 year-old animal. *Salmonella* Dublin (13 cases) and *Salmonella* Typhimurium (four cases) were isolated in Ireland during 2013 following examination of carcasses of adult cattle with lesions suggestive of enteritis, septicaemia, metritis and pneumonia.

Clostridial disease in Cattle

Diseases caused by the various clostridial bacteria remained a significant cause of mortality in cattle in the island of Ireland during 2013. The clostridial bacteria associated with disease are widely distributed within the environment particularly in soil. Under favourable conditions, clostridial spores may germinate allowing rapid multiplication of the bacteria and toxin production, ultimately causing the disease. Husbandry factors, changes in management, trauma or parasite associated damage may all act as the catalyst for clinical disease. Clostridial disease is usually very acute such that affected animals are often found dead, with the exception of botulism and tetanus, which are more protracted and the animals may survive several days.

As in previous years blackleg, black disease and botulism were the most frequently recorded clostridial diseases detected during 2013 (Figure 18).

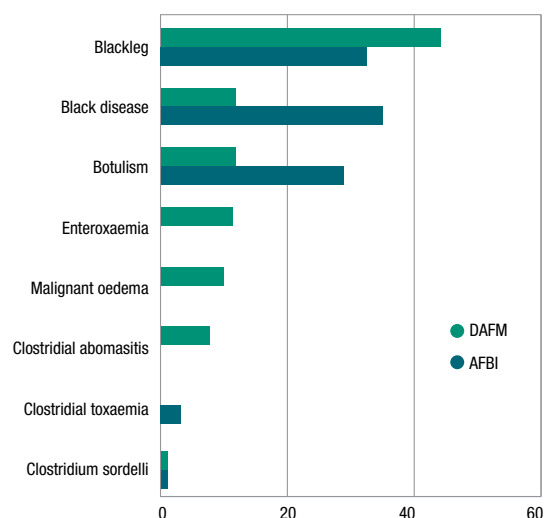


Figure 18: The number of clostridial diseases diagnosed by AFBI (n=98) and DAFM (n=94) laboratories during 2013.

BLACKLEG

Seventy-five cases of blackleg were diagnosed in 2013 on the island of Ireland. Most cases of blackleg were diagnosed in grazing animals in summer and autumn although cases were also observed in housed cattle during the winter months. While both adult cattle and younger stock were affected most cases in cattle were diagnosed in animals less than twelve months old. Blackleg is caused by *Clostridium chauvoei*. Infection is acquired by ingestion of *C. chauvoei* spores, leading to the presence of spores in muscle. Spores become activated in conditions of lowered oxygen tension as occurs during traumatic injury to muscle (Figure 19). After germination of the spores the bacteria multiply rapidly and produce toxin. The clinical course of blackleg is rapid due to toxæmia and bacteraemia and animals are often found dead.



Figure 19: Typical blackleg lesion in muscle of a six month-old calf. (Photo Seán Fee)

BLACK DISEASE

Forty five cases of black disease were recorded in the island of Ireland in cattle during 2013. Most cases were seen in cattle older than twelve months of age. As in previous years, the highest incidence was seen in the autumn and early winter with 75 *per cent* of cases (34 cases) diagnosed from August to December. Black disease is caused by *Clostridium novyi* bacteria, the spores of which are widely distributed in soil. After the spores are ingested by a grazing animal they become located

in the liver as latent infections. The spores can become activated by migrating immature liver fluke which produce favourable conditions in the liver for germination. Rapid multiplication of the *C. novyi* bacteria precedes the production of potent toxins, which in turn causes the disease (Figure 20).



Figure 20: Irregular pale area of acute necrosis with haemorrhagic margin in the right lobe of the liver of a 15 month-old bull, characteristic of black disease. (Photo: Seán Fee)

BOTULISM

Thirty-nine cases of botulism were diagnosed during 2013 in the island of Ireland, increasing from 26 cases in 2012 and 14 cases in both 2011 and 2010. Botulism in cattle is caused by the ingestion of preformed toxin which has been produced by the growth of *Clostridium botulinum* bacteria in decaying vegetation or in animal or bird carcasses. The botulinum toxin is a very potent neurotoxin which affects nerve cells by inhibiting the release of the neurotransmitter acetylcholine, blocking the transmission of nerve impulses to muscles. As a result the animal presents with flaccid paralysis. Cattle are extremely sensitive to the effects of botulinum toxin, and the ingestion of very small amounts of toxin can lead to clinical disease. Access to carrion and broiler litter at pasture are frequently associated risk factors for botulism in cattle. In some cases cattle have gained access to stored broiler litter containing broiler carcasses. In other cases the litter was spread on land on which

cattle were grazing or subsequently grazed. On occasions, cases were found in cattle grazing on fields near to the land on which broiler litter was spread. It should be noted that litter from laying hens has not been associated with botulism on the island of Ireland.

DAFM has agreed a code of practice with the farming organisations on the proper handling storage and use of chicken litter which virtually eliminates the risk of botulism in cattle. Containers used to store dead birds should be dedicated to that purpose. In particular, containers used to store dead birds should never be used to store animal feed or bedding. Dead birds may not be buried or burned on site but sent for disposal to approved plants. Poultry litter that does not contain dead birds may be used for land-spread on site, or it may be sent to another premises for use or disposal. In the event that poultry litter is being held for a short time prior to land-spreading, then it should be stacked on a concrete base away from rivers, streams and other water courses and any runoff should be collected. The stack should be put in a place where animals (including neighbours' animals) do not have access to it (Reference: Code of good practice for poultry farmers, <http://www.agriculture.gov.ie/animalhealthwelfare/diseasecontrol/botulism>).

Clinically, cattle with botulism present progressive flaccid paralysis leading over several days to recumbency and death. Recovery is unusual and euthanasia on welfare grounds is frequently advised. Sudden deaths may be seen. Diagnosis of botulism is primarily based on the clinical signs, exclusion of other causes of flaccid paralysis (for example hypocalcaemia) and history of potential exposure to carrion or broiler deep litter.

Laboratory confirmation of botulism can be extremely problematic since pathology is not specific and detection of toxin is often difficult. Toxin detection at AFBI was traditionally based on

the detection of botulinum toxin in gastrointestinal content samples by the mouse bioassay test. Nowadays toxin detection at AFBI is based on a culture-ELISA assay of gastrointestinal content. Initially the submitted samples are tested for the presence of botulinum toxin using an ELISA. Subsequent to this, the gastrointestinal samples are exposed to a heat shock procedure followed by anaerobic culture in an effort to promote elaboration of the botulinum toxin by *Clostridium botulinum* spores, the sample is again tested for the toxin using an ELISA. The use of the culture-ELISA technique has improved the confirmation rate in clinically suspect botulism cases from 16 *per cent* using the mouse bioassay to 36 *per cent*. Studies at AFBI have also found that the detection of botulinum toxin by the culture-ELISA technique is diagnostically significant in cattle.

Reference

Brooks C.E., Clarke H.J., Ardis T.C. and Ball H.J. (2011) Temperature dependency of *Clostridium botulinum* C and D toxin production from anaerobically enriched bovine gastrointestinal samples. *Letters in Applied Microbiology* 53, 174–77.

Bovine Neonatal Enteritis

Bovine neonatal enteritis (in calves under one month of age) continued to account for a large number of submissions to AFBI and DAFM veterinary laboratories during 2013. The largest percentage of submissions coincided with the peak calving times.



Figure 21: Calf with soiled perineal area from which *Cryptosporidium* spp. was isolated. *Escherichia coli* was isolated from a number of organs. ZST result was three, indicating a complete lack of colostral antibody transfer. (Photo: Dónal Toolan)

Prevention of Neonatal Enteritis

INCREASE THE RESISTANCE OF THE CALF TO INFECTION.

The main aim at calving time is to feed adequate good quality colostrum at the correct time. The recommendation is to feed three litres of first milking colostrum within two hours of birth to all calves. It is not practical to expect that the newborn calf will receive an adequate supply of colostrum solely by being left to suckle the dam.

Proper feeding of calves shortly after calving is essential to improve their resistance to infection, particularly in dairy calves. It is recommended to feed 13-15 *per cent* of the calf's birth weight a day of whole milk or good quality milk replacer. In addition, adequate roughage and clean fresh water should be available to calves.

Dystocia, including prolonged parturition, results in hypoxia and metabolic acidosis and increases the risk of opportunistic infections in calves. Also, problematic calvings can reduce teat-seeking activity and sucking drive. Consequently dystocical calves will have lower intakes of colostrum, lower body temperatures and decreased ability to withstand cold stress.

If the cause of the diarrhoea has been identified in previous years, then appropriate vaccination of the dam should be considered. The success of vaccination relies on correct nutrition of the transition cow and efficient transfer of colostral antibody.

REDUCE THE LEVEL OF INFECTION

- Ensure cows are not grossly contaminated with faecal material when calving.
- Ensure clean dry bedding is available throughout the rearing period.
- Clean out calf pens/hutches between batches of calves.
- Clean feeding equipment.
- Deal with youngest calves first to reduce the exposure of the youngest most susceptible animals to infection from older calves. Ensure proper operator hygiene e.g. wash hands and change/clean foot wear before entering calf shed.
- Pay particular attention to hygiene towards the end of the calving season when infection levels will be at their highest.
- Isolate sick calves to reduce the exposure to healthy calves.



Figure 22: Calf that died from neonatal enteritis showing sunken eye i.e. dehydration. (Photo: Dónal Toolan)

Causes of neonatal enteritis

As in previous years, rotavirus and *Cryptosporidium* spp. have been the most frequently isolated enteropathogenic agents in neonatal calves submitted for *post mortem* examination to DAFM and AFBI laboratories during 2013 (Figure 23).

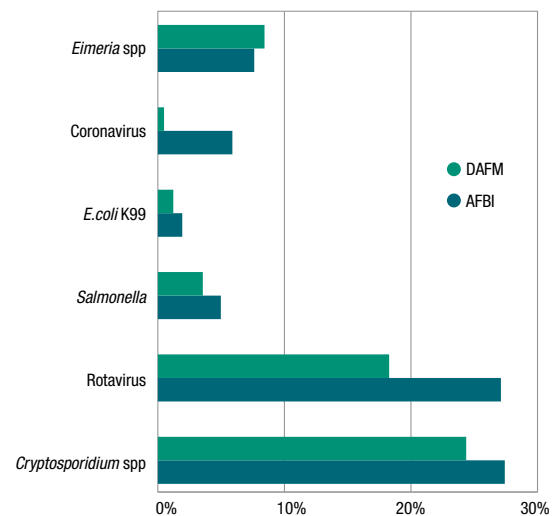


Figure 23: The relative frequency of enteropathogenic agents identified in post mortem submissions of calves less than one month of age during 2013.

Calves are most susceptible to rotavirus diarrhoea from one to three weeks of age. The severity of the symptoms depends on several factors, including the age of the animal, the immune status of the dam and absorption of colostral antibody. Depending on these factors, the clinical signs observed can range from little or no observed abnormality to severe diarrhoea and dehydration (Figure 22).

Cryptosporidium parvum is a small single cell organism which causes damage to the cells of the lower (distal) end of the small intestine (ileum), resulting in mild to severe diarrhoea. It is typically seen in seven to 13 day-old calves. It is highly infectious, via the faecal-oral route, through contact with infected animals, by ingesting oocysts present in dried faecal matter present in the floor of trailers, on walls and floors of pens and houses

and protective garments of handlers. Other sources include oocysts contaminating feeding utensils and anything else calves may find to lick and suckle.

C. parvum is difficult to eliminate from the hosts and to remove from the environment. Control of this disease relies on separation of affected from non-affected animals and proper cleaning and disinfection of calf houses, particularly at the end of the calving period. Ammonia-based disinfectants should be used after all faecal contamination has been removed. The critical control measure for *Cryptosporidium* is dessication. Calf houses must be left to dry out completely and left empty for 3-4 months.

In affected herds with a pure *C. parvum* infection morbidity is high but mortality is usually low. In situations where there is concurrent infection with another neonatal enteric pathogen, usually rotavirus, mortality increases.

Coronavirus is less frequently isolated than rotavirus, but it can cause severe diarrhoea in affected calves. Coronavirus causes villous atrophy by causing lysis and exfoliation of surface enterocytes. Typical clinical signs are similar to those seen with enteritis associated with rotavirus and *Cryptosporidium* i.e. depression, reluctance to suck and diarrhoea. Disease progression can be rapid leading to recumbency, severe dehydration and death. Disease is seen in calves up to 20 days of age.

E. coli K99 causes diarrhoea in calves up to one week of age. It is only routinely tested for in AFBI laboratories in this age of animal. It causes a secretory scour. *E. coli* K99 toxins cause hypersecretion of water and electrolytes from the intestinal mucosa causing rapid dehydration. Diagnosis in calves of this age is based on observation of severe diarrhoea with high mortality.

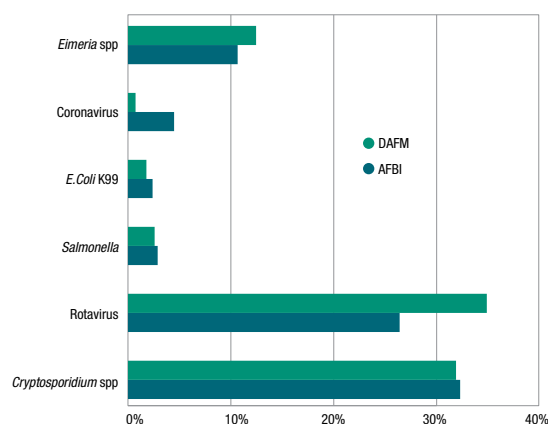


Figure 24: The relative frequency of enteropathogenic agents identified in faecal submissions of calves less than one month of age during 2013.

Infection with *Salmonella* spp. (most commonly *S. Dublin*) may mimic the neonatal diarrhoea caused by other agents or it may cause an acute fibrinous enterocolitis with septicaemia in a proportion of cases.

Coccidiosis is most commonly associated with diarrhoea in calves older than three weeks of age. Coccidiosis can cause a severe bloody diarrhoea with straining and occasionally rectal prolapse. The same principles of prevention and control apply to diarrhoea caused by coccidiosis and that caused by other agents. *Eimeria zuernii* and *Eimeria bovis* are the coccidia most frequently associated with disease of housed calves. Sub-clinical coccidiosis together with clinical cases have a serious economic impact through cost of treatment and poor performance of affected calves. A number of calves should be sampled for coccidial oocyst detection to allow for occurrence of disease in the pre-patent period, which is about three weeks. The detection of coccidial oocysts must be interpreted in association with farm history and clinical signs as the presence of non-pathogenic strains will also result in oocyst detection. Coccidiosis can also affect calves outdoors. This is particularly a risk on heavily contaminated pasture with a high stocking density. All calves in the affected group

should be treated and preventative treatment must be considered for other animals exposed to the same environment.

ZOONOTIC AGENTS

A large number of the agents involved in neonatal diarrhoea are zoonotic. Thus, measures must be employed to safeguard against infection when treating or handling any calves with neonatal diarrhoea. Hand washing, foot baths, changing clothes and ensuring immuno-compromised people are excluded from this area are some of the measures indicated. Prompt medical attention must be sought if humans are affected.

Zinc Sulphate Turbidity Test

BOVINE

The Zinc Sulphate Turbidity (ZST) test is an indirect measurement of the passive transfer of immunoglobulins via the colostrum from the dam to the neonate. This transfer provides protection to neonates from common infectious diseases that lead to conditions such as enteritis and septicemia. Due to the structure of the bovine placenta, immunoglobulins are prevented from passing from the dam to the foetus *in utero*. Consequently calves are born hypogammaglobulinaemic and the consumption of colostrum immunoglobulins is essential.

Failure of passive transfer is not a disease, but a condition that predisposes the neonate to development of disease. Ideally the first feed should be given to the calf within two hours of birth and certainly no later than twelve hours after birth. This is because the ability of the neonate to absorb immunoglobulins falls after 4 to 6 hours of life and ceases after 24 hours of life. Failure of passive transfer can also occur if an inadequate quantity of colostrum is given. A new born calf weighing between 35 kg and 45 kg needs approximately three litres of colostrum to meet its immunoglobulin requirement. Calves allowed to nurse to satiety may not obtain this volume of colostrum from the

dam without intervention. The quality of the dam's colostrum can be improved by milking the cow directly after calving and giving this to the calf and by having at least three weeks of a dry period.

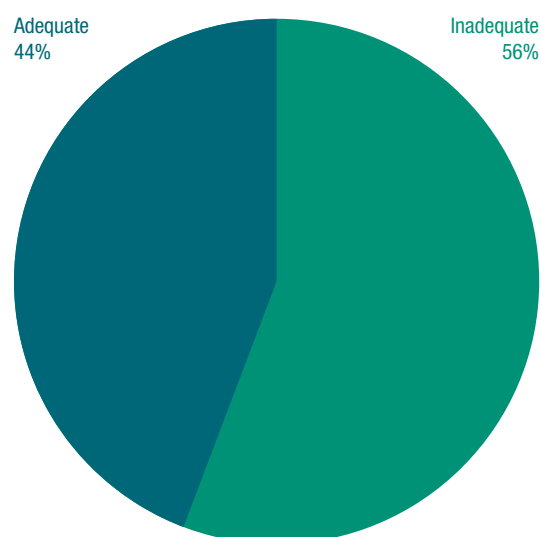


Figure 25: The results of zinc sulphate turbidity tests on bovine calf serum samples performed by AFBI and DAFM laboratories in 2013. Adequate colostrum immunity is defined as greater than or equal to 20 units and inadequate as less than 20 units (n=2186).

The ZST test is performed on calf serum to give an indirect measure of serum immunoglobulin concentrations. During 2013 a combined total of 2186 ZST tests were performed by AFBI and DAFM laboratories on samples submitted by private veterinary practitioners (1096 samples) and from carcasses examined *post mortem* (1090 samples). Of the 2186 samples that were tested, 1218 (56 per cent) had values of less than 20 units, indicating a failure of passive transfer (Figure 25).

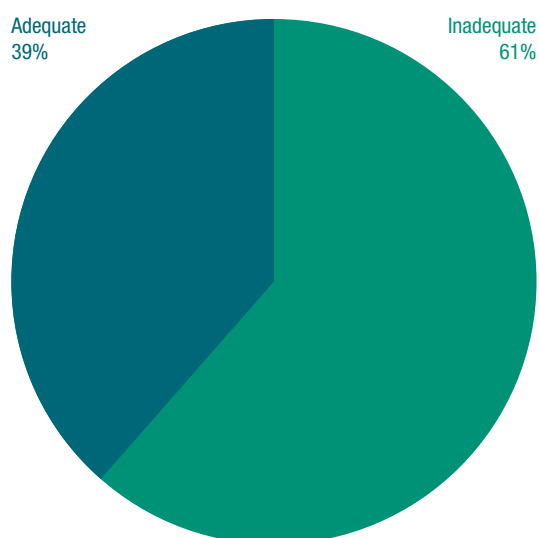


Figure 26: The results of zinc sulphate turbidity tests on bovine calf serum taken from calves submitted for *post mortem* examination to AFBI and DAFM laboratories in 2013. Adequate colostral immunity is defined as greater than or equal to 20 units and inadequate as less than 20 units (n=1090).

Of the 1090 samples tested from carcasses at *post mortem* examination 669 (61 *per cent*) had values of less than 20 units (Figure 26).

Although the results have remained relatively stable over the last few years, there was a reduction in the percentage of samples showing a failure of passive transfer during 2013 (56 *per cent*) compared to 2012 (63 *per cent*). Adequate passive transfer has been shown to reduce disease rates, reduce mortality and increase weight gain in calves. Adherence to good colostrum management would aid in a reduction of morbidity of the common infectious diseases and consequently bring down mortality rates due to these diseases.

OVINE

The Zinc Sulphate Turbidity test was performed on 229 serum samples from lambs aged less than two weeks in AFBI and DAFM laboratories during 2013. All of these samples came from carcasses submitted for *post mortem* examination. Fifty-three *per cent* of the samples had a ZST value of less

than 20 units (Figure 27), indicating a deficiency in the transfer of immunoglobulins via the colostrum from the ewe to the neonate.

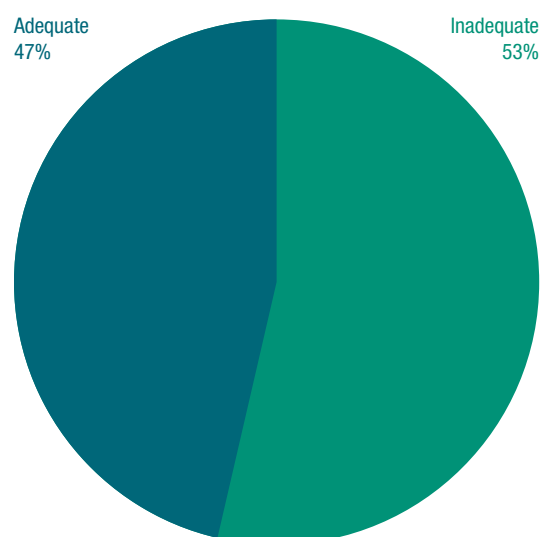


Figure 27: The results of zinc sulphate turbidity tests on serum taken from lambs submitted for *post mortem* examination to AFBI and DAFM laboratories in 2013. Adequate colostral immunity is defined as greater than or equal to 20 units and inadequate as less than 20 units (n=229).

Bovine abortion

Bovine abortions cause considerable losses to the cattle industry. However, the cause of the abortion is only found in a small percentage of the submitted foetuses. Most foetuses submitted for abortion diagnosis to the AFBI and DAFM laboratories are in the second or third trimester of gestation. Along with appropriate laboratory testing, the submission of a clinical and vaccination history, epidemiological information and proper sampling increase the chances of reaching an etiologic diagnosis. Most of the diagnosed abortions can be attributed to infections by a moderate number of bacterial, viral, fungal and protozoal agents. Foetal carcass, placenta and maternal serum constitute the standard minimum requirement for an abortion submission and subsequent diagnosis. Inclusion of the placenta is critical in the diagnosis of some mycotic and bacterial abortions where the

placenta is the primary tissue affected. On many occasions, submission from several abortions are needed to make a definitive diagnosis. As a result of the national brucellosis eradication program, *Brucella abortus* infection and abortion is no longer present in Ireland and similarly in Northern Ireland, where the last case was detected in February 2012. Notwithstanding, continuous surveillance is vital to preserve Ireland's *Brucella*-free status. Thus, it is a statutory requirement to submit a foetus/placenta or at a minimum a blood sample from the animal which has aborted for *Brucella* testing. Routine microbiological cultures of foetal samples examined in the laboratories always include *Brucella* culture as part of the protocol.

Salmonella as a cause of abortion is associated predominantly with *Salmonella* Dublin. In 2013, 5.8 *per cent* of bovine abortions were attributed to *S. Dublin* (Table 1). It usually occurs in the second half of the pregnancy. A bacteraemic episode normally originating in an intestinal tract infection leads to proliferation of the infection and localisation in the placentomes. *Salmonella* induced abortions present a seasonal peak in October and November (Figure 28). Stress factors such as drying off and housing may play an important role in the increase of abortions in *Salmonella* carrier animals.

Similar to *S. Dublin*, *Listeria* species are widespread in the environment and clinical disease is associated with ingestion of poorly fermented silage. Following ingestion, *Listeria monocytogenes* proliferates first in the placenta, followed by infection of the fetal liver, septicemia and death. The proportion of diagnosed abortions attributed to *L. monocytogenes* infection is normally low, amounting to 1.7 *per cent* of the total abortions during 2013 (Table 1). Most listerial abortions have a sporadic occurrence, and they are rarely associated with listerial encephalitis. A markedly autolysed foetus is usually aborted in the third trimester of gestation.

A diverse group of bacterial species are also associated with opportunistic infections of the

placenta and foetus and subsequent abortion. These bacteria are not normally contagious pathogens and they can be found in the environment or on mucosal surfaces. A maternal bacteraemia is the presumed way by which they reach the gravid uterus and subsequently infect the placenta. Among the bacteria in this group, *Trueperella pyogenes*, with 208 abortion cases in 2013, was as in previous years the most commonly identified species (Table 1). Other bacteria isolated include *Bacillus licheniformis* (165 cases, Table 1), *Streptococcus* spp. (68), *Staphylococcus* spp. (18), *Pasteurella* spp. (13), and *Pseudomonas* spp. (9) among others (Table 2). For those sporadic opportunistic bacteria to be considered significant as a cause of abortion, they must be isolated in pure growth from foetal tissues and, in addition, microscopic lesions consistent with bacterial infection have to be present in the foetal organs or placenta. Although usually sporadic, multiple abortions in a herd associated with normally sporadic pathogens could be related to maternal health issues that facilitate haematogenous bacterial infections.

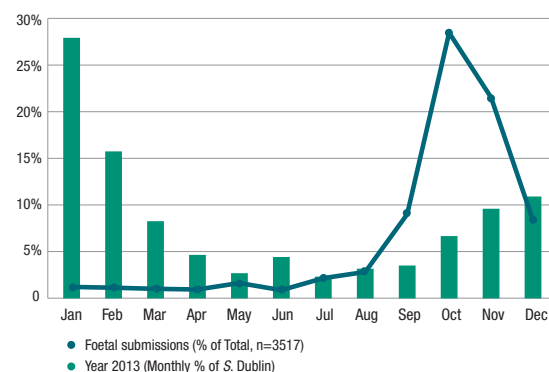


Figure 28: The monthly relative frequency of *Salmonella* Dublin isolates from foetal bacterial cultures in both AFBI and DAFM laboratories (line graph), compared to the monthly relative frequency of foetal submissions (bar graph) during 2013. *Salmonella* Dublin isolates peak in October-November, while the higher frequency of foetal submission occurs in January-February.

Abortifacients	Positive samples	Percentage of total samples	
Agent/Year	2013	2013	2012
<i>Trueperella pyogenes</i>	208	5.9%	6.8%
<i>Bacillus licheniformis</i>	205	5.8%	4.0%
<i>Salmonella</i> Dublin	165	4.7%	4.6%
<i>Listeria monocytogenes</i>	61	1.7%	2.1%
<i>Aspergillus</i> spp	28	0.8%	0.9%

Table 1: Combined frequency of detection of selected abortion agents by routine foetal culture in the AFBI and DAFM laboratories during 2013 (n=3517) compared to 2012 (n=3731).

Organism	Total
Coliforms	493
<i>Streptococcus</i> spp	68
<i>Bacillus</i> spp	35
<i>Aerococcus</i> spp	23
Fungal/Yeast	20
<i>Staphylococcus</i> spp	18
<i>Pasteurella</i> spp	13
<i>Pseudomonas</i> spp	9
<i>Listeria</i> spp (other than <i>L. monocytogenes</i>)	7
<i>Salmonella</i> spp (other than <i>S. Dublin</i>)	5
<i>Campylobacter</i> spp	3
<i>Corynebacterium</i> spp	2
<i>Corynebacterium bovis</i>	1
<i>Histophilus somnus</i>	1
<i>Mycoplasma</i> spp	1
<i>Yersinia pseudotuberculosis</i>	1

Table 2: Number of cases of abortion associated with other bacterial and fungal agents in AFBI and DAFM laboratories during 2013.

Other important abortifacient agents are *Leptospira* Hardjo and the protozoan parasite *Neospora caninum* (Table 3). *Leptospira* Hardjo is adapted to cattle which serve as a maintenance host. *Leptospira* are labile and difficult to culture, thus diagnosis normally relies on the detection of antibody in foetal fluid or obtaining positive results on the fluorescent antibody test (FAT) on foetal kidney, lung and adrenal gland smears using multivalent antisera. Therefore leptospirosis is likely to be an under-diagnosed cause of abortion in cattle. Abortion is frequently the only clinical sign observed in a herd, except in lactating cattle where signs of acute leptospirosis may include agalactia, mastitis, fever, hemolytic anemia, hemoglobinuria and icterus.

Cows chronically infected with *Neospora caninum* may transmit the protozoa transplacentally to the foetus. Some infected cows abort, but many foetal infections produce a congenitally infected calf which is able, in the case of female calves, to transmit the infection onto the next generation, and as a result maintain the infection in the herd. *N. caninum* infection can also be acquired by ingestion of oocysts shed in the faeces of dogs, the definitive host. Normally an infected herd experiences an endemic low rate of abortions, with some of the cows repeatedly aborting in subsequent years, but occasionally epidemic episodes of *Neospora* abortions also occur. Neosporosis is normally diagnosed by foetal serology. Histopathology may also be carried out, and typical findings include non-suppurative interstitial infiltrates in sections of the CNS (Figure 29) or myocardium. On some occasions, it is necessary to study dam serology on a herd basis to investigate the association between seropositivity and abortion.

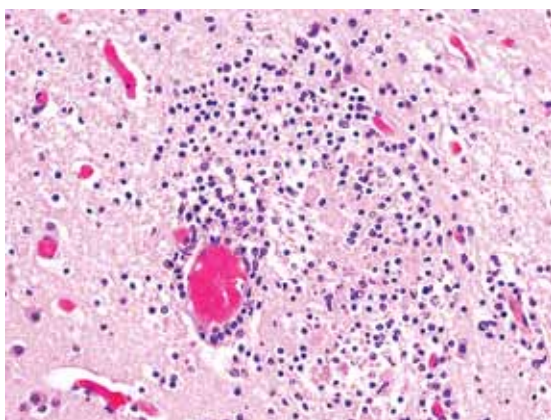


Figure 29: Photomicrograph of encephalitis in a bovine foetus, associated with *Neospora caninum* infection and characterized by necrosis, non-suppurative infiltration, perivascular infiltration of mononuclear cells, and congestion. (Photo: Cosme Sánchez-Miguel)

	DAFM	AFBI
<i>Neospora caninum</i>	82 (4.2%)	42 (8.0%)
<i>Leptospira Hardjo</i>	122 (7.4%)	28 (5.3%)

Table 3: Number of positive diagnoses expressed as a percentage of foetuses tested (in parentheses) for *Neospora caninum* and *Leptospira Hardjo*, in DAFM and AFBI laboratories during 2013.

Hereditary and developmental abnormalities

During *post mortem* examination of abortion/stillbirth submissions to DAFM in 2013, serious congenital defects were recorded in 171 cases of a total of 2991 foetuses submitted, equivalent to a prevalence rate of 5.7 *per cent*. This figure is well above the prevalence rate of congenital defects observed in a previous study by Crilly (www.teagasc.ie/research/reports/dairyproduction/4992/hyper24birthdefects.asp) in foetal and stillborn calves submitted to the Cork RVL from 1989 to 2003, in which an overall average prevalence rate of 2.6 *per cent* was found. The cause of this discrepancy remains to be elucidated, but one of

the factors could be the recent incursion of the Schmallenberg virus (SBV) in the south-eastern areas of the country (Figure 30).

The musculoskeletal system was found to be the system most frequently affected by congenital defects during 2013 in samples submitted to DAFM laboratories, accounting for 135 of 171 cases (79 *per cent*). Sixty-six cases (39 *per cent*) showed defects related to the central nervous system, and 52 of the 66 cases also showed musculoskeletal defects. There were a wide range of skeletal defects with different degrees of severity, particularly deformities of the limb, neck and head. Most of these defects were thought to be part of the arthrogryposis-hydranencephaly syndrome (AHS) resulting from intrauterine exposure to SBV (Figure 30). The infection was confirmed in 15 cases by detection of antigen (PCR assay) and another 13 cases by demonstrating the presence of antibodies to the virus. Congenital joint laxity and dwarfism (Figure 31) also represented a large proportion of the musculoskeletal defects observed during 2013, similar to numbers found in previous years (11 cases, compared to 10 cases during 2012). The most commonly diagnosed defect of the nervous system was hydrocephalus/hydrancephaly. The most frequently reported digestive system defects were intestinal atresia (13 cases) and hepatic lesions (2 cases). In the cardiovascular system (6 cases) findings included ectopia cordis, congestive heart failure and/or ascites/hydrothorax.



Figure 30: Arthrogryposis and torticollis in a stillborn calf resulting from intrauterine exposure to SBV. (Photo: Cosme Sánchez-Miguel)



Figure 31: Congenital joint laxity and dwarfism in a calf. (Photo: Cosme Sánchez-Miguel)

Bovine mastitis

Early diagnosis of the causative agent of clinical mastitis by bacterial culture can optimise treatment results, save costs and avoid the ineffective use of antibiotics. Mastitis leads to direct costs (veterinarian's time, herdsman's time, the cost of drugs, discarded milk, and reduced yield) and indirect costs (higher culling rate, risk of fatality, extra services and extended calving intervals), and has very important financial implications for the dairy industry.

The control of mastitis in cows is based on six fundamental principles:

1. Hygienic teat management (and housing management).
2. Prompt treatment of mastitis cases.
3. Appropriate dry cow therapy.
4. Culling of chronic cases.
5. Proper milking machine maintenance.
6. Proper record keeping.

	2010	2011	2012	2013
DAFM	5466	3528	2939	3422
AFBI	2787	4507	1911	2781

Table 4: Submission of milk samples to DAFM and AFBI veterinary laboratories from 2010 to 2013.

The submission of milk samples to the DAFM and AFBI veterinary laboratories rose from 2012 to 2013, following a sharp drop from 2011 to 2012 (Table 4). It is likely that the fodder crisis last spring and the subsequent poor grazing conditions on pasture in late spring will have had a significant detrimental effect on udder hygiene and increased the likelihood of infection.

Submissions to DAFM laboratories are clearly seasonal, rising during the spring when large numbers of cows are coming into milk and also rising in the autumn. Submissions to AFBI laboratories rose in the second quarter of the year reaching a peak in the third quarter. Autumn samples are often submitted to aid in choosing dry cow therapy.

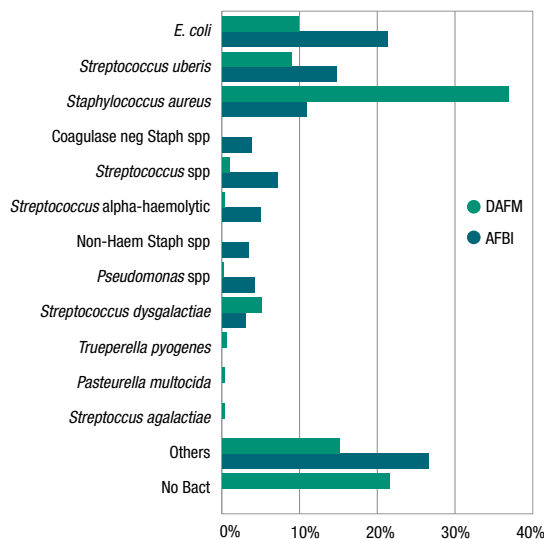


Figure 32: The relative frequency of detection of selected mastitis pathogens by AFBI (n=2781) and DAFM (n=3422) during 2013.

The relative frequency of detection of selected mastitis pathogens in milk samples submitted to AFBI and DAFM laboratories shows a similar pattern to previous years. *Staphylococcus aureus* isolation by DAFM laboratories accounts for over 36 *per cent* of culture results, although the real incidence is likely to be lower since the receipt of composite samples selected from cows with a high somatic cell count over a prolonged period, will introduce a submission bias towards detection of *S. aureus*. *Escherichia coli* and other coliforms were isolated in 10 and 21 *per cent* of DAFM and AFBI submissions respectively, making it the most commonly isolated mastitis pathogen in Northern Ireland, followed by *Streptococcus uberis* (15 *per cent*) (Figure 32).

Staphylococcus aureus is a contagious mastitis pathogen commonly associated with chronic mastitis and raised somatic cell counts. *S. aureus* infects cows particularly at milking time, due to both poor milking hygiene facilitating direct transfer, and faults in milking machine function, for example damaged teat liners and fluctuations in vacuum (Barrett *et al* 2005). Herds with mastitis caused by *S. aureus* infection should reassess their milking hygiene and segregate infected cows so

that they are milked last or in a separate unit if possible.

E. coli is both an opportunistic mastitis pathogen and a very common contaminant of milk samples. Coliform mastitis, sometimes termed acute mastitis or toxic mastitis, is a severe, acute mastitis with a well recognised clinical presentation, and release of endotoxin triggers severe clinical signs. Hygienic teat preparation prior to milking and improvement in environmental hygiene are the most important control measures, and teat injuries and the use of bedding contaminated with faecal material may be predisposing factors.

Contamination of the sample with dust or faecal material will usually result in the growth of coliform-type bacteria. It is imperative that samples for mastitis culture are collected aseptically.

Aseptic technique for milk sample collection

Materials for Sampling

- Disposable gloves (if available).
- Sterile screw-top plastic tubes (20ml capacity approximately).
- 70 *per cent* alcohol (or methylated spirits if this is unavailable).
- Cotton wool balls.
- Paper towels.

Sampling Technique

1. Take the samples before milking.
2. Soak a number of cotton wool balls in alcohol.
3. Label the tubes prior to sampling with the cow number, date and quarter if collecting a separate sample from an (or each) individual quarter.
4. Using a hand or paper towel, brush any loose dirt, straw or hair from the underside of the udder and teats.

5. Washing should be avoided if possible, but if teats are very dirty they should be washed and carefully dried with paper towels.
6. Dip all four teats with teat dip and leave for at least one minute.
7. Wear gloves if available. If not, then wash and dry the hands thoroughly and use some of the cotton wool balls to wipe them with alcohol.
8. Beginning with teats on the far side of the udder, scrub the ends thoroughly with the cotton wool and alcohol balls until the teats are very clean. Spend at least ten seconds on each teat. Do not use a cotton wool ball on more than one teat.
9. Begin sampling with the teats on the near side of the udder. Remove the cap of the sampling tube and keep the top face down in the palm. Hold the open tube (in the same hand as the top) at an angle of 45 degrees (holding it straight up will allow dust etc. to fall inside). Using the free hand, discard a few streams of milk on to the ground before collecting three or four streams in the tube. Do not allow the teat ends to make contact with the tube. Close the tube immediately after collection of each sample.
10. If it is felt that some contamination has occurred, discard the sample and use a new tube.
11. When all cows have been sampled, put the tubes in a fridge and cool to 4°C. This is very important.
12. Samples should be sent the laboratory as quickly as possible

Streptococcus uberis was isolated in a significant proportion of submissions to AFBI (15 *per cent*) and DAFM laboratories (9 *per cent*) (Figure 32). *S. uberis* is an environmental pathogen and causes opportunistic infections. The organism is found throughout the cow house environment and on the animal's body, hence isolation of *S. uberis* is significantly greater in herds with suboptimal housing (Barrett *et al* 2005). Some strains of *S. uberis* are capable of establishing chronic, recurrent mastitis which responds poorly to antibiotics. If the prevalence of chronic *S. uberis* infections are high within a herd this pathogen can spread as a contagious pathogen, being transmitted from cow to cow during the milking process.

Streptococcus dysgalactiae was identified in three and five *per cent* respectively of AFBI and DAFM milk samples cultured during 2013 (Figure 32). This pathogen resides mainly in the cow's udder and in teat wounds, but also elsewhere in the cow and its surroundings. Clinical signs may be more severe than infections caused by other streptococcal species, and the disease tends to be more acute in presentation. This bacterium is also isolated from summer (or dry cow) mastitis (Sandohlm *et al*, 1995).

Streptococcus agalactiae is an obligate pathogen of the cow's udder, and "blitz-therapy", or treatment of all diseased animals simultaneously is recommended (Sandohlm *et al*, 1995).

Trueperella pyogenes is the most commonly isolated pathogen from cases of summer mastitis, which is associated with severe clinical signs of mastitis in the udder, a suppurative and foul-smelling secretion, and permanent loss of the milk production from the affected quarter. Insect vectors are considered central to the disease as both vectors and as a cause of damage to the teat pore opening, which explains the higher prevalence of this disease during the summer months, when diptera flies are most active.

Pseudomonas spp. were isolated in four *per cent* of submissions to AFBI but only in 0.14 *per cent* of submissions to DAFM. *Pseudomonas aeruginosa* and other species are common in the environment of cattle, and infection can originate in contaminated water (Radostits *et al* 10th edition).

Mycoplasma bovis is a mastitis-causing pathogen which will not be detected by routine culture. If it is suspected, microaerophilic culture or polymerase chain reaction (PCR) tests may be used. During 2013, 232 milk samples were tested in DAFM laboratories using PCR for detection of *Mycoplasma bovis*, and eleven were positive. Mastitis caused by *Mycoplasma bovis* is a highly contagious disease causing outbreaks of clinical mastitis. Secretions from affected quarters may settle into a sediment and a thinner aqueous supernatant in some, but not all cases. Intramammary infection with *Mycoplasma bovis* is often not responsive to commonly used mastitis protocols, and it may be necessary to identify and segregate or cull affected cows (Radostits *et al* 10th edition).

Environmental mastitis pathogens found in bulk milk may be derived from non-specific contamination from cow skin, bedding, manure, or water. To achieve an accurate diagnosis, it is vital that samples are collected aseptically. Contagious pathogens generally do come from intramammary infection, but the sensitivity of a single bulk milk bacterial count is low. Most information is gathered if samples are collected and tested at the individual quarter level (Lam *et al* 2009).

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Bovine Respiratory Disease

Bovine respiratory disease results in significant morbidity and mortality on cattle farms. During 2013 it was diagnosed in a total of 981 bovine *post mortem* diagnoses in DAFM and AFBI laboratories across all age categories, representing a 16 *per cent* of all bovine carcasses examined during this period. Of the 981 respiratory disease diagnoses, 95 *per cent* were related to pneumonia with many cases involving several infectious organisms. The remaining diagnoses included tumours (Figure 33), oedema, haemorrhage, embolic disease, upper respiratory tract disease and several cases of respiratory tract obstruction related to recently administered mineral boluses.



Figure 33: Tumour nodules of lymphosarcoma in the mucosa of a cow's larynx. (Photo: AFBI – Omagh)

Sixty-three *per cent* of the respiratory disease diagnoses during 2013 on the island of Ireland were made in cattle under six months of age (Figure 34). Taking the total number of respiratory

disease cases across all ages, bacterial causes of pneumonia were the most frequently recorded diagnosis comprising nearly 44 *per cent* of diagnoses (Figure 35).

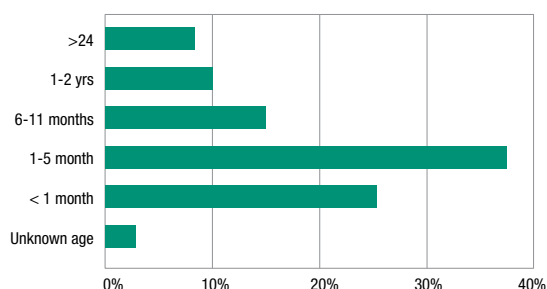


Figure 34: Age distribution of cattle submitted for *post mortem* examination at DAFM and AFBI laboratories and diagnosed with respiratory disease as a percentage of all respiratory disease cases during 2013.

The most frequently identified bovine respiratory pathogen during 2013 on the island of Ireland was *Pasteurella multocida*, accounting for almost 17 *per cent* of all pneumonia diagnoses, followed by *Mannheimia haemolytica* (16 *per cent*) (Figure 35). The relative frequency of *M. haemolytica* rose to 70 *per cent* in the group of calves under 6 months of age tested in AFBI laboratories.

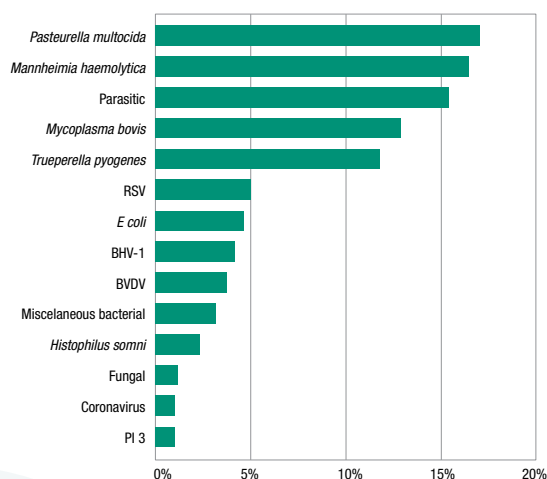


Figure 35: Relative frequency of diagnosed respiratory bovine pathogens as a percentage of the total pneumonia cases where a primary pathogen was identified in DAFM and AFBI veterinary laboratories during 2013.

P. multocida was the most commonly isolated pathogen in one to five month-old calves. It is carried in the nasopharynx of healthy calves and can become involved in pneumonia along with other infections or after the lung is damaged. The bacteria produce toxins which damage areas of lung tissue allowing the bacteria to grow in the necrotic material where the defences of the lung are sub-optimal and antibiotic penetration is also poor.

M. haemolytica can colonise the nasopharynx of healthy calves in low numbers, but multiplies rapidly if cattle are stressed, e.g. weaning, transport, procedures such as dehorning and castration or concurrent respiratory infections. In addition, bacteria in stressed animals may produce larger quantities of toxins, damaging tissue and combined with the animal's own immune response can lead to pneumonia.

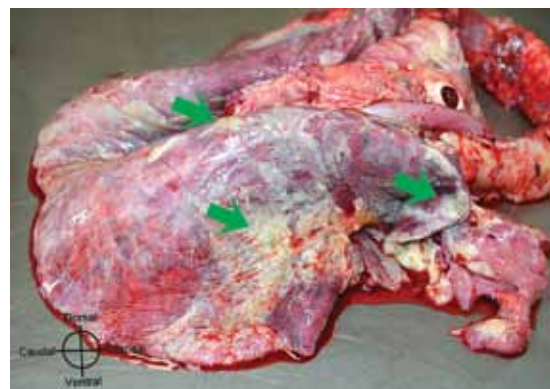


Figure 36: Pleuritis associated with *Mannheimia haemolytica* infection in a 6-week old heifer calf. (Photo: Pauline Baird)

The third most frequently diagnosed cause of pneumonia during 2013 was parasitic pneumonia (hoose) due to the lungworm *Dictyocaulus viviparus* (Figure 35). Cattle are infected by ingesting larvae either at pasture or in freshly cut grass. Larvae may overwinter on grass to re-emerge and infect animals the following year. Carrier cattle may also play a role. Infected cattle then pass larvae in their faeces to further contaminate pasture so burdens of larvae on pasture increase through the summer, with larvae on grass surviving longest in damp, cooler conditions.

Historically, disease caused by *Dictyocaulus viviparus* infection was associated with young animals in the late summer to autumn of their first season at grass. Disease in mature cattle has been associated with reinfection syndrome, where partially immune animals are re-infected and develop coughing, rapid breathing and potentially pneumonia. In reinfection syndrome, partial immunity prevents the lungworm larvae from maturing and reproducing so the cattle don't shed infectious larvae. However, for a number of years maturing infections have been recognised in older cattle and during 2013, 17 *per cent* of the diagnoses of lungworm in *post mortem* analyses in AFBI were in two to six year-old cattle. The development of hoose in older cattle is believed to be related to worming regimes which prevent cattle being exposed to the lungworm for long enough to develop immunity. Exposure to lungworm is needed each year to boost and maintain that immunity.

During 2013, nearly 80 *per cent* of the confirmed cattle lungworm cases were detected between September and November reflecting build-up of larvae on pasture over the grazing season. Lungworm infection was diagnosed in AFBI laboratories in a four month-old calf in January which is an unusual occurrence. Five calves of a group of 15 died in this outbreak.



Figure 37: Bovine trachea filled by a large number of adult lungworm (*Dictyocaulus viviparus*). Photo AFBI-Omagh

Mycoplasma bovis was detected in 13 *per cent* of all pneumonia diagnoses in the island of Ireland during 2013 (Figure 35). In AFBI laboratories the incidence increased to 70 cases in 2013 compared to an average of 46 cases per year over the four previous years. Seventy four *per cent* of the *M. bovis* cases diagnosed in calves under nine months of age, reaching a peak in November and December. *M. bovis* alone can cause clinical disease, not only of the respiratory tract but also involving middle ear infections (Figure 38), pneumonia and otitis often affecting younger age groups, and arthritis and mastitis affecting older stock. The middle ear infections can occur as single cases or as outbreaks and affected animals present with drooping ears, head carried at a tilted angle or balance problems; some calves have problems swallowing and others may develop meningitis.



Figure 38: *Mycoplasma bovis* associated otitis media in a 2-month old calf. The right middle ear is filled with pus and the nearby bone is eroded and infected, while the middle ear on the left is normal. (Photo: Pauline Baird)

M. bovis can also be isolated from clinically healthy animals which may shed it, sometimes for months and years. These otherwise healthy animals may be critical in spreading *M. bovis* to other cattle. In younger animals, infected milk and spread from the dam are important routes of infection. Calves suffering a *Mycoplasma bovis* infection shed large numbers of the organisms, and infected respiratory secretions are believed to play a role in infecting

other animals. No commercial vaccine for *M. bovis* is available, and control of the disease should include feeding pasteurised milk or milk replacer, avoiding the mixing of age groups and the isolation of sick calves.

Trueperella pyogenes was isolated in nearly 12 per cent of pneumonia diagnoses (Figure 35). *T. pyogenes* commonly colonises mucous membranes of cattle, especially the nasopharynx. It can also act as an opportunistic infectious agent as circumstances allow, for instance after a primary infection or trauma, and often with other bacteria as a mixed infection. *T. pyogenes* is typically associated with pus-producing lesions which become chronic, such as abscesses, and can affect many tissues including udder, liver and bone as well as lung.

Similar to the other bacterial causes of bovine pneumonia, *Histophilus somni* colonises the respiratory tract of healthy cattle, but some animals will develop disease after changes in management or other stressors. *H. somni* can cause disease on its own (as a primary pathogen), or in conjunction with other infections. The most common manifestation of the infection is bronchopneumonia, and it can also be involved in cases of laryngeal abscessation, encephalitis, pericarditis and myocarditis.

CLINICAL PATHOLOGY DATA

Bovine coronavirus was the most commonly isolated respiratory virus from live clinical cases of pneumonia in DAFM during 2013 (Figure 39). In the past, coronavirus was associated with calf diarrhoea and winter dysentery in housed adult cattle. In more recent times, the virus has come to be recognised as a major pathogen in the bovine respiratory disease complex without the involvement of other pathogens (Decaro *et al.* 2008)

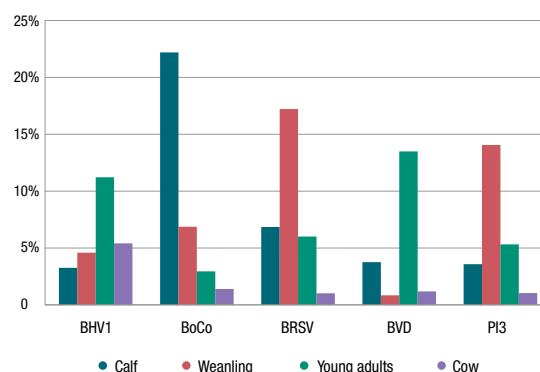


Figure 39: The detection rates of respiratory viruses on nasal swabs from clinical cases of bovine respiratory disease in DAFM laboratories during 2013, categorised by animal age. BHV1: Bovine herpesvirus 1, causal agent of IBR; BoCo: Bovine coronavirus; BRSV: Bovine respiratory syncytial virus; BVD: Bovine viral diarrhoea; PI3: Parainfluenza3 virus.

Parainfluenza3 virus on its own is rarely of clinical importance. However, this virus can act as a “gateway” by facilitating secondary bacterial infection in infected animals.

The significance of detection of BVD virus in cases of respiratory disease lies in the fact that BVD virus may predispose to bacterial pneumonia by causing an immunosuppressive state in the animal.

Figure 40 outlines the seasonal patterns observed in the detection of viral pathogens associated with respiratory disease. A trend is evident in the distribution of infection, with a peak in virus detection coinciding with housing, during the winter months. Continuing the pattern noted in previous years, there was a significant increase in coronavirus infections in March-April of 2013.

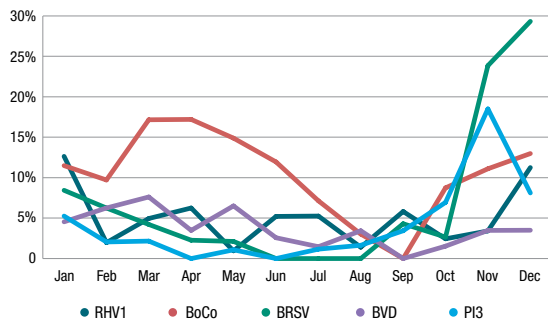


Figure 40: The monthly detection rates of respiratory viruses on nasal swabs from clinical cases of bovine respiratory disease in DAFM laboratories during 2013 as a percentage of samples examined (n=5237). BHV1: Bovine herpesvirus 1, causal agent of IBR; BoCo: Bovine coronavirus; BRSV: Bovine respiratory syncytial virus; BVD: Bovine viral diarrhoea; PI3: Parainfluenza3 virus.

Farm diagnostic investigations

CHRONIC RESPIRATORY DISEASE IN A DAIRY HERD

Sligo RVL conducted an investigation in a dairy herd with ongoing respiratory problems. The respiratory problems were recorded in calves up to three months of age, with some recovered animals subsequently relapsing as weanlings. Many of the affected animals showed mild stunting compared to their comrades. The problem had existed for over twenty years but there had been a number of losses in the previous twelve months.

The herd followed a closed-herd policy with only the stock bull coming from outside the herd. It was noted that calves of different ages used to be penned in the same airspace due to the use of a computerised feeder but this was no longer the case at the time of the investigation. Regular vaccination against salmonellosis was carried out.

It was noted during the farm visit that animals were in good condition albeit in some cases their coats appeared dry. A small number showed evidence of ringworm. There were no acutely ill animals

on the day of the visit but there was a noticeable difference in size between animals which had suffered the condition and those which had not.

Blood samples for serology testing and nasal swabs for PCR were taken from a selection of animals between four and eight months of age. Respiratory virus PCR identified BHV-1 (causal agent of IBR) and BVD virus. BHV-1 antibodies were present in six of the nine weanlings sampled. These results provide evidence of circulating BHV-1 and BVD on farm. The BHV-1 serology results which reflected the presence of naïve and seroconverted animals were suggestive of an active outbreak of IBR.

Based on the history alone it appears obvious that this was a case of acute respiratory disease becoming chronic and leading to stunting of animals on farm, aggravated by a failure to vaccinate appropriately. The presence of BVD is also significant in exaggerating the effect of IBR in this herd through its immune suppressing effect.



Figure 41: Severe fibrino-necrotic tracheitis in a feedlot weanling calf with infectious bovine rhinotracheitis (IBR). (Photo: Cosme Sánchez-Miguel)

An intra-nasal IBR vaccine was recommended to counteract the active spread of IBR through the herd.

AN INVESTIGATION INTO A HIGH BOVINE MORTALITY RATE ON A DAIRY FARM

Limerick RVL carried out a disease investigation on a Holstein-Friesian dairy enterprise. The farm of 400 acres was fragmented, with the farm buildings (residence, milking parlour, cubicle houses and calf housing) located on a 150-acre land parcel. It had 120 lactating dairy cows, 40 dry cows, 80 heifers, 60 bulls and heifers under a year of age and 20 calves. Animals were vaccinated against clostridial diseases only.

A mortality and development problem in weanlings had been ongoing for a few years. According to the owners, calves would routinely develop a cough and a snotty nose prior to or during weaning. Affected calves responded poorly to antibiotics and a significant number of them died. Delay in development of some of the heifers would lead to these heifers calving at around three years of age.

It was noted during the investigation that some weanlings showing symptoms of disease were thin, weak and stunted, presenting with some mild respiratory signs as well as other conditions such as ringworm and lameness. Some heifers were in poor body condition.

In the previous 11 months a high mortality (in excess of 20 *per cent*) had been recorded but unfortunately none of these had been submitted to the laboratory for *post mortem* examination.

Blood and faecal samples were taken from some weanlings and cows. A bulk tank milk sample was also taken for testing. Haematology revealed a raised white blood cell (leukocytosis) count in many of the weanlings which was indicative of an inflammatory response. Copper and magnesium were found to be deficient in some animals at different ages, and some animals had antibodies for *L. Hardjo*, *N. caninum* and *S. Dublin*. Evidence pointed to RSV, PI3 and *Pasteurella* spp involvement, while no evidence of BHV-1 presence was found. Veterinary involvement with sick animals appeared to have been minimal.

Recommendations suggested on foot of the visit included:

- Calving pens, calf pens and feeders were to be kept clean and disinfected. An 'all in-all out' system was to be employed. Sick calves were to be managed and treated promptly.
- Calves should receive adequate nutrition and stress should be minimised at weaning.
- Vaccination of calves against RSV, PI3 and possibly *Pasteurella* spp. to reduce the risk of a respiratory disease outbreak.
- Vaccination of cows against *E. coli* K99, rotavirus and coronavirus in the appropriate window before calving to ensure that the calves get the best possible protection from neonatal diarrhoea in the first few weeks of life.
- Ensure calves get an adequate feed of colostrum within the first three hours of life.

National bovine viral diarrhoea (BVD) eradication programmes

ECONOMICS OF DISEASE

Bovine viral diarrhoea is a disease of great economic importance around the world, particularly where cattle industries account for a sizable proportion of the agricultural output. On an individual herd level, it is also a cause of serious concern as it can precipitate hidden losses within the herd where lower growth rates and reduced fertility are achieved, providing a poorer return on the farmer's investment (Houe, 2003). A study in Ireland quantified annual losses due to BVD in the Irish cattle industry to be around 102 million euro (Stott *et al*, 2012).

Due to its economic impact, a number of countries have embarked on regional or national BVD control programmes around the world. These include Germany, Switzerland and Austria. A number of other countries have already eradicated this disease

including Norway, Sweden and Denmark. From a national industry standpoint, it is of considerable advantage to those countries in relation to trade of their produce and the prices they can attract for their produce, by having this BVD-free status.

AETIOLOGY

Bovine viral diarrhoea virus is a pestivirus, which causes a number of distinct disease manifestations. It can lead to immunosuppression of animals within the herd leaving them more vulnerable to the effects of other diseases such as pneumonia, mastitis or diarrhoea. It may also cause early embryonic death, abortions, foetal malformations and the birth of calves that are persistently infected (PI) with the virus and can shed large quantities of the virus throughout their lives. The most emphatic manifestation of the disease is mucosal disease, an intractable diarrhoea, which inevitably leads to the death of that animal and occurs only in PI animals. PI animals are constantly shedding large quantities of virus into the surrounding herd. The PI animal is infected *in utero* prior to the development of its own immune system, and thus typically it will not produce antibodies against the BVD strain virus infecting them.

From a control point of view, it makes most sense to identify and eradicate these PIs, as they represent the greatest source of virus within an infected herd.

PREVALENCE OF BVD IN IRELAND

The prevalence of the disease in Ireland is not exactly known but based on data from both published and unpublished sources, an accurate estimate can be made. On an individual level, the seroprevalence lies between 60-80 *per cent*, whereas on a herd level, 98.8 *per cent* of suckler herds and 98.5 *per cent* of dairy herds have seropositive animals which would indicate present or past exposure to virus. These levels are similar to the prevalence of infection in England and Wales. The prevalence of PI animals during 2013 based on antigen detection rather than seroprevalence was 0.77 *per cent*.

Results in 2013

2013 was the first year of the compulsory phase of the eradication programme in Ireland. Results were recorded on the national database for 99.5 *per cent* of the 2,096,584 calves registered during 2013, with the majority of untested calves having died before they were tested. Of the samples submitted, 0.77 *per cent* were deemed positive, 0.03 *per cent* were deemed inconclusive and 1.16 *per cent* of samples were classified as “empty” based on the initial tissue sample submitted. Farmers have the option of retesting animals with initial positive and inconclusive results, and when these results are taken into account, the prevalence of PI calves during 2013 was 0.67 *per cent*. Although initial estimates suggest that the frequency of empty containers is decreasing during 2014, the continued presence of empty containers during 2013 serves as a reminder that farmers need to be sure that they are getting material in the punch. Having calves as securely restrained as possible whilst tagging will help avoid this outcome.

Confirmatory testing of animals of inconclusive or unknown status

During 2013, as part of Animal Health Ireland confirmatory testing and in conjunction with Sligo RVL, there were 7,234 submissions for confirmatory testing, with a mean of 2.4 animals (samples) per submission.

As part of the confirmatory testing, 11,347 calves were tested using a BVD antigen-based ELISA. Two thousand three hundred and sixty of these samples came from calves whose initial samples were described as “Empty” when received by commercial laboratories for screening, and upon re-test 78 (0.3 *per cent*) of these samples were found to be BVD virus positive.

Of those samples from calves submitted to Sligo RVL for retesting, and excluding samples initially classified as empty, 5,774 of a total of 8,987 calves tested (64 *per cent*) were BVD virus positive

to the BVD antigen based ELISA. Some of the confirmatory samples, an additional three *per cent* (317 samples), which were found to be negative on the confirmatory samples, ELISA test proved to be BVD virus positive when subsequently tested by the BVD PCR which is routinely applied to all ELISA negative confirmatory samples.

During 2013, as part of confirmatory testing, samples from 8,126 dams of identified PI calves were tested using a BVD antigen-based ELISA. Of the total number of dams tested, 487 (6 *per cent*) were found to be BVD virus positive.

Retention of Persistently Infected animals

The prompt removal of PI cattle by culling of calves or slaughter of older animals is vital to the success of the national BVD eradication programme, and selling of animals with a non-negative result is banned by legislation in Ireland.

During 2013 some herd owners retained PI calves in an attempt to rear them to slaughter weight. While this practice is understandable, it will in the majority of cases, have been in vain, as the odds of PI animals surviving to slaughter weight are slim. By retaining PIs on farm, herd owners are retaining a source of infection that may well create a further crop of PI calves the following year, due to contact between these animals and breeding animals in the critical stage (30-120 days) of pregnancy. To maintain the progress made so far, it is strongly recommended to remove all PI animals as soon as possible.

Path to Success

There are three major components to eradication of the disease.

1. Virus detection – Early virus detection by ensuring that calves are tagged and tested immediately after birth is essential. The longer the status of any calf within the herd remains unknown, the greater the risk of infection establishing itself within the herd.
2. Virus elimination – Once identified, the PI animals on the farm must be removed. The longer they remain on the premises, the greater the risk of spreading the disease within the herd.
3. Biosecurity – The greatest threat in relation to infection is the buying in of transiently infected or PI stock. The optimal way to ensure that the disease is kept out is by maintaining a closed herd, or failing that, to rigorously screen and isolate for 28 days any 'bought-in' stock. This will greatly reduce the risk of introduction of the disease. In practice, pre-purchase testing of stock of unknown status is recommended. As the national programme develops, the numbers of known negative animals being traded will increase. The buying-in of pregnant animals is a particular risk, as non-PI dams may subsequently deliver a PI calf (Trojan dams). Insofar as possible, pregnant stock should be grazed away from boundaries to minimize contact with cattle from other herds, this practice should be adhered to both on the home farm and on out-farms.
4. Monitoring to detect re-infection – this is closely linked with biosecurity. Once the herd is negative, it is imperative to keep it that way. This can be achieved by active surveillance for the disease amongst newly introduced stock and each crop of calves.

BVD CONTROL IN NORTHERN IRELAND

Animal Health and Welfare Northern Ireland (AHWNI) was formally launched in 2012. It is an industry-led, not for profit partnership supported by the government and overseen by a board of directors (www.animalhealthni.com). It operates in a manner similar to, and in close cooperation with, Animal Health Ireland (AHI). The BVD implementation group (BVDIG) in Northern Ireland have implemented a programme with a first voluntary period during 2013 and with the main

screening again being done on tissue sample tags collected during routine tagging of calves.

This programme has now been running since 1st January 2013 and continues to make good progress. Up to April 1st 2014, approximately 190,000 tissue sample tags had been ordered for use in 3,000 herds. In 2013 over 62,000 samples were tested, and of this, 0.62 *per cent* of tissue samples from calves have tested positive, 0.01 *per cent* were inconclusive and 2.46 *per cent* have returned 'unknown' results or empty containers. In most cases, only one PI was found in positive herds during 2013, with 95 *per cent* of herds having four or less PIs identified. In many cases, blood samples from dams of positive calves were collected and tested for BVD antigen detection, reaching a 5.9 *per cent* of positive results, consistent with their calves also being PI. Following a public consultation in 2013, the Department of Agriculture and Rural Development (DARD) have taken the decision to make the programme compulsory, and planning is now underway to deliver this. Although a specific start date for this next phase is not yet available, it is hoped that it will be in place by the end of 2014.

Fatal poisonings

Cattle

Poisoning in cattle has increased over the last three years and mortality in cattle due to poisoning during 2013 was the highest since 2010, the first year in which the All-Island Animal Disease Surveillance report was published (Table 5).

Year	Number of cases
2010	65
2011	47
2012	61
2013	75

Table 5: The total number of cases of bovine deaths due to poisoning recorded on the island of Ireland in AFBI and DAFM laboratories in the period 2010-2013.

Seventy-five cases of death in cattle due to poisoning were diagnosed on the island of Ireland during 2013 (Table 6).

Poisonous agent	AFBI	DAFM
Lead	1	34
Ragwort	1	18
Yew	2	2
Copper	1	2
Cobalt	0	3
Halogenated salicylanilides	2	0
Oak / acorn	0	2
Rape	0	2
Rhododendron	1	0
Ivy	1	0
Cherry laurel	1	0
Selenium	0	1
Formaldehyde	1	0
Total	11	64

Table 6: The poisonous agents responsible for fatalities in cattle during 2013 in Northern Ireland (AFBI) and Ireland (DAFM).

LEAD POISONING

Lead continues to be the most common cause of fatal poisoning of cattle on the island of Ireland with 35 cases diagnosed during 2013. As in previous years most cases were seen in spring and early summer following the turnout of cattle to pasture. Lead poisoning in cattle is usually associated with the accidental ingestion of sources of lead, mainly discarded lead batteries (Figure 42), lead-based paints, crankcase oil and bonfire ash after lead-containing products have been incinerated.

The quantity and the molecular form of the lead ingested will determine whether the effects are acute, subacute or chronic and in many cases the animals are found dead. Where clinical signs are observed, nervous signs are frequently present (convulsions, blindness, tremors and head-pressing). Livestock farmers are advised to check their pastures for potential sources of lead which may have been discarded over the winter, before the spring turn out of cattle.



Figure 42: Photograph of unearthed fragments of a lead battery which was associated with the deaths of two weanlings. (Photo Alan Johnson)

RAGWORT

Ragwort (*Senecio* spp.) was the second most frequently recorded fatal toxicosis of cattle on the island of Ireland in 2013 with 19 cases diagnosed. This represents a dramatic increase in the number of cases of ragwort toxicity in recent years, since four cases of ragwort toxicity were diagnosed during 2012, one during 2011 and there were nine cases during 2010. In Ireland, ragwort is also commonly known as “ragweed”, “benweed” or *buachalán buí*. Ragwort is a biennial plant with the familiar golden yellow flower appearing in the second year of the plants life. All stages of the plant are toxic, with the yellow flowers being more toxic than green parts of the plant. Ragwort is unpalatable to cattle and is only eaten at pasture when grass is very scarce, or during the weeks after mowing or spraying when it seems to be more palatable. The plant remains toxic after drying or ensiling, meaning that hay and silage containing ragwort are particularly dangerous. In one outbreak of ragwort toxicosis during 2013 multiple deaths occurred as the farmer mistakenly calculated that the toxic effect of a five-acre field of herbage heavily contaminated with ragwort would be sufficiently diluted by the remaining 55 acres of ragwort free herbage to be ensiled.

YEW

Four cases of yew (*Taxus* spp.) toxicity were diagnosed during 2013. Yew is an evergreen tree common in graveyards, ornamental gardens and parks throughout Ireland. All parts of the plant except the fleshy red part of the fruit contain toxic alkaloids. Fallen branches and hedge trimmings remain poisonous and are a common source of toxicity when they fall into fields or are tossed over fences. The alkaloids present in yew depress electrical conduction within the heart and lead to arrhythmias and rapid death (Figure 43).



Figure 43: Yew leaves within the rumen contents of a poisoned five month-old calf that died suddenly. (Photo: Seán Fee)

COPPER

Three cases of fatal copper toxicity were observed during 2013. Cases of copper toxicity in cattle are usually associated with accidental over-supplementation with copper. Copper is an essential element for growth and production in cattle, but as excess copper can be hazardous, supplementation with copper should only be done in cases where copper deficiency has been diagnosed.

COBALT

Three cases of cobalt toxicity were diagnosed in Ireland in seven to eight week-old calves. These were considered to be cases of over-supplementation of cobalt. The calves presented with haemorrhagic gastroenteritis.

HALOGENATED SALICYLANILIDES

Halogenated salicylanilides are anthelmintics used in the treatment of liver fluke infestations and include closantel and rafoxanide. Two cases of suspected toxicity with halogenated salicylanilides were recorded during 2013 in Northern Ireland. In both cases the animals presented with nervous signs, inco-ordination, blindness and recumbency. Diagnosis was based on the presence of typical histological lesions within the white matter of the brain (Figure 44).

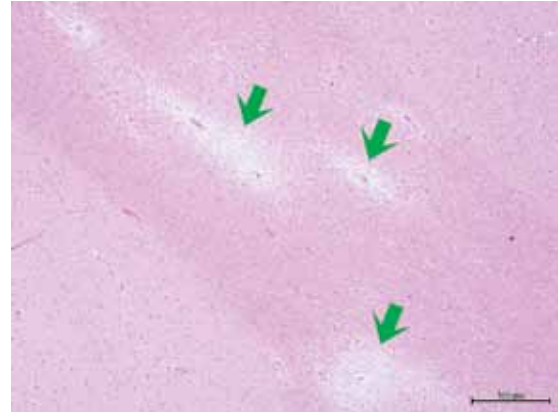


Figure 44: Perivascular leucomalacia (arrows) in the white matter of a 17 month-old steer with suspected halogenated salicylanilide toxicity. (Photo: Seán Fee)

OAK /ACORN

Two cases of poisoning due to ingestion of oak (*Quercus* spp) or acorns were recorded during 2013 in Ireland. Oak contains toxic tannins which can be poisonous if large numbers of acorns, oak leaves or oak buds are eaten.

RAPE

Two cases of rape (*Brassica nassus*) toxicity in heifers were diagnosed in Ireland during 2013. Both heifers were grazing on grass undersown with rape. Rape is a member of the brassica family which also includes cabbage and kale. The brassicaceae are nitrate accumulators and also contain toxic glucosinolates. When immature plants are stressed by drought or frost, increased levels of nitrate can build up in the stems and leaves which may lead to nitrate/nitrite toxicity if large amounts of the leaves and stems are eaten by cattle. Cattle with nitrate/nitrite toxicity can die very quickly.

Sheep

Thirty one cases of fatal toxicoses were recorded in sheep during 2013 on the island of Ireland, which was considerably less than the 75 cases diagnosed in 2012 (Table 7).

Similar to 2012, copper was the most frequently recorded cause of fatal poisoning in sheep with ten cases recorded during 2013 (Figure 45). Copper is an essential part of enzymes governing many biological functions but sheep are particularly susceptible to the toxic effects of copper with copper toxicity most frequently observed in the Charolais, Texel and Suffolk breeds, and less frequently observed in the mountain breeds. Sheep breeds that are less susceptible to copper toxicity tend to be more susceptible to copper deficiency (e.g. 'swayback') and vice versa. However all breeds of sheep are highly susceptible to copper toxicity. Feeding concentrate feeds containing high levels of copper, excessive administration of copper-containing mineral supplements, and grazing pastures which have been dressed in pig slurry are typical scenarios in which cases of ovine copper toxicity may present.

Poisonous Agent	AFBI	DAFM
Copper	4	6
<i>Pieris</i>	8	1
<i>Rhododendron</i>	5	0
Ivy	2	0
Rhubarb/Sorrel/Dock	0	2
Box (<i>Buxus sempervirens</i>)	1	0
Cobalt	0	1
Nitroxylin	0	1
Total	20	11

Table 7: Causes of death due to poisoning recorded in sheep during 2013 in Ireland (DAFM) and Northern Ireland (AFBI).

Ingestion of noxious plants remained, as in other years, an important cause of mortality in sheep. *Pieris* (forest flame) was the most frequently detected plant poison in 2013 (nine cases) followed by *Rhododendron* (5 cases). *Pieris* and *Rhododendron* contain the poisonous substance andromedotoxin. Cases of plant poisoning in sheep are most frequently seen when sheep break out and gain access to plants, particularly when weather is inclement or when food sources are scarce.



Figure 45: Yellow pigmented sclera in a sheep with copper toxicity. (Photo: Seán Fee)

Horses

One case of fatal toxicosis in an equine was recorded. Coumarin toxicity due to ingestion of anti-coagulant rodenticide was diagnosed by AFBI in a thirty-year-old horse. At *post mortem* examination a large quantity of blue green substance was present in the stomach and the large intestine was filled with a large blood clot. Toxic levels of bromadiolone (a coumarin derivative pesticide) were detected within the liver.

Dogs

Three cases of fatal poisoning were detected in dogs during 2013. Ethylene glycol toxicity was diagnosed by DAFM in one dog. Ethylene glycol is a major constituent of radiator antifreeze in cars and because of its sweet taste it is highly palatable

to dogs. Carbofuran toxicity was diagnosed in one dog. Carbofuran is an insecticide and nematocide and its use has been banned in the EU. Finally, flocoumafen, a second generation anticoagulant rodenticide was detected in the carcase of a dog.

Wild birds

Three cases of fatal toxicoses were diagnosed by DAFM in wild birds during 2013. Toxic levels of carbofuran (an insecticide) and alphachloralose (a rodenticide) were detected in a red kite. Nitroxylnil was detected in the carcase of a white-tailed eagle. Nitroxylnil is a product licenced to treat liver fluke infections in cattle and sheep. Bromadiolone was detected in a Peregrine Falcon.

Schmallenberg virus

During 2013, a serological survey on Schmallenberg prevalence in Ireland was carried out by DAFM laboratories in collaboration with Sheep Ireland, regional veterinary offices and a number of private veterinary practitioners. In order to estimate the level of exposure to Schmallenberg virus (SBV) among Irish sheep flocks, blood samples from a series of flocks in Ireland were tested for the presence of antibodies to SBV at six-week intervals over the course of summer 2013. The geographical distribution of flocks with positive samples was similar to that of confirmed clinical cases in cattle and sheep and concurrent with cattle herds where there was evidence of exposure (Table 8). Contrary to the expectation that SBV would spread northwards over the course of the summer, this survey and other serological studies in cattle indicated that there was no increase in the levels of exposure over the summer months, indicating SBV was not spreading as had been anticipated.

Counties with evidence of exposure in sheep	Counties with no evidence of exposure in sheep	Inconclusive
Carlow	Donegal	Laois
Kilkenny	Galway	
Waterford	Kildare	
Wexford	Longford	
Wicklow	Mayo	
	Offaly	
	Roscommon	
	Sligo	
	Westmeath	

Table 8: Summary of counties in Ireland with serological evidence of exposure to SBV infection in sheep in 2013 survey.

The results of this study questioned the levels of SBV activity in flocks which had already experienced cases of SBV in 2012. Therefore, in November 2013 a serological survey of 2013-born lambs

was carried out. Positive animals in this SBV-naïve group, would indicate that they were exposed to the virus during 2013. The results of this study clearly shows that exposure to SBV during 2013 in lambs born in the same year was only found in some flocks in Wexford (Table 9). Unexpectedly, these two surveys show low levels of SBV activity during 2013. While this was an unforeseen finding, it is not unprecedented, as Akabane virus, which is related to SBV, shows similar variation in year-to-year activity.

County	No of flocks tested	No of flocks with evidence of exposure to SBV in 2013 lambs
Carlow	1	0
Cork	2	0
Kilkenny	6	0
Wexford	5	3

Table 9: Flock level results of a 2013 lamb survey in a sample of flocks with confirmed cases of SBV in Ireland.

During 2013, DAFM veterinary laboratories tested 624 bovine, 162 ovine and 2 caprine samples from suspected SBV cases by PCR for SBV virus detection. The test showed the presence of virus in 28 bovine and 48 ovine samples, with no positives detected in the caprine samples. In addition, 5,778 bovine, 987 ovine, 2 caprine and 30 cervine serum samples were tested by ELISA for the presence of antibodies against SBV virus. Of the serum samples, 2,052 bovine, 106 ovine and 1 caprine were positive for the presence of antibodies, with no evidence of antibodies found in the cervine samples.

In Northern Ireland, AFBI laboratories tested 43 bovine and 28 ovine clinical samples from 71 suspected cases by PCR for Schmallenberg virus. Positive results were found in two bovine samples and one ovine sample. In total 205 serum samples

were tested for the detection of antibodies against SBV and 29 of them were positive samples. All positive *post mortem* cases studied in Northern Ireland originated in Co. Down. Five calves showed positive titres to antibodies against SBV, and two of these animals had virus detected by PCR.

Diseases of sheep

The most frequently diagnosed causes of sheep mortality in Northern Ireland and Ireland during 2013 are shown in Figure 46. The data is presented on a disease category basis and as a percentage of the total submissions, excluding abortions.

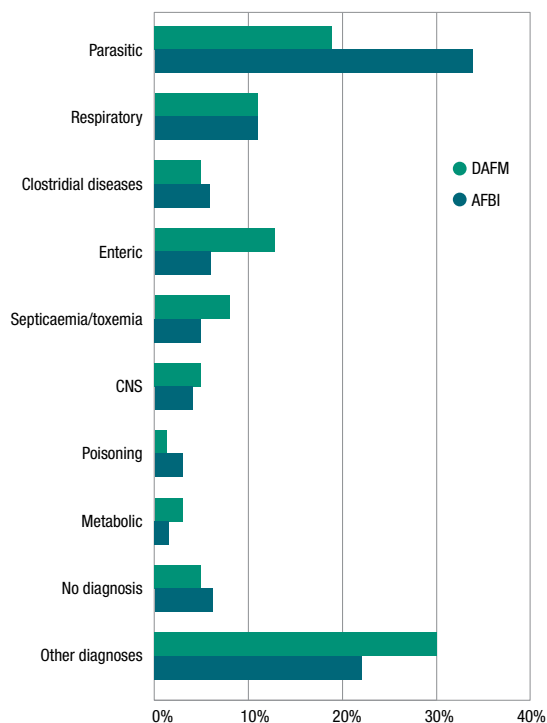


Figure 46: The relative frequency of causes of mortality in sheep of all ages submitted for *post mortem* examination in Northern Ireland (AFBI, n=779) and Ireland (DAFM, n=1126). CNS=Central Nervous System.

Similar to 2012, parasitic, respiratory and enteric diseases were the most commonly diagnosed causes of death in sheep of all ages in Ireland during 2013 (Figure 46). *Mannheimia haemolytica* remained the most common cause of bacterial pneumonia in both Northern Ireland and Ireland during 2013 (Figure 47), followed by *Trueperella pyogenes* and *Pasteurella multocida*. Jaagsiekte (ovine pulmonary adenocarcinoma) remains more commonly diagnosed in Northern Ireland than

in Ireland. In Northern Ireland during 2013 the total number of diagnoses of jaagsiekte (Figure 48) increased to 2.9 *per cent* of all submissions excluding abortions, compared to the 2012 level of 2.2 *per cent*.

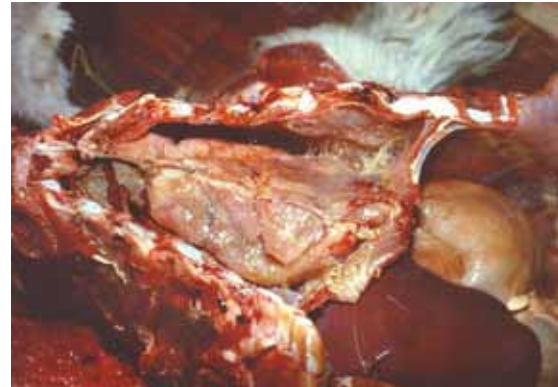


Figure 47: Fibrinous pleurisy in a lamb with *Mannheimia haemolytica* infection (pasteurellosis). (Photo: Cliff Mason)

The Pneumonia Complex in Sheep

- Pneumonic pasteurellosis
Mannheimia haemolytica
- Viral pneumonia
PI3, RSV, adenovirus, reovirus
- Mycoplasmal (atypical) pneumonia
Mycoplasma ovipneumoniae
- Other Specific Causes
Jaagsiekte, Lungworm, Maedi

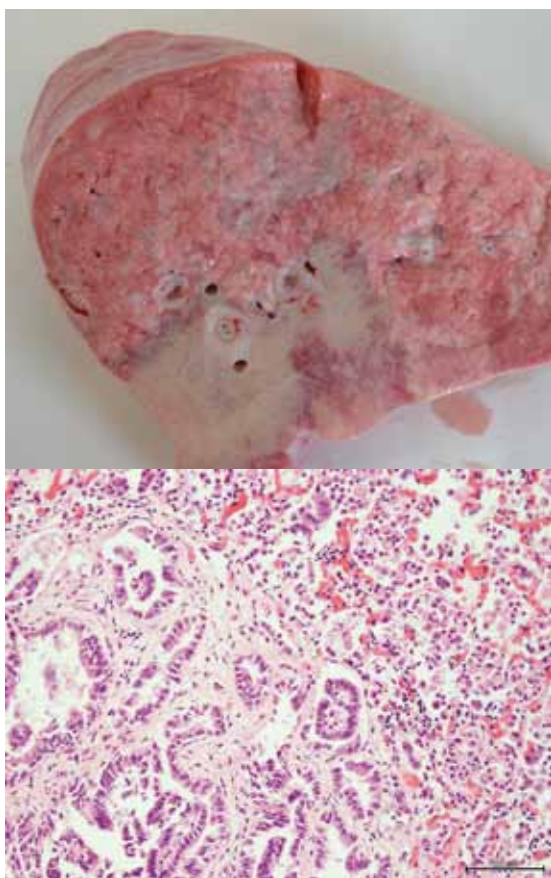


Figure 48: Macroscopic view and photomicrograph of lung and lung tissue from a sheep with clinical jaagsiekte. Extensive nodular and confluent grey lesions can be seen. These firm masses are composed of neoplastic tissue characteristic of ovine pulmonary adenocarcinoma. The histological preparation shows multiple proliferative foci of cuboidal or columnar cells lining the alveoli and forming projections into the alveolar lumina. (Photo: Seán Fee)

Colibacillosis, ovine neonatal enterotoxaemia ('watery mouth') and cryptosporidiosis are common causes of enteric disease in young lambs. Enteric viral infections (rotavirus and coronavirus) remain uncommon diagnoses on an all-island basis.

Similar to 2012, septicaemia and toxæmia were more commonly diagnosed in Ireland than Northern Ireland during 2013. Clostridial disease

showed a similar prevalence throughout the island of Ireland during 2013, thus repeating the pattern of 2010, 2011 and 2012. Clostridial disease remains a common diagnosis despite the availability of effective vaccines for ewes, rams and lambs. Many cases of clostridiosis are associated with incomplete or non-existent vaccination programmes in flocks.

During 2013, listeriosis remained the most frequently diagnosed disease associated with the central nervous system, as it was during 2012. Copper and *Pieris* spp (forest flame) were the most commonly diagnosed causes of poisoning during 2013. Overall, the number of poisoning cases on the island of Ireland was greatly reduced in 2013 (31 cases) compared to 2012 (75 cases).

Parasitic disease in sheep

Fasciola hepatica diagnoses in laboratory submissions highlighted continuing problems with fasciolosis during 2013 (Figure 49). This was most probably due to weather conditions which remained largely favourable to the mud snail's intermediate host. The number of acute cases however was reduced in 2013 compared to 2012 levels, especially in Ireland.

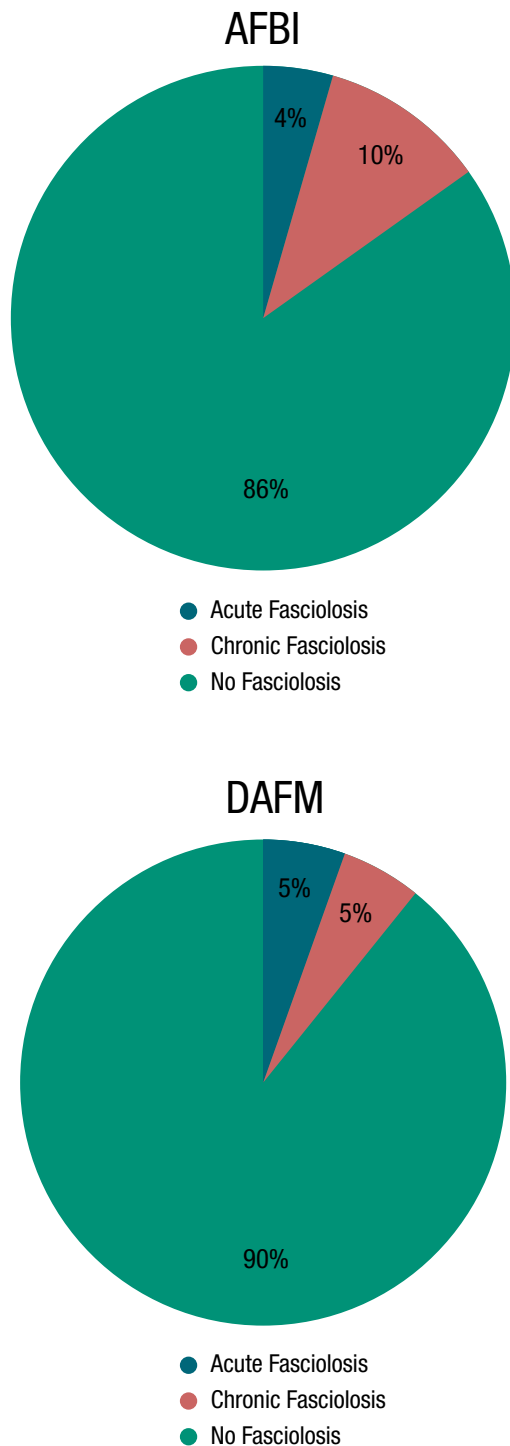


Figure 49: The percentage of all ovine mortality caused by acute and chronic liver fluke infection diagnosed by AFBI and DAFM veterinary laboratories during 2013.

Treatment of Liver Fluke in Sheep — Key Issues

- Choose the right product
- Re-infection and re-treatment — often are due to a lack of residual effect
- Use of flukicides effective only against adult flukes
- Avoid unnecessary use of combinations
- Correct dose rate, drenching / application technique.

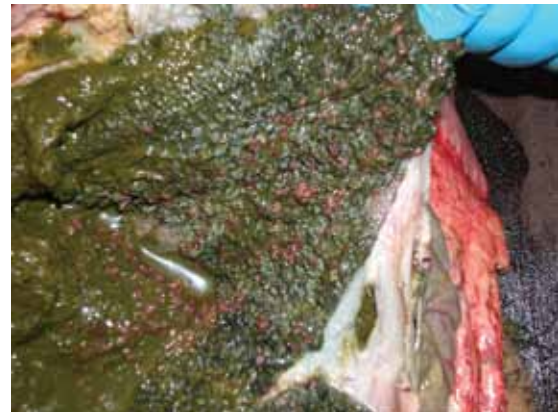


Figure 50: *Calicophoron daubneyi* on the rumen mucosa. The pink/red adult rumen flukes can clearly be seen adhered to the mucosa of the rumen. (Photo: Seán Fee)

Rumen fluke parasite belongs to the Paramphistomidae family. *Calicophoron daubneyi* is the species present in sheep in both Northern Ireland and Ireland. There are a small number of reports of the parasite causing disease in sheep (see Parasitic Disease section). Clinical disease may occur when large numbers of larval flukes are ingested by grazing animals over a short period of time. The immature flukes attach to the wall of

the upper small intestine and feed on plugs bitten from the wall causing severe enteritis (Figure 50). Adult flukes present in the rumen may contribute to ill-thrift and production loss although the effect of small burdens of this parasite is yet to be researched and confirmed.

Control of Rumen Fluke in Sheep — Key Issues

Biosecurity – prevent introduction of rumen flukes by faecal examination for presence of eggs and treatment of positive animals

Reduce exposure – restricting access to snail (intermediate host) habitats such as water-logged areas, drains and ponds

Treatment – Oxytetracycline based products are effective against both immature and mature rumen fluke. Follow best drenching practice as recommended by the Sustainable Control of Parasites in Sheep group (SCoPS).



Figure 51: The water snail *Galba truncatula* is the likely intermediate host for *Calicophoron daubneyi*. (Photo: Bob Hanna)

Figure 52 below shows the diagnostic analyses for all endoparasitic disease in Northern Ireland and Ireland during 2013. Each disease is represented as a percentage of the total number of post-mortem submissions in which parasitic disease was recorded as the cause of death.

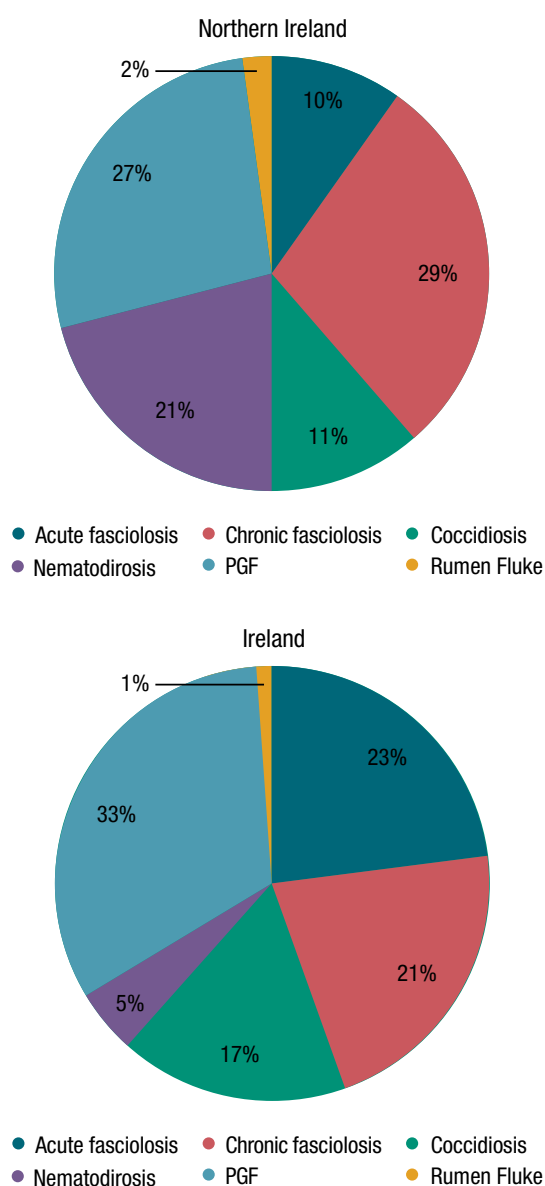


Figure 52: Specific endoparasitic conditions diagnosed during 2013 in sheep as a percentage of all ovine endoparasitic disease diagnoses made in Northern Ireland and Ireland (PGE: parasitic gastroenteritis).

Clostridial disease in sheep

Clostridial organisms are naturally present in the soil, where the spores can survive for a long time but they can also live in the gut of healthy animals.

	Total lambs	Total adults (>12 months of age)
Blackleg	0	2
Black Disease	1	19
Abomasitis	6	0
Malignant oedema	3	5
Enterotoxaemia	13	16
Pulpy Kidney disease	22	10

Table 10: The number of diagnoses of clostridial disease in sheep on *post mortem* examination in veterinary laboratories on the island of Ireland during 2013.

The overall pattern remains similar to 2012 with pulpy kidney disease recorded as the most commonly diagnosed clostridial disease on the island of Ireland (Table 10). Pulpy kidney disease is caused by infection with *Clostridium perfringens* type D. It is commonly identified in fast growing lambs, typically over one month of age, that are consuming high concentrate rations, or sucking ewes which are heavy in milk. Losses in a flock often coincide with a sudden change in feed or an increase in the plane of nutrition which causes proliferation of the organism with release of toxin. The finding of rapidly autolytic kidneys ('pulpy kidneys'), glucosuria and the presence of a serous clot in the pericardium are highly suggestive of pulpy kidney disease.



Figure 53: Black disease (caused by *Clostridium novyi* type B) lesion in an ovine liver. A pale coloured area of necrosis surrounded by a broad zone of intense hyperaemia can be seen. Black disease is frequently associated with the migration of immature liver flukes through the liver. (Photo: Seán Fee)

As in cattle, black disease was particularly prevalent in adult sheep. It is caused by *Clostridium novyi* type B, which becomes active in liver tissue damaged by the liver fluke (Figure 53). Control relies on clostridial vaccination and the elimination of liver fluke.

Ovine Abortion

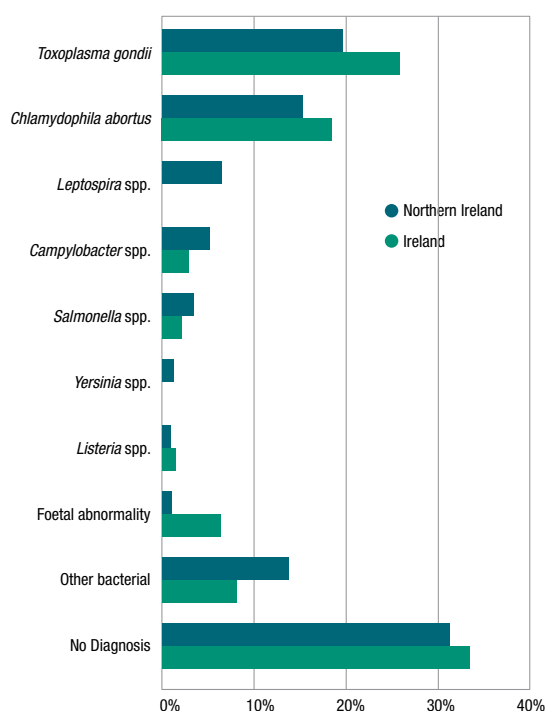


Figure 54: The relative frequency of the causes of ovine abortion in Ireland (n=371) and Northern Ireland (n=331) as a percentage of the total number of ovine abortions during 2013.

The diagnosed causes of abortion in sheep during 2013 were broadly similar in Ireland and Northern Ireland. The data presented here reports the occurrence of each diagnosis as a percentage of all ovine abortion cases, with at least one diagnosis being recorded per case. The data from Ireland has been refined to farm level i.e. a case includes all the post abortion specimens (foetus and/or foetal membranes) submitted from one flock whereas the data from Northern Ireland could record more than one case for one flock. Ireland recorded 386 diagnoses from the 371 flocks that submitted ovine abortion material for investigation. Northern Ireland recorded 362 diagnoses from 331 cases. The percentage of cases in which no diagnosis was reached was 33 *per cent* in Ireland and 31 *per cent* in Northern Ireland and, as in previous years, *Toxoplasma gondii* and *Chlamydophila*

abortus (causative agent of enzootic abortion) were the two most commonly diagnosed causes of abortion in both jurisdictions (Figure 54). Bacterial causes of abortion accounted for the majority of the remaining diagnoses and the rates again were broadly similar between the DAFM and AFBI data.

During 2013, leptospirosis was diagnosed as the cause of abortion in 6.6 *per cent* of cases in Northern Ireland but was not diagnosed in Ireland (Figure 54). In Northern Ireland, diagnosis of leptospirosis is based on antigen detection in the foetus (fluorescent antibody test) whereas this test is not routinely carried out in Ireland. Salmonellosis caused abortions in sheep flocks in Ireland and Northern Ireland; most cases were due to *Salmonella* Dublin, although cases of *S. Diarizonae* (n=3), *S. Agama*, *S. Muenster* (n=1) and *S. Derby* (n=1) were also identified in cases of ovine abortion.

Following the confirmation of Schmallenberg virus in both Ireland and Northern Ireland in November 2012, initial cases of Arthrogryposis-Hydranencephaly Syndrome (AHS) were seen mainly in early-lambing sheep flocks in Ireland. 25 flocks were diagnosed with AHS in Ireland in 2013 based on *post mortem* submissions and one flock in Northern Ireland. The diagnosis was based on typical gross pathology and/or virus detection by PCR test in midbrain tissue or foetal hair-coat fluid.

Diseases of pigs

Every case presented in this section represents a farm that could have submitted one or more pigs for *post mortem* examination. During 2013 a diagnosis was recorded for 174 cases submitted to AFBI and for 59 cases, comprised of 120 pigs, submitted to DAFM veterinary laboratories. As in previous years the most frequently recorded cause of death by AFBI and DAFM laboratories was pneumonia. In AFBI, another significant cause of mortality during 2013 were diseases due to *E. coli*, torsion of abdominal organs (significantly increased from 2012) and diseases caused by streptococcal infections, while in the DAFM, pneumonia as a cause of mortality was closely followed by septicaemia.

Pneumonia in pigs

Porcine pneumonia is a major problem for the contemporary swine industry. Its incidence, prevalence and mortality rates are multifactorial depending on management practices, host defences, the environment and the pathogens themselves.

The term porcine respiratory disease complex (PRDC) describes pigs with signs of respiratory infection involving one or more viruses and/or bacteria including mycoplasmas. Reflecting this, multiple pathogens were detected in a number of submissions to AFBI and DAFM during 2013. The bacterial pathogen most frequently isolated was *Pasteurella multocida*, present in 13 cases. Other bacterial pathogens detected included *Actinobacillus pleuropneumoniae* (6 cases), *Bordetella bronchisepticum* (2 cases), *Actinomyces pyogenes* (2 cases), *Mannheimia haemolytica* (1 case), *Aerococcus* spp (4 cases), *Trueperella pyogenes* and *Streptococcus suis* (1 case each). *Mycoplasma hyopneumoniae* is the pathogen responsible for enzootic pneumonia in swine and was isolated in five cases.



Figure 55: Chronic fibrinous epicarditis (cor villosum) associated with *Pasteurella multocida* in an adult boar. (Photo: Cosme Sánchez-Miguel)

Three cases of viral pneumonia were detected during 2013 in AFBI and DAFM laboratories. Two cases involving Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) and one case where Swine Influenza Virus (SIV) was detected.

No agent was identified in 20 (34 *per cent*) of the 59 cases of pneumonia reported by AFBI and DAFM during 2013. This could be due in part to the high number of cases submitted that have already received antibiotic therapy. In other cases opportunistic pathogens such as *Pasteurella multocida* and *Trueperella pyogenes* were isolated and PCR testing for respiratory viruses which were most probably the primary pathogens gave inconclusive results. This may reflect the fact that *post mortem* submissions are not in the acute phase of the infection, when primary pathogens may be isolated by culture or viruses detected by PCR testing.

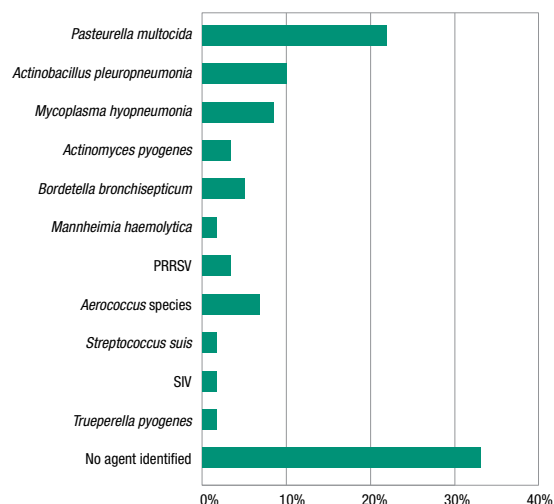


Figure 56: The distribution of aetiological agents identified in pig cases diagnosed with pneumonia on *post mortem* examination by AFBI and DAFM during 2013.

Escherichia coli infections

Infection due to *E. coli* was reported as the cause of death in 36 cases submitted to AFBI and DAFM for *post mortem* in 2013. Nine cases of enteritis, seven cases of septicaemia, five cases of oedema disease, three cases of abortion, eleven cases of colibacillosis and one case of peritonitis were reported as a result of *E. coli* infection.

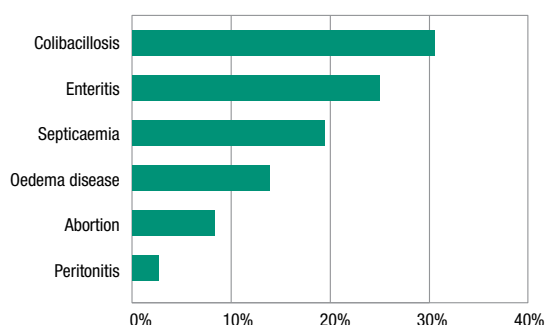


Figure 57: The relative frequency of diseases in pigs attributed to infection with *E. coli* species diagnosed from *post mortem* submissions to AFBI and DAFM veterinary laboratories during 2013.

Streptococcal infections

Streptococcal infections are mainly opportunistic as streptococci are commensals on mucous membranes. *Streptococcus suis* is a significant pathogen in pigs, associated with meningitis (Figure 58), arthritis, septicaemia, bronchopneumonia and endocarditis. Carrier pigs harbour the organism in tonsillar tissue and disease outbreaks can occur following stressful situations such as overcrowding or poor ventilation. Sows carrying the organism can infect their litters leading either to carrier animals or neonatal deaths.

Sixteen cases of streptococcal infections were reported by AFBI laboratories during 2013. Four of these infections had resulted in meningitis and six had resulted in septicaemia.

DAFM laboratories reported 14 cases of streptococcal infections involving 32 pigs. Five of these infections resulted in septicaemia, eight cases in pneumonia and one case in tenosynovitis.

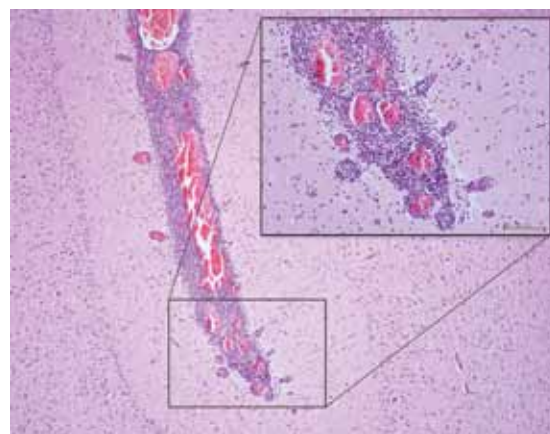


Figure 58: A photomicrograph of a case of bacterial meningitis from a 10-week old pig in which *Streptococcus suis* was cultured from a brain swab. The inset shows in detail the sulcus filled with neutrophils, other mononuclear cells, cell debris, oedema fluid and fibrin. (Photo: Siobhan Corry)

Reproductive diseases

Sixteen cases of reproductive diseases including abortions were investigated in Northern Ireland and Ireland during 2013. *Escherichia coli* was the most common reported cause of abortion in pigs on the island of Ireland during 2013.

Notifiable Diseases

No pigs with Aujeszky disease were reported on the island of Ireland using passive surveillance meaning it has maintained Aujeszky disease free status for 2013.

One case of Porcine Reproductive and Respiratory Syndrome Virus (PRRSV) was reported in Northern Ireland and another one in Ireland during 2013.

Four cases of salmonellosis were reported by AFBI in 2013. In two of these cases *Salmonella* Typhimurium was identified as the serotype. This is a significant reduction compared to 2012 when nine cases of salmonellosis were identified.

DAFM reported three cases of salmonellosis where *Salmonella* Typhimurium was identified as the serotype.

Other diagnoses

Eighteen cases of torsion of the abdominal organs were recorded by AFBI during 2013. This is a significant increase compared to 2012 when only eight cases were recorded. As in 2012 intestinal torsion was most frequently recorded with 13 cases, followed by three cases of liver torsion and two cases of stomach and spleen torsion (Figure 59).

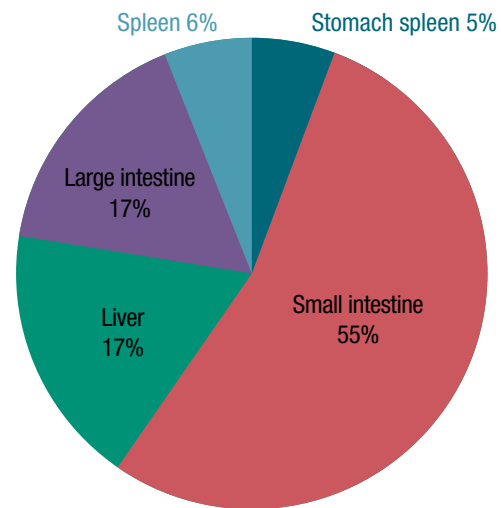


Figure 59: The relative frequency of torsion of abdominal organs diagnosed in pigs submitted for *post mortem* to AFBI during 2013 (n=18).

Gastric ulceration and subsequent haemorrhage was the reported cause of death in nine cases in Northern Ireland during 2013, all animals aged one to five months (Figure 60). One case of gastric ulceration developed into gastric rupture. This incidence more than doubles that of 2012. Gastric ulceration is multifactorial, the main risk factors being diet and stressful situations like overcrowding, upsets in feeding regime and mixing of pigs. Many of these risk factors are determined by economic competitiveness and are therefore likely to remain.



Figure 60: An opened pig stomach, showing an ulcer of the epithelium and associated haemorrhage. (Photo: Seán Fee)

Two cases of exudative epidermitis (“greasy pig disease”) were investigated in Ireland during 2013. One case involved six seven-week old pigs submitted with a longstanding herd history of necrosis on the tips and margins of the pinna of the ears. The submitted animals also had sparsely scattered areas of encrustation over the face, dorsum and occasionally distal limbs. Histopathologically they showed acute to subacute subcorneal pustular dermatitis with large numbers of intralesional cocci (Figure 61). *Staphylococcus hyicus* and *Staphylococcus aureus* were isolated from this case. Another interesting case involved three one-week-old pigs with characteristic malodorous exudation affecting the head, ears, ventral abdomen and inner legs. Histopathologically there was a superficial pustular dermatitis with intralesional gram positive cocci. No significant pathogens were isolated. Treatment history of these animals was not supplied.

Exudative epidermitis is caused by *Staphylococcus hyicus* and is most common in pigs 5-35 days of age. Although *S. hyicus* is a member of the normal skin flora of healthy pigs, trauma resulting in a breach of the skin barrier may predispose pigs to developing skin lesions. The pathogenesis of exudative epidermitis is not well understood. However, trauma from fighting, unclipped teeth, rough bedding, or other factors leading to exposure of the epidermis may allow bacteria to establish the infection. Nutrition of the pigs and other intercurrent diseases may also increase susceptibility.

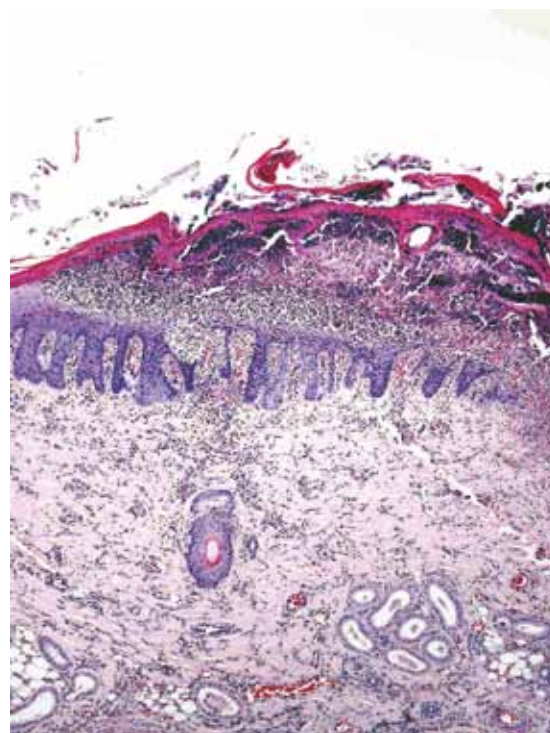


Figure 61: A photomicrograph of a case of exudative epidermitis in a pig showing intracorneal and subcorneal pustule formation. (Photo: Máire McElroy)

Diseases of poultry

During 2013, 297 poultry carcasses from commercial and backyard flocks were examined by DAFM. A total of 249 avian carcasses were examined in AFBI laboratories. Most of the submissions came from commercial producers and other sources of submissions were backyard flocks, wild birds and exotic birds from ornamental collections.

Digestive system conditions were the most common diagnosis in Ireland (23 *per cent*) and Northern Ireland (26 *per cent*). In DAFM laboratories digestive system diagnoses included coccidiosis, gizzard erosions/ulcerations and the presence of foreign material e.g. in turkeys, the twine used to seal bags of concentrate became trapped around the base of the tongue after being used as bedding material causing duodenal obstruction. Gizzard ulceration was seen in layer hens and broilers, and it is occasionally associated in broilers with adenovirus inclusion bodies. Other causes of gizzard erosions include mycotoxins (such as T2, MAS, DAS, oosperein), copper sulphate, biogenic amines, gizzerosine in fishmeal, vitamin B6 deficiency, and less commonly starvation, sulphur amino acid deficiency and quaternary ammonium compounds in water. In Northern Ireland, coccidiosis was the most frequent condition within the digestive system group (18 cases), followed by histomoniasis (blackhead) and clostridial enteritis.

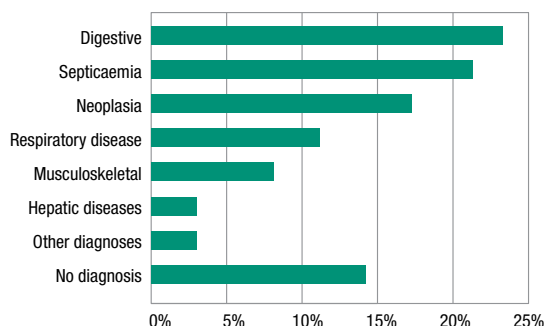


Figure 62: The relative frequency of the most commonly diagnosed causes of mortality in poultry in DAFM laboratories during 2013 (n=297).

Hepatic diseases were the second most common cause of mortality in Northern Ireland (18 *per cent* of submission). In Ireland hepatic diseases were diagnosed in three *per cent* of the total number of submissions, of which two *per cent* were hepatitis, while other hepatic conditions were inclusion body hepatitis, and fatty liver.

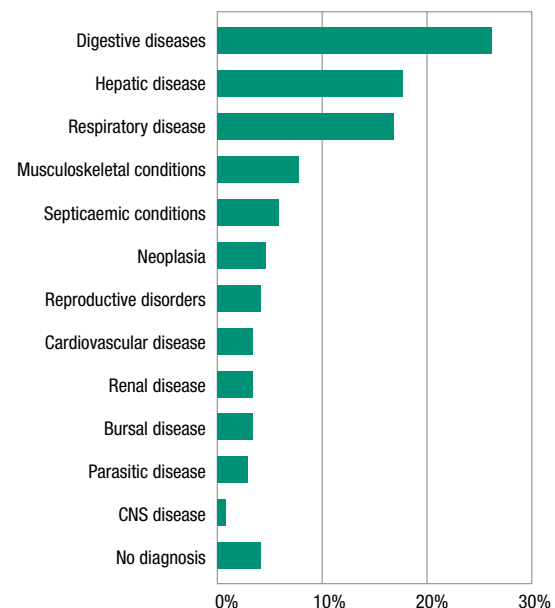


Figure 63: The most frequently diagnosed conditions in *post mortem* examination in poultry in AFBI laboratories during 2013 (n=249). CNS: Central nervous system.

In Ireland, septicaemia accounted for 21 *per cent* of submissions during 2013, the most frequent causes being *E. coli* and *S. aureus*. An outbreak of colisepticaemia in Ireland was diagnosed in 24 week-old broiler breeders. The flock was starting production and in good health but mortality rose to 10 *per cent* per house. Most birds had fibrinous peritonitis associated with bacteria while a few had fibrinous pericarditis. Fibrin thrombi were observed within the sinusoids of the liver. Pathogenic *E. coli* may invade the bird's body from the respiratory tract following infection with other respiratory pathogens, especially when the bird's resistance is lowered by environmental stress and poor air quality (dust or high ammonia levels). Good litter management

and properly ventilated houses are vital factors in the control. Live vaccines (e.g. Newcastle disease or IB), coccidiosis and nutritional deficiencies may all increase susceptibility. In Northern Ireland, septicaemia cases included pasteurellosis, *E. coli* and *Salmonella*.

In Northern Ireland, the most significant diagnosed condition affecting poultry during 2013 was infectious laryngotracheitis (ILT), and it was especially significant in flocks during the latter part of the year. The causative agent of ILT is a herpesvirus, commonly seen in backyard and pet chickens. It can cause severe outbreaks of respiratory disease in previously uninfected flocks, with coughing, gasping, nasal discharge and high mortality. Introduction may be through contaminated equipment and litter, and transmission between birds can occur rapidly. As with other herpesviruses, recovered birds can become carriers of the virus, and thus act as a source of infection. Rapid identification of the virus by PCR and histological examination allows for differentiation of the disease from Avian Influenza and Newcastle Disease, the presenting signs of which can be very similar.

Syngamus trachea was seen in 16 week-old emaciated pheasants in Ireland. This is the gapeworm of poultry, found in the trachea of chickens, turkeys, guinea fowl and many species of wild birds. It is of particular importance in farm-raised pheasants. Earthworms play an important role in the life cycle, serving as transport (paratenic) hosts. Other invertebrates may also serve as paratenic hosts and these include terrestrial snails and slugs. Young birds are most severely affected with migration of larvae and adults through the lungs causing severe pneumonia. Worms in the bronchi and trachea provoke a haemorrhagic tracheitis and bronchitis with formation of large quantities of mucus, plugging the air passages and, in severe cases, causing asphyxiation. Blockage of the bronchi and trachea with worms and mucus will cause infected birds to gasp for air. This

“gaping” posture has given rise to the common term “gapeworm” to describe *Syngamus trachea*. These clinical signs first appear approximately one to two weeks after infection. Severely affected birds, particularly young ones, will deteriorate rapidly, stop drinking and become anorexic. Adult birds are usually less severely affected and may only show an occasional cough or even no obvious clinical signs.

Musculoskeletal conditions can be diagnosed across all age groups, but are particularly important in young rapidly growing commercially reared chicks, both from an economic and a welfare point of view. There are a number of often interlinked aetiologies including infectious, physiologic and metabolic causes as well as nutritional. Examples of the conditions diagnosed in Northern Ireland were rickets and tibial dyschondroplasia, staphylococcal arthritis and tendonitis, tendon rupture and deep pectoral myopathy (Oregon disease). Deep pectoral myopathy is a condition usually affecting turkeys, but also broilers and broiler parents. The deep pectoral muscle is enclosed within a fairly unyielding membrane, and either during periods of rapid growth, or even periods of intense exercise causing muscle expansion the blood supply to the deep pectoral muscle is restricted and ischaemic necrosis results. The condition usually does not cause any clinical signs but can cause downgrading of meat at slaughter. In Ireland, gastrocnemius tendon rupture of unknown aetiology was seen in 34-week old broiler breeders which were going down on their hocks suddenly and had curled toes (Figure 64). The problem started at peak lay at 27 weeks of age and was of welfare concern. Five to ten *per cent* of birds were affected in two out of four houses. The birds had been vaccinated with inactivated reovirus vaccine at 14-weeks of age. Cultures of tendon sheaths did not yield significant bacteria and an early case of rupture did not contain the lymphoplasmacytic infiltrates which are associated with reoviral infection. It is speculated that the problem represents mechanical tendon

failure following overloading of an inadequately conditioned tendon, occurring in birds which are too light coming into lay. These birds subsequently put on a lot of weight in a relatively short space of time during the early part of lay, when there are also factors such as hormonal changes, mating activity and jumping up and down to nest boxes putting additional strain on tendons. The problem seems to be more prevalent in the heavier meat type birds.



Figure 64: Ruptured gastrocnemius tendon and haemorrhage in a 34 week old broiler breeder.
(Photo: Ann Sharpe)

Chronic lymphoplasmacytic tenosynovitis due to reovirus was suspected in 25-day-old broilers in a farm in Ireland. The isolated strain of reovirus in tenosynovitis cases can be serologically differentiated from the chicken reovirus reference strain — S1133 — by virus neutralisation test. Prevention and control of reovirus infections is based on vaccination of broiler breeders to protect chicks by maternally derived antibodies, with homologous strains giving optimal protection. The S1133 strain forms the basis of commercial reovirus vaccines for chickens. There are reports that standard reovirus vaccination of broiler breeder flocks is not affording protection. Therefore, alternative vaccination strategies are being considered, as well as ensuring good hygiene and biosecurity practices in broiler supply chains. Reoviruses are considered ubiquitous in poultry, can cause other

diseases in chickens, and are not associated with public health or international trade implications.

In Northern Ireland ruptured aortic aneurysm was diagnosed as the cause of death in a 20-week-old turkey, which was one of three sudden deaths in a house of 400 birds. This condition most commonly affects growing male turkeys and can have an incidence of one to two *per cent*. Suggested aetiologies have been high blood pressure in fast-growing male turkeys and copper deficiency. Copper is required for the formation of collagen and elastic fibres in the body.

AVIAN INFLUENZA AND NEWCASTLE DISEASE SURVEILLANCE

In 2013, AFBI tested 115 birds for Avian Influenza Virus and 99 birds for PMV-1, both by RT-PCR and all samples were negative.

Equine diseases

The Irish Equine Centre

The Irish Equine Foundation Ltd (trading as the Irish Equine Centre or IEC) is a registered charity. It is an independent organisation whose aim is to protect the wellbeing of Ireland's horse population. The IEC provides laboratory services for the diagnosis, management and prevention of diseases of horses. This is a whole island service.

An extensive range of diagnostic services are provided and supported through a number of units including clinical pathology, microbiology, pathology, virology, quality assurance and administration. Its services are always available, with an emergency service available outside of business hours.

The IEC offers three main diagnostic services to the equine industry: Code of practice testing, clinical pathology service and *post mortem* examination. In this section, findings on *post mortem* examination are presented.

In Ireland, the majority of equine *post mortem* examinations are carried out at the IEC. In total, 407 equine *post mortem* procedures were performed during 2013 by the IEC.



Figure 65: Osteomyelitis of the second phalanx (arrow) of the right hind leg in a 6 year-old mare. (Photo: Ursula Fogarty)

Post-mortem findings in the different age groups are outlined in tables below. These tables outline the more common findings in the cases examined. While each case could have more than one associated finding, many findings are of secondary interest and were not considered to be the primary cause of death.

Ninety adult horses were examined during 2013 (Table 11). All of them were screened for equine dysautonomia (all samples tested negative). In addition, across all age groups, those cases diagnosed as enteritis, typhilitis and colitis were also screened for *Campylobacter* spp., *Cryptosporidium* spp., *Listeria* spp., *Salmonella* spp., Clostridial toxins A, B, E and *C.difficile*.

Diagnosis	Number of Cases
Shot — malicious	2
Trauma to the head and neck/ fracture of cervical vertebrae	11
Colitis / Typhilitis / Enteritis	4
Uterine related haemorrhage	5
Fractured pelvis and haemorrhage	3
Gastric rupture	3
Ruptured aorta	1
Ruptured caecum	1
Toxaemia	1

Table 11: The most frequent findings on *post mortem* examination of adult horses at the Irish Equine Centre during 2013.

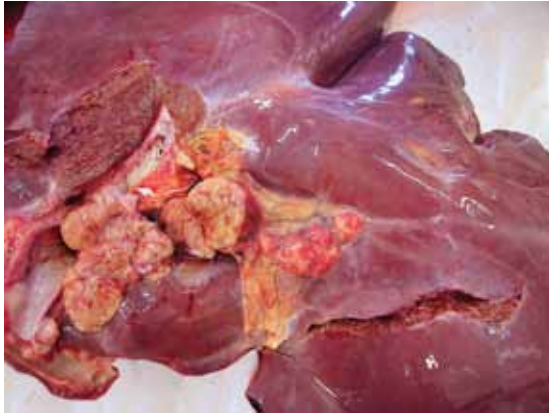


Figure 66: Enlarged lymph nodes in the liver of a 10 year-old mare diagnosed with lymphoma. (Photo: Ursula Fogarty)

During 2013, there were a total of 51 *post mortem* examinations in neonatal foals (foals less than 1 month of age) (Table 12). They were all screened for equine herpesvirus 1 (EHV-1), EHV-4 and equine viral arteritis (EVA). Five were positive for EHV-5 and one was positive for EHV-4.

Diagnosis	Number of cases
Foreign body pneumonia	20
Immune depletion	16
Enterocolitis – 12 haemorrhagic	15
History of asphyxiation during the birth process/ red bag presentation	13
Fractured ribs + complications	12
Septicaemia	10
Intra uterine compromise	9
Multi organ failure	6
Renal failure	6
Pyloric stenosis / Duodenal necrosis	6
Sleepy foal disease (<i>Actinobacillus equuli</i>)	3
Joint ill	3
Neonatal isoerytholysis	3
Trauma to head anterior thorax / sudden death	2
Tyzzer's disease	2
Gastric rupture	2
Intracranial haemorrhage	2
Ruptured small intestine	1
Small intestinal intussusception	1
Ruptured liver	1
Osteomyelitis pelvis	1
<i>Strongyloides westerii</i> >12,000	1
<i>Eimeria leukartii</i>	1
Abdominal haemorrhage portal	1
Enlarged thyroid	1

Table 12: The most frequent findings on *post mortem* examination of neonatal foals (foals up to 1 month of age) at the IEC during 2013

Twenty foals of one to six months of age were examined at the IEC during 2013

Description	Number of cases
Endocarditis	1
Acute interstitial pneumonia	16
Acute interstitial pneumonia and <i>Rhodococcus equi</i> abscessation.	1
Acute haemorrhagic necrotising enteritis	1
Colitis	1
Extensive parasitic thrombosis	1

Table 13: The most frequent findings on *post mortem* examination of one to six month-old foals at the IEC during 2013.

A total of 72 equine abortions were examined at the IEC during 2013. Examined material is comprised of foetuses and placental membranes. All the foetuses are screened for EHV-1 (13 positives), EHV-4 (1 positive) and EVA. Twenty-three foetuses were diagnosed with congenital abnormalities, the most common ones being scoliosis of the cervical or thoracic vertebrae (10 cases), contracted limbs (seven cases) and deviation of the nasal bone (two cases).

Findings	Number of cases
Chronic placental pathology	62
Cervical placentitis	24
Chronic placental pathology/placentitis	22
Necrosis of cervical region	13
Placental insufficiency	10
In utero growth retardation	7
Acute placental pathology/torsion of the umbilical cord	6
Chronic umbilical cord pathology	6
Twin pregnancy	2
Hydroallantois	1
Placental haemorrhage	1

Table 14: The most frequent findings on examination of placental membranes from equine abortions material at the IEC during 2013 (n=72).

Post-mortem examination was carried out in 36 donkeys at the IEC during 2013. All of them were screened for Asinine herpesvirus (AHV) (1 positive) and equine dysautonomia (all negative). Not all the findings were classified as cause of death. Some of the more common findings included dentition problems (19 donkeys), hepatic fibrosis (16 donkeys), enteritis, typhilitis and colitis (14 donkeys) and chronic laminitis (13 donkeys).

AFBI and DAFM Laboratories

The majority of equine *post mortem* analysis on the island of Ireland are carried out at the IEC, which is the only facility specialising in equine diagnostic pathology. Nevertheless, AFBI and DAFM veterinary laboratories complete a significant number of equine *post mortem* examinations and diagnostic tests throughout the year. In addition, the laboratories perform a number of equine specific tests for Code of Practice purposes or as part of the requirements for the movement of horses. Furthermore, they continue to be the national reference centre for some equine diseases, like CEM, Dourine and EIA. DAFM and AFBI Laboratories may also perform *post mortem* examinations in support of animal welfare investigations by law enforcement authorities in their respective jurisdictions.

Diseases of Aquatic Animals

Statutory testing

The Fish Health Unit (FHU) at the Marine Institute and the Fish Diseases Unit (FDU) at the Agri-Food and Biosciences Institute are the National Reference Laboratory in Ireland and Northern Ireland respectively for diseases of finfish, molluscs and crustaceans and performs surveillance programmes for diseases listed under EU Directive 2006/88/EC.

Commission Decision 2010/221/EU has granted Ireland and the UK additional guarantees in relation to freedom from the finfish diseases bacterial kidney disease (BKD), spring viraemia of carp (SVC) and gyrodactylosis (infestation with *Gyrodactylus salaris*). The entire Island of Ireland is free from these diseases but the FHU and the FDU continues to perform regular testing in order to maintain freedom. Commission Decision 2011/187/EC approves the national measures for preventing the introduction of Ostreid herpesvirus 1 μ var (OsHV-1 μ var) into those areas of Ireland which remain free of the disease. At the end of 2013, eleven areas in Ireland remain free of the disease. In May 2013, Ireland presented a declaration for disease freedom for Koi Herpesvirus (KHV) in accordance to Annex IV of Commission Decision 2009/117/EC to the Standing Committee on the Food Chain and Animal Health (SCOFAH) which was passed and the regulations will be updated to reflect the new status. Northern Ireland has approved zone status in respect of the listed fish diseases IHN, VHS, ISA, *Bonamia ostreae* (except for Lough Foyle and Strangford Lough), *Marteilia*, SVC, BKD and GS and routine surveillance must be carried out to confirm/maintain this disease free status. Under Commission Decision 2011/187/EC, the FDU in Northern Ireland is undertaking a surveillance programme for the early detection of Ostreid herpes

virus-1 μ var in Pacific Oysters (*Crassostrea gigas*). There is a surveillance programme underway with the aim of achieving disease freedom for KHV in the near future.

The FHU in Ireland also provides a diagnostic service for the aquaculture industry, the wild fish sector, Inland Fisheries Ireland and veterinarians, in relation to diseases currently not listed under EU Directives or by the OIE. The FHU laboratory is also accredited to ISO 17025 standards for a number of test methods, including those used for testing the above listed diseases.

The FDU laboratory in Northern Ireland is ISO 17025 accredited for the following range of real-time RT-PCR and PCR assays: SAV (Salmonid alphavirus), IHN, VHS, ISA, KHV and GS. All other work in the laboratory is carried out at ISO 9001:2008 standard.

Diagnostic testing

During 2013 in Ireland over 3,000 finfish were tested for disease pathogens either as part of surveillance programmes, diagnostic samples received into the laboratory or screening tests for the aquaculture industry. The majority of the finfish species tested were Atlantic salmon (*Salmo salar*, 89 *per cent*) and rainbow trout (*Oncorhynchus mykiss*, four *per cent*) along with a smaller number of brown trout (*Salmo trutta*) (Figure 68), common carp (*Cyprinus carpio*), perch (*Perca fluviatilis*) and coarse fish including pike (*Esox lucius*), roach (*Rutilus rutilus*) and rudd (*Scardinius erythrophthalmus*) were also tested. Ireland remains free of finfish diseases listed under Directive 2006/88/EC and also those included under Commission Decision 2010/221/EU. The main diseases of finfish detected in 2013 were diseases which are not listed, either under EU Directives or by the OIE. The most significant disease to affect farmed finfish in 2013 remained amoebic gill disease (AGD) caused by the parasite *Neoparamoeba perurans*. The disease has remained a significant cause of mortality in marine farmed Atlantic salmon in Ireland since

it reappeared in 2011. A similar situation was observed in Scotland and 2013 also saw an increase in the number of AGD cases in Norway, the largest producer of farmed Atlantic salmon in the world. Despite a reduction in the number of cases over the previous two years, pancreas disease caused by a salmonid alphavirus returned in 2013. Even though the majority of fish going to sea were vaccinated against the disease, a small number of sites still reported significant mortality due to pancreas disease. On a positive note, 2013 was the first year in over a decade that no clinical outbreaks of infectious pancreatic necrosis (IPN) were reported. IPN is a viral disease of salmonids, both in freshwater and seawater, caused by an aquabirnavirus. The virus has been present in the country since before fish farming began, initially it was a problem for rainbow trout farming but has since resulted in sporadic mortalities for the Atlantic salmon sector. A rhabdovirus was isolated from a sample of farmed perch submitted to the laboratory. Although small in numbers, perch farming in Ireland has been established for over ten years (Figure 67), during which time the perch rhabdovirus has been regularly isolated from farmed samples. Analysis of archived samples going back to 1993 has shown that this virus was present in wild populations of perch in Ireland and is a likely source of infection of the farmed perch.



Figure 67: Eurasian perch from Lough Sheelin. Perch are farmed in Ireland where it is also an important coarse angling species (Photo: Neil Ruane).

In the same period, over 2,000 molluscs and crustaceans were tested by the FHU. The vast majority of the testing focused on Pacific oysters, *Crassostrea gigas* in relation to screening for the presence of Ostreid herpes virus-1 μ var and *Vibrio aesturianus*. Temperatures were significantly higher in 2013 than the previous two years and mortality reports related to the presence of OshV-1 μ Var were also higher. Twenty of the twenty nine previously infected bays reported mortality in 2013 and samples tested from these bays were positive for the virus. In addition, OshV-1 μ var was detected in a further three bays previously negative for the virus, bringing the total number of positive bays in Ireland to 32. Following reports of significant mortality episodes in half grown and adult oysters associated with the presence of *V. aesturianus* in France during 2012, the FHU carried out targeted surveillance for the pathogen during mortality episodes during 2013. Testing for *V. aesturianus* focused particularly on those events associated with half grown and adult oysters. *V. aesturianus* was detected in all of the cases involving adult and half grown oysters as well as in three cases where mortality was confined to seed and juveniles. Whilst *V. aesturianus* DNA was detected by PCR no pathology consistent with infection with *V. aesturianus* was observed and hence the exact role of the bacterium in the mortality events reported remains unclear. The entire coast of Ireland remains free from *Marteilia refringens* whilst the entire coast, with the exception of eight bays, is considered free from *Bonamia ostreae*.

In Northern Ireland during 2013 almost 2,000 finfish were tested for disease pathogens as either part of statutory surveillance programmes or diagnostic samples received into the laboratory from the aquaculture industry and private veterinarians. The finfish species tested were Rainbow trout (55 *per cent*), Atlantic salmon (30 *per cent*), Brown trout (10 *per cent*) (Figure 68), common carp including koi carp (3 *per cent*) and roach (2 *per cent*). Northern Ireland remains free of

finfish diseases listed under EU Directive 2006/88/EC and Commission Decision 2010/221/EU.



Figure 68: Wild brown trout with tapeworm infestation in the intestines (Photo: Neil Ruane).

The only diseases that were detected in finfish in Northern Ireland during 2013 are not listed under EU directives or by the OIE. These diseases are pancreas disease (PD), infectious pancreatic necrosis (IPN), Heart and skeletal muscle inflammation (HSMI), Cardiomyopathy syndrome (CMS) and amoebic gill disease (AGD) caused by *Neoparamoeba perurans*. All of these diseases are commonly diagnosed in Atlantic salmon reared in sea cages. PD and IPN are detected in the laboratory by virus neutralisation and virus isolation in cell culture, real-time PCR, IFAT and genetic sequence analysis. *N. perurans*, CMS and HSMI infections are detected in the laboratory by real-time PCR and genetic sequence analysis.

In addition and during 2013 a total of 1,175 molluscs and crustaceans were tested for disease pathogens by the FDU in Northern Ireland. Eight hundred and fifty five Pacific oysters (*Crassostrea gigas*) were screened for Osterid herpes virus-1 μ var (OSHV-1 μ var) for both surveillance programmes and research projects. OSHV-1 μ var was detected in Carlingford Lough in 2013 with 22 pacific oysters out of 60 testing positive by real-time PCR and confirmed by genetic sequence analysis. One hundred and ten native oysters (*Ostrea edulis*) and sixty mussels (*Mytilus edulis*)

were screened for *Bonamia ostreae* and *Marteilia refringens*; both these diseases are listed by the OIE. The entire coastline of Northern Ireland is designated free from *Marteilia refringens* and *Bonamia ostreae* (with the exception of Strangford Lough and Lough Foyle where *Bonamia ostreae* has been found previously) (Figure 69). One hundred and fifty Green crabs were screened for White Spot Syndrome virus (WSSV) and they all tested negative by real-time PCR.

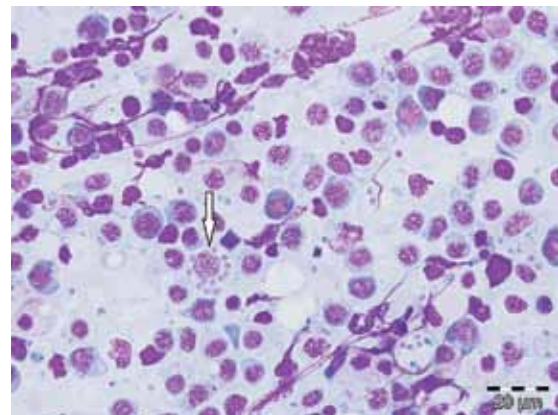


Figure 69: Stained heart blood print from the native flat oyster (*Ostrea edulis*) showing the protozoan parasite *Bonamia ostreae* multiplying an oyster haemocyte (arrow) (Photo: Evelyn Collins).

Research

Advance Through Disease Control project (ATDC) is managed by the Aquaculture Initiative and is supported by the European Fisheries Fund 2007-2013 and the Department of Agriculture and Rural Development. This project was started in September 2011 and was finished in July 2013. The project is a response to the rise of mortalities and difficulties presented to oyster farming in Northern Ireland by the herpes oyster virus new variant. The objectives of the ATDC are to help seven participating oyster farmers in Northern Ireland to look at farming methods that can help them reduce mortality and maintain growth despite the threat of the herpes oyster virus new variant.

In Ireland and under the Marine Institute Fellowship Programme, the FHU in collaboration with Dublin City University, published a PhD thesis entitled “*An investigation into the existence of cyprinid herpesvirus3 encoded microRNAs*”. 2013 saw a new fellowship started with Galway & Mayo Institute of Technology on “Gill disease in Atlantic salmon with particular emphasis on amoebic gill disease”. Under the EU FP7 program, the FHU was involved in *BIVALIFE Management of Infectious Diseases in Oysters and Mussels in Europe* which aimed to improve disease diagnostics and management for European molluscan aquaculture.

Scientific publications

N.M. Ruane, E.M. Collins, M. Geary, D. Swords, C. Hickey and F. Geoghegan. (2013) Isolation of *Streptococcus agalactiae* and an aquatic birnavirus from doctor fish *Garra rufa* L. *Irish Veterinary Journal* 66: 16.

D. A. Graham, A. Brown, P. Savage, *et al.* (2013) Detection of salmon pancreas disease virus in the faeces and mucus of Atlantic salmon, *Salmo salar* L., by real-time RT-PCR and cell culture following experimental challenge *Journal of Fish Diseases* 35: 949-951

M. Braceland, R. Bickerdike, J. Tinsley, D. Cockerill, M.F. McLoughlin, D.A. Graham, R.J. Burchmore, W. Weir, C. Wallace and P.D. Eckersall. (2013) The serum proteome of Atlantic salmon, *Salmo salar*, during pancreas disease (PD) following infection with salmonid alphavirus subtype 3 (SAV3) *Journal of Proteomics* 94: 423-436

D.A. Graham, H.R. Rowley and P. Frost. (2013) Cross-neutralization studies with salmonid alphavirus subtype 1-6 strains: results with sera from experimental studies and natural infections. *Journal of Fish Diseases* 20

Parasitic Diseases

The number of faecal samples submitted to AFBI and DAFM veterinary laboratories for parasitological examinations dropped during 2013 compared to 2012. This was primarily the result of a move by DAFM away from on-demand testing (Figure 70).

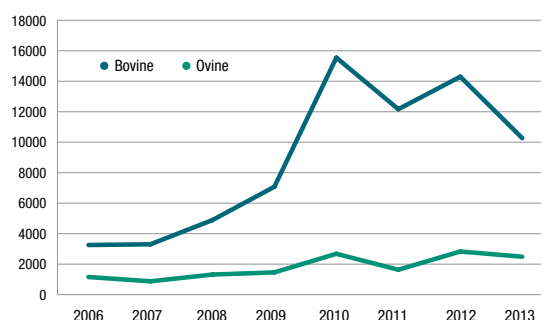


Figure 70: The number of faecal samples submitted for liver fluke egg detection to AFBI and DAFM laboratories in the years 2006 to 2013.

Liver and rumen fluke infections

During 2013, 10,268 bovine faecal samples were analysed for the presence of liver and rumen fluke eggs (4,509 by AFBI and 5,759 by DAFM). A total of 1,306 (12.7 *per cent*) of the bovine samples analysed were positive for liver fluke eggs (16.7 and 9.6 *per cent* in AFBI and DAFM laboratories respectively). This is a higher result compared to 2012 and may reflect the wetter autumn and winter of 2012. In total 42.8 *per cent* of the bovine samples analysed were positive for rumen fluke eggs (43.1 and 42.5 *per cent* in AFBI and DAFM laboratories respectively), an increase compared to 39.0 *per cent* in 2012 and 34.8 *per cent* in 2011. Recent analysis of rumen flukes collected in Ireland has shown that *Calicophoron daubneyi* appears to be the dominant species in cattle and sheep. This species of rumen fluke uses the mud snail (*Galba truncatula*) as its intermediate host, as does the liver fluke. It was erroneously considered before that *Paramphistomum cervi*, which uses a different intermediate host, the water snail, was

the most common and significant rumen fluke. Figure 71 illustrates the change in frequency rate of positive results for liver and rumen fluke eggs by quarter.

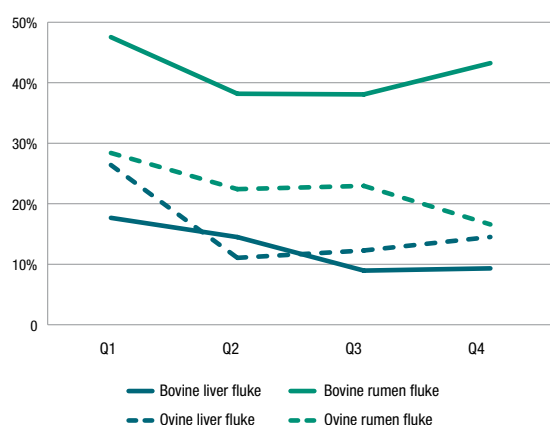


Figure 71: The percentage of bovine and ovine faecal samples positive for fluke eggs by quarter during 2013.

A total of 2,487 ovine faecal samples were analysed for the presence of liver fluke eggs (1,521 and 966 in AFBI and DAFM laboratories respectively) during 2013, of which 17.7 *per cent* were positive (17.6 and 17.7 *per cent* in AFBI and DAFM laboratories respectively), a significant rise compared to the 13.8 *per cent* positive samples during 2012, and especially compared to 6.1 *per cent* of positives in 2011.

In addition, 23.3 *per cent* were positive for rumen fluke eggs (24.1 and 22.0 *per cent* in AFBI and DAFM laboratories respectively), again a rise compared to 2012 (17.7 *per cent*) and 2011 (17.9 *per cent*).

Strongyles

During 2013, 11,052 bovine faecal samples (4,991 and 6,061 in AFBI and DAFM laboratories respectively) and 3,606 ovine faecal samples (1,789 and 1,817 in AFBI and DAFM laboratories respectively) faecal samples were examined for strongyle eggs. Egg counts above 500 per gram are

considered to be positive, and based on this criteria 717 (6.5 *per cent*) bovine (4.8 and 7.8 *per cent* in AFBI and DAFM laboratories respectively) and 939 (26.0 *per cent*) ovine (22.4 and 29.6 *per cent* in AFBI and DAFM laboratories respectively) samples were found to be positive. Figure 72 illustrates the quarterly results for both bovine and ovine species.

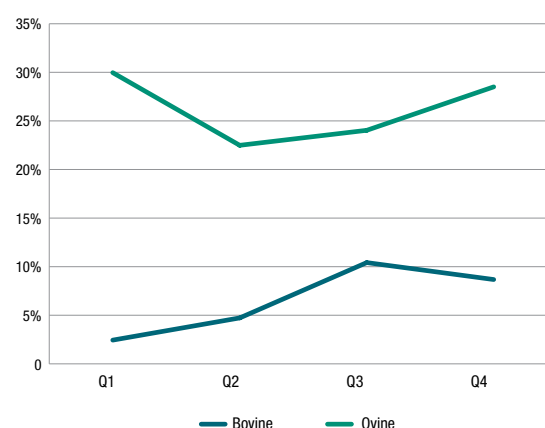


Figure 72: The percentage of positive bovine and ovine faecal samples per quarter tested for strongyle eggs positive during 2013 (positives are samples ≥ 500 strongyle eggs per gram).

Coccidiosis

During 2013, 9,058 bovine faecal samples (5,139 and 3,919 in AFBI and DAFM laboratories respectively) were tested for the presence of coccidial oocysts. Of these 1,745 samples (19.3 *per cent*) were positive (15.4 and 24.4 *per cent* in AFBI and DAFM laboratories respectively). As in previous years, the majority of the positive samples contained low number of oocysts (78.3 *per cent*) and would not be considered of clinical significance (Figure 73).

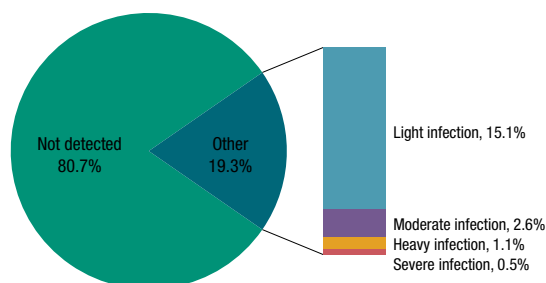


Figure 73: Breakdown of the results following the analyses of bovine faecal samples for coccidial oocysts during 2013 in AFBI and DAFM laboratories (n=9,058).

3,466 ovine faecal samples (1,827 and 1,639 *per cent* in AFBI and DAFM laboratories respectively) were tested for the presence of coccidial oocysts during 2013. Of the total number of samples tested 57.3 *per cent* were positive (56.7 and 57.9 *per cent* in AFBI and DAFM laboratories respectively), a far higher number than during 2012 (37.2 *per cent*). As in previous years, there were also a far higher percentage of positive ovine samples than bovine samples. Figure 74 illustrates the results by severity of infection for 2013.

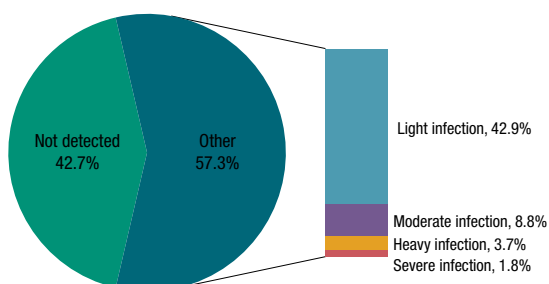


Figure 74: The breakdown in results following the analysis of ovine faecal samples for coccidial oocysts during 2013 (n=3,466) in AFBI and DAFM laboratories.

Sheep scab

Sheep scab and bovine psoroptic mange are caused by the same mange mite, *Psoroptes ovis*, but there is little evidence of spread between cattle and sheep.

There were 10 laboratory confirmed outbreaks of sheep scab recorded during 2013, seven diagnosed by AFBI laboratories and three by DAFM. In cattle, there were four laboratory-confirmed outbreaks of bovine psoroptic mange recorded (two by AFBI and two by DAFM).

Clinical Chemistry

The identification of mineral deficient animals and their supplementation to prevent or treat the clinical signs of mineral deficiency are common practices among both veterinary practitioners and their farming clients. Both AFBI and DAFM laboratories provide analyses for a number of minerals which play a role in maintaining good health and thrive in farm animals. Here the results of some of the more commonly requested mineral analyses.

Copper analyses

Copper deficiency may be described as either a primary or a secondary deficiency. Primary copper deficiency might arise as a result of inadequate copper in forage grown on deficient soils. Secondary deficiency may come about due to inhibition of copper absorption arising from excess molybdenum or iron in the diet. Young growing cattle are particularly susceptible to copper deficiency but older cattle may also be affected. Clinical signs of copper deficiency include ill thrift, changes in hair colour, chronic diarrhoea, anaemia and increased susceptibility to infection due to a diminished immune response. Swayback (enzootic ataxia) is a specific condition associated with copper deficiency in lambs.

While the concentration of copper in liver tissue is the best marker of the copper status of an animal, the determination of copper in plasma or serum is a useful practical approximation. A bovine serum copper value of nine micromoles per litre or less is suggestive of copper deficiency. When assessing the copper status of a herd, it is important to take samples from a number of animals in each age group.

Copper analysis was carried out on 10,702 blood samples submitted to AFBI and DAFM laboratory services during 2013, of which 16.5 *per cent* (1772 samples) were found to be deficient (Figure 75).

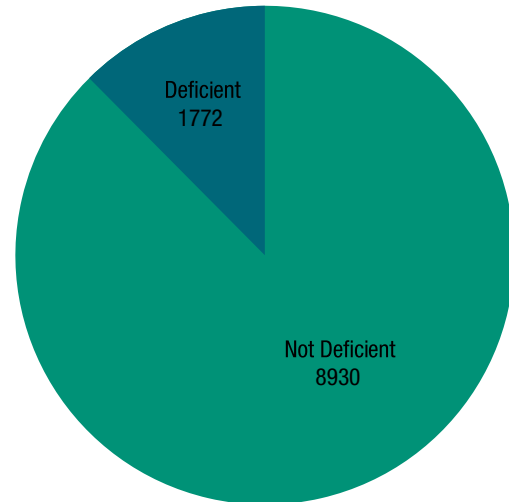


Figure 75: The number of bovine blood samples submitted to AFBI and DAFM laboratories during 2013 which were analysed for Copper status and were identified as deficient or non-deficient.

Selenium analyses

Selenium is an essential trace element for mammals which forms part of the enzyme glutathione peroxidase (GSH-Px), which catalyses the reduction of hydrogen peroxide and lipid hyperperoxides preventing the potential for oxidative damage to body tissues. Selenium deficiency in cattle can result in nutritional myodegeneration (white muscle disease), retained placenta, infertility and a decline of immune function.

The selenium status of cattle can be determined either by directly measuring blood selenium levels or by measuring GSH-Px activity in red blood cells. GSH-Px activity reflects incorporation of selenium into erythrocytes during erythropoiesis and therefore is an indicator of selenium status sometime earlier than the time of sampling. Submission of whole blood samples is required for selenium or GSH-Px analysis.

During 2013, selenium status testing was carried out on 12,311 bovine blood samples submitted to AFBI and DAFM laboratory services of which 6.7

per cent (822 samples) were found to be deficient (Figure 76).

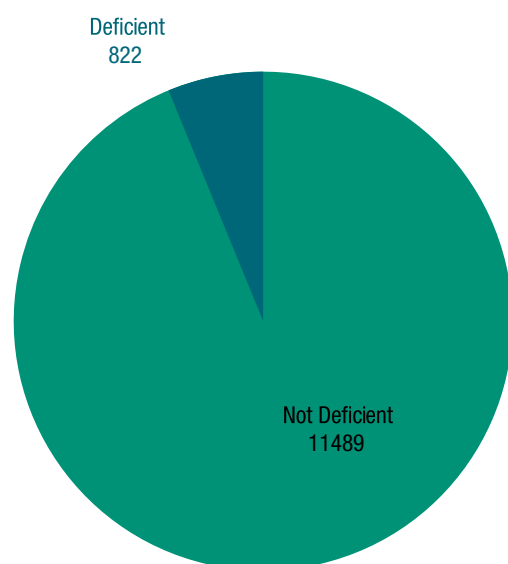


Figure 76: The number of bovine blood samples submitted to AFBI and DAFM laboratories during 2013 which were analysed for Selenium status (either by blood selenium analysis or measurement of glutathione peroxidase activity) and were identified as deficient or non-deficient.

Iodine analyses

DAFM laboratories do not carry out iodine analysis. Plasma inorganic iodine is used by the AFBI laboratories to assess iodine status and gives an indication of current iodine intake (previous 2-3 days), but it does not account for body reserves of iodine. Plasma inorganic iodine results of less than 30 microgrammes per litre indicate very low recent iodine intake.

Iodine deficiency in cattle herds is associated primarily with reproductive disorders and impaired viability in young calves. Deficient cows suffer decreased fertility, increased susceptibility to uterine infections, embryonic loss, stillbirths and retained placentae. Calves born to deficient cows suffer an increased incidence of neonatal disease due to weakness, inability to suck and impairment

of immune function. Iodine is required for the manufacture of the thyroid hormone thyroxine. Thus, iodine deficiency results in reduced thyroxine production causing the pituitary gland to secrete more thyroid stimulating hormone, thus stimulating thyroid gland hyperplasia and causing development of a goitre. Goitre caused by iodine deficiency is most commonly seen in newborn calves.

Results should be interpreted on a herd basis as an individual low result does not necessarily mean an animal is deficient and has not enough stored iodine to satisfy the needs of short term thyroxine production. A low result does indicate however that intake on the day of sampling was low and prolonged intakes of this level are likely to result in deficiency, if they have not already done so.

During 2013, a total of 3146 blood samples were tested for inorganic iodine in AFBI laboratories and 31.5 *per cent* of them (991 samples) were found to be deficient in inorganic iodine (Figure 77).

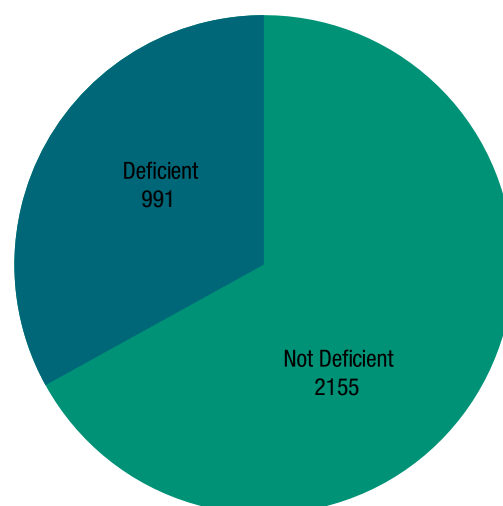


Figure 77: The number of bovine blood samples submitted to AFBI laboratories during 2013 which were analysed for inorganic iodine status and were identified as deficient or non-deficient.

Cobalt

Cobalt deficiency in ruminants occurs primarily in areas in which the soils are deficient in cobalt. In ruminants, cobalt is needed in the manufacture of vitamin B12 which is in turn required for the metabolism of propionate fatty acid through the gluconeogenesis pathway, an important source of energy for the animal. The clinical signs of cobalt deficiency in ruminants include poor appetite, weight loss, muscle wasting and anaemia.

In sheep a specific condition associated with cobalt deficiency is ovine white liver disease. This condition is associated with low liver cobalt levels and low plasma concentrations of vitamin B12. At necropsy the liver looks pale, swollen and greasy as a result of severe fatty infiltration causing hepatic failure.

Liver cobalt concentrations of less than 0.7 micromoles per kilogram wet weight are considered deficient. During 2013, a total of 204 ovine liver samples were tested in DAFM laboratories for cobalt content and 42 *per cent* of them were found to be deficient (Figure 78).

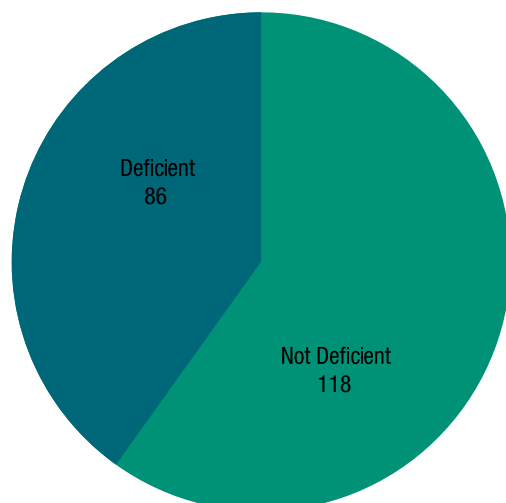


Figure 78: The total number of ovine liver samples analysed by DAFM laboratories during 2013 which were found to be deficient or not deficient.

Haematology

Haematology testing is available in all of AFBI and DAFM laboratories. Haematological examination may be performed to assess general health or the presence or absence of a systemic inflammatory response in a sampled animal. Blood should be drawn from the animal at rest with the minimal degree of stress to minimise physiological variations in cell counts, the blood should be collected into an EDTA blood tube and submitted to the laboratory as soon as possible, preferably within 12 hours but certainly no later than 24 hours after collection. The fresher the sample, the more reliable the results, in particular in relation to white cell parameters as white cells degrade more quickly. Abnormal findings on a haemogram are often non-specific, therefore it is important that findings are interpreted in conjunction with a thorough history and consideration of the clinical signs. The laboratories can also examine blood films. These are useful in the diagnosis of haemoparasitic diseases such as tick-borne fever or babesiosis.

Anthelmintic resistance

In Ireland, DAFM established in 2013 the Sheep Technology Adoption Programme (STAP), aimed at increasing profitability on Irish sheep farms by using discussion groups to encourage and enable the adoption of best management practice. Among the STAP tasks was a “drench test”, designed to test the efficacy of anthelmintic treatment as practiced on Irish farms. The drench test involves counting nematode eggs in a pooled faecal sample from a group of lambs before and after anthelmintic treatment in order to determine if any nematodes survived the treatment. A study involving farmers who chose these tasks as part of STAP was carried out to determine the effectiveness of commonly used anthelmintic treatments as practiced on Irish farms and to determine if different anthelmintic classes had different efficacies.

The anthelmintic treatment took place between June and October and farmers dosed their lambs with an anthelmintic product of the farmer’s choice from the benzimidazole, levamisole or macrocyclic lactone classes of anthelmintic products. Fresh faecal samples were collected pre-treatment and seven days post-treatment if a levamisole product was used and 14 days post-treatment if a benzimidazole or macrocyclic lactone product was used. Samples were pooled and tested on seven different private laboratories approved by DAFM. *Nematodirus* spp, other Trichostrongyle species and *Strongyloides papillosus* eggs were enumerated and the presence or absence of eggs from other parasitic species such as *Moniezia* spp, *Trichuris* spp, *Eimeria* spp or coccidia recorded.

When the reduction in FEC post-treatment was less than 95 *per cent*, the treatment was considered ineffective. Results were analysed for a total of 1585 participants. The distribution of anthelmintics of choice was 46.3, 28 and 23.2 *per cent* to

use a benzimidazole, macrocyclic lactone and levamisole product respectively. The remaining 2.4 *per cent* used either a combination benzimidazole/levamisole product, or a flukicide active product only and were eliminated from the study.

Drench	Bz	LM	ML
% FEC reduction	Percentage of flocks (n)		
0	17 (27)	6 (5)	4 (5)
1-50	20 (31)	6 (5)	3 (4)
51-80	21 (34)	16 (13)	6 (8)
81-94	11 (18)	21 (17)	12 (16)
95-100	31 (49)	51 (43)	76 (102)
Total	100 (159)	100 (83)	100 (135)

Table 15: The relative frequency of ovine farms participating in the STAP programme during 2013 displaying varying levels of faecal egg count (FEC) reduction following treatment with benzimidazole (Bz), levamisole (LM) and macrocyclic lactone (ML) in Ireland.

The study showed that overall approximately 52 *per cent* of treatments were deemed to be effective (higher than 95 *per cent* FEC reduction) and the level of treatment success was lowest with benzimidazole products (31 *per cent*) and highest with macrocyclic lactone products (76 *per cent*), levamisole products showing an intermediate level of success (51 *per cent*) (Table 15).

Other recent studies have found that over 80 *per cent* of flocks tested in Ireland have shown evidence of resistance to benzimidazole (Good *et al.*, 2012, McMahon *et al.*, 2013). Despite these reports, benzimidazole was the most popular anthelmintic product choice between STAP participants, followed by macrocyclic lactone products and levamisole products being the least popular choice. While resistance to macrocyclic lactone products has been reported in other countries (Kaplan, 2004, Papadopoulos *et al.*, 2012, Sargison *et al.*, 2001),

until recently resistance to macrocyclic lactone among sheep nematode populations in Ireland has only been suspected (Good *et al.*, 2012), and it was confirmed by this study. Resistance to levamisole had also been reported in almost 40 *per cent* of farms in Ireland (Good *et al.*, 2012).

The reason for treatment failure is currently unknown. However, there was a significant difference in treatment efficacies with different classes of anthelmintics, although failure for reasons other than resistance are also possible. Irrespective of the reason for treatment failure, this study provides strong evidence that anthelmintic treatment as practiced in Irish sheep flocks has a high failure rate. Nevertheless, the vast majority of treatments were effective for *Nematodirus* species, a parasitic species for which anthelmintic resistance is rarely reported.

A number of factors are known to influence the rate at which anthelmintic resistance arises and spreads. These include inappropriate dosing (dosing too often or not administering the correct dose quantity), the proportion of nematodes not exposed to the anthelmintic and the movement of animals harbouring anthelmintic resistant nematodes (Coles, 2002). Strategies to prevent anthelmintic resistance must be considered on all sheep farms in order to prevent/reduce the development of anthelmintic resistance. This is essential to ensure the availability of effective anthelmintics for the future. SCOPS (Sustainable Control of Parasites) is a UK industry led group that represents the interests of the sheep industry. It recognises that, left unchecked, anthelmintic resistance is one of the biggest challenges to the future health and profitability of the sheep industry

SCOPS recommended strategies to reduce anthelmintic resistance

1. Quarantine treatments of bought in sheep. This will help prevent the introduction of resistant worms onto your farm. All introduced sheep should be dosed with a new generation wormer and quarantined off pasture for 24-48 hours so that all worm eggs have been passed. Turn them onto dirty pasture to ensure that any worms that may have survived treatment are diluted by worm eggs already on the pasture.
2. Always administer drenches correctly and at the correct dose.
3. Test for resistance. Establish if you have resistance to benzimidazoles, levamisole or macrocyclic lactones on your farm by properly conducting a drench test.
4. Reassess your parasite control strategies. Discuss with your vet/ adviser on how to better tailor your strategy and to introduce strategies to reduce the number of anthelmintic treatments.
5. Reduce dependence on anthelmintics where possible. Use pasture management e.g. use silage aftergrass, graze after cattle, turn younger animals onto pasture that has been grazed by adult animals instead of young animals. Other strategies may include the inclusion of certain types of forage or further research in the selection of animals that have increased resistance to nematodes.

6. Only use anthelmintics when necessary. Use FECs to determine when and what animals require dosing. Move away from regular, routine dosing without investigating the worm burden. Adult animals should have developed immunity to nematodes and should not require regular dosing.
7. Select the most appropriate anthelmintic e.g. if you have identified a liver fluke problem on farm, only use a flukicide product and not a combination product.
8. Preserve susceptible worms i.e. do not increase the selection pressure for resistant worms. If post worming animals are moved directly onto clean pasture, then the only worms that go with the lambs will be resistant worms resulting in pasture with a fully resistant worm population. The two strategies available to help preserve a susceptible worm population are a) treat animals and leave them on dirty pasture for a few days or leave a small number (10 *per cent*) of the sheep untreated.

Wildlife Surveillance

Echinococcus surveillance of wild foxes

Alveolar echinococcosis is a potentially fatal disease of humans caused by the tapeworm *Echinococcus multilocularis*, which is one of the most lethal parasitic zoonoses in temperate and arctic regions of the Northern Hemisphere and is endemic in many countries in mainland Europe. The tapeworm's definitive host is the red fox (*Vulpes vulpes*) but it can also infect dogs. As Ireland is considered to be free from *E. multilocularis* it is a requirement under the pet travel scheme (PETS) that all dogs entering the country are given an anthelmintic treatment effective against *Echinococcus* spp. prior to entry. In order to provide scientific evidence of the island of Ireland's *Echinococcus multilocularis* free status, Commission Regulation (EU) 1152/2011 requires that an annual surveillance of the wild fox population is carried out to detect a prevalence of *E. multilocularis* of one *per cent* at a confidence level of 0.95. Samples from 654 foxes (297 from AFB1 and 357 from DAFM) received in 2013 were examined by the sedimentation and counting technique and all were negative for *E. multilocularis*, thus providing assurance of the island of Ireland's *Echinococcus multilocularis* free status.

Trichinella surveillance of wild foxes

Trichinellosis is a zoonotic disease caused by a nematode of the genus *Trichinella*. Numerous mammalian species can harbour the parasite and humans can develop severe disease following infection. In Europe, horsemeat, wild boar and pork meat are the main sources for human infection. *Trichinella* has a sylvatic cycle, which is maintained mainly by wild carnivores. The red fox (*Vulpes vulpes*) is the principal sylvatic reservoir in Europe. An annual *Trichinella* risk-based wildlife monitoring programme is in place in the island of Ireland, where the risk of *Trichinella* in domestic pigs is officially recognised as negligible.

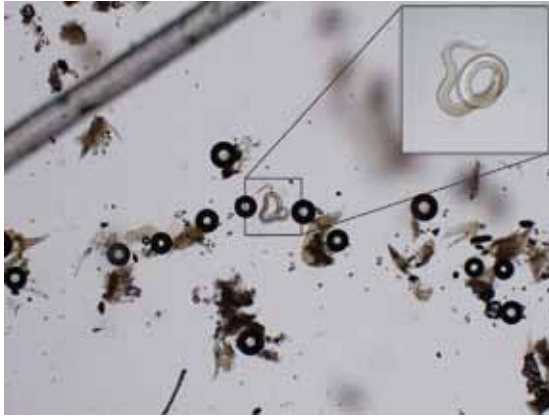


Figure 79: *Trichinella spiralis* larvae found in a fox in County Kilkenny during 2013. (Photo: Montse Gutiérrez and William Byrne)

In 2013, 628 foxes were sampled and tested from across Ireland (132 by AFBI and 496 by DAFM). One fox captured in county Kilkenny, was found to be positive for *Trichinella spiralis* larvae (Figure 79) and the results were confirmed following submission of the larvae for PCR testing to the EU Reference Laboratory for Parasites, in Rome. Figure 80 illustrates the capture location of the foxes including the positive fox.

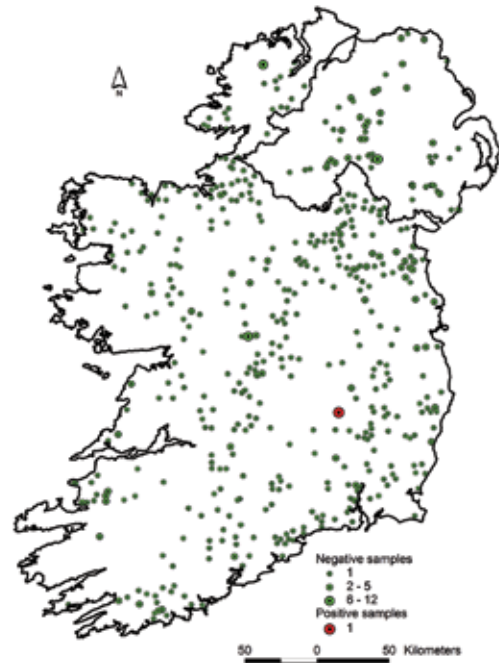


Figure 80: The capture location of the foxes tested for *Trichinella* spp in the island of Ireland during 2013.

Post-mortem of two True's Beaked Whales

A female true's beaked whale (*Mesoplodon mirus*) was found stranded on Five Fingers Strand, Malin Head, County Donegal on 12 May 2013. Two days later a True's beaked whale calf was stranded 15km away, on Trabreaga Bay. This is a very rare whale and it was a unique opportunity to learn more about this species of which very little is known. Both strandings were thought to be live on stranding and were transported to the Athlone RVL by the National Parks and Wildlife Service of Ireland for *post mortem* examination (Figure 81). Post-mortem examination was carried out by Drs. Simon Berrow and Joanne O'Brien from the Galway-Mayo Institute of Technology and the Irish Whale and Dolphin Group, and Gema Hernandez Milian from the Department of Zoology, Ecology and Plant Sciences at University College Cork.

Both individuals showed external haemorrhaging, supporting the idea they were live stranded. The adult female was lactating and the calf was still suckling as demonstrated by papillae on the calves tongue. Tissue samples sent to the Centre for Geogenetics at the National History Museum of Denmark have shown that it was most likely the adults' calf.



Figure 81: Post-mortem examination being carried out on a True's Beaked Whale in Athlone RVL. (Photo: Simon Berrow)

Stomach contents from the adult consisted mainly of squid beaks, which was expected, but also a large plastic "cartridge"! The stomachs were also analysed for microplastics (plastic particles <1 mm) as part of a PhD study at GMIT and preliminary analysis has shown very large numbers of fibres, which was totally unexpected as this species lives offshore in deep waters.

There were 10 records of True's beaked whale stranded in Ireland prior to this event and around 20 worldwide.

Wildlife Crime

AFBI and DAFM play a role in the investigation of cases of suspected wildlife crime (Figure 82).



Figure 82: X-ray of a peregrine falcon (*Falco peregrinus*) that had been shot (arrows indicate the location of two lead pellets).

A protocol agreed between the National Parks and Wildlife Service (NPWS), DAFM and the State Laboratory facilitates the *post mortem* examination and toxicology testing of suspect wildlife crime cases. In 2013 the species submitted for examination included hares, a seal, wood pigeons, a swan, rooks, jackdaws, starlings, gannets, and a number of raptor species (peregrine falcons, a sparrowhawk, a white-tailed sea eagle, common buzzards, a barn owl, red kites, a short-eared owl and a hen harrier). Cases of nitroxylin (white-tailed sea eagle), carbofuran (red kites) and alpha chloralose (common buzzard, rook, jackdaws, peregrine falcon and red kite) poisoning were diagnosed. Rodenticide toxins (bromadiolone, flocoumafen, brodifacoum, difenacoum) were detected in many of the raptors examined, but as the tests were qualitative rather than quantitative it was not possible to determine whether these were just incidental findings or whether the toxins had contributed to the death of the birds.

While poisoning has been diagnosed in some cases, many of the causes of death were not determined or were considered to be from natural causes. For example a 72-day-old hen harrier (*Circus cyaneus*) was submitted to Limerick RVL in August (Figure 83). It and its sibling had satellite-tracking devices fitted before fledging and the movements were being monitored and posted online by the NPWS. When it was noticed that the movement of this bird had stopped a search was initiated and the carcass was recovered in a field in west Limerick. On examination the bird was found to be emaciated. The bird had lost 40 *per cent* of its body weight in a six-week period. It was concluded that the bird had not adapted to hunting for itself in suitable habitat and had starved to death.



Figure 83: A juvenile hen harrier (*Circus cyaneus*) that had starved to death. (Photo: Alan Johnson)

Proficiency testing

In the island of Ireland, many of the test methods performed by DAFM and AFBI veterinary laboratories are accredited to ISO 17025 and all of the veterinary laboratories follow an internal quality system, which includes quality control of sample testing.

In addition to their own quality controls, DAFM and AFBI veterinary laboratories participate in a number of independent proficiency testing (PT) schemes such as microbiology culture and isolation (including samples for antibiotic sensitivity testing), and haematology (ruminant blood).

The DAFM veterinary laboratories participate in PT schemes for *Brucella abortus* (CFT/SAT and iELISA testing of blood and milk samples), *E. coli* 0157, *Salmonella* serotyping, *Salmonella* serology, Aujeszky's disease serology, BVD virus antigen, BHV-1 serology, Enzootic Bovine Leukosis in serum, Equine Infectious Anaemia, Equine Viral Arteritis, *Mycobacterium avium* subsp. *paratuberculosis* bovine serology, *Mycobacterium bovis* detection in tissue, *Leptospira* Hardjo *bovis* analysis, BSE and scrapie Immunoblot, *Taylorella equigenitalis* isolation and analysis of lead and copper in tissue samples. Participation in a PT scheme on detection of *Bacillus anthracis* has been added in 2013.

Participation in parasitology PT schemes include detection of *Trichinella spiralis*, *Neospora caninum*, and worm and fluke egg detection.

The DAFM veterinary laboratories also participate in a number of clinical chemistry PT schemes, including testing of proteins, metabolites, liver enzymes, major and trace element tests.

In Northern Ireland, AFBI veterinary laboratories participate in a broad range of PT schemes operated by Animal Health and Veterinary Laboratories agency (AHVLA), the United States

Department of Agriculture (USDA) and GD Animal Health. The range of PTs include molecular detection of pathogens, microbiology culture and isolation, immunofluorescence tests, and haematology (ruminant blood). Specific schemes include detection of *Bacillus anthracis*, *Taylorella equigenitalis*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa* and antibiotic sensitivity testing. Serological PT schemes include detection of antibodies to *Mycobacterium avium* subsp. *paratuberculosis*, BVD virus, Infectious BHV-1, Bovine Parainfluenza type 3 virus (PI3V), Bovine Respiratory Syncytial virus (RSV), Porcine Parvovirus, *Neospora*, *Chlamyphila abortus* (EAE), *Leptospira* Hardjo and the detection of antigen to BVD, rotavirus and coronavirus.

Clinical chemistry PT schemes include lead and copper analysis in tissue samples, while parasitology schemes include *Trichinella spiralis* and worm and fluke egg detection.

Other PT schemes that AFBI laboratories participate in are Aujeszky's disease serology, Enzootic Bovine Leukosis (EBL) serum, Equine Infectious Anaemia (EIA), Equine Viral Arteritis (EVA), Bluetongue virus (BTV), *Brucella abortus* (CFT/SAT and iELISA), *Salmonella* serotyping, *Salmonella* serology, *Mycobacterium bovis*, BSE and Scrapie Immunoblot.

Zoonoses

Zoonotic diseases are defined by the World Health Organisation (WHO) as “a group of infectious diseases that are naturally transmitted between vertebrate animals and humans”. The greatest risk for zoonotic disease transmission occurs at the human-animal interface through direct or indirect human exposure to animals, their products and/or their environments. More than 60 *per cent* of the newly identified infectious agents that have affected people over the past few decades have been caused by pathogens originating from animals or animal products. The emergence of zoonotic disease is complex and multifactorial, driven by factors which include evolving ecology, microbial adaptation, human demographics and behaviour, international travel and trade, agricultural practices, technology and industry. As a result, agriculture is at the front of zoonotic threat and therefore must remain vigilant at all times to prevent the spread and perpetuation of these diseases.

During 2013, DAFM and AFBI laboratories isolated and positively identified a number of zoonotic agents in the course of disease diagnostics. A few of the most common and unusual diseases are discussed in this section.

Toxoplasmosis

Toxoplasma gondii is a protozoan parasite that infects humans and other warm-blooded animals including sheep. Felines are the only definitive hosts of toxoplasmosis, therefore wild and domestic cats can serve as the main reservoir of infection. There are three infectious stages of toxoplasmosis; tachyzoites, which are a rapidly multiplying form, bradyzoites (found as tissue cysts) and sporozoites (found in oocysts). Toxoplasmosis can be transmitted by accidental ingestion of infectious oocysts in cat faeces, consumption of tissue cysts in infected meat, and by transplacental transfer of tachyzoites from mother to foetus. *Toxoplasma*

spp. is a significant cause of foetal death and resorption, abortion, or stillbirth in sheep and goats. Particularly at risk are animals moved late in pregnancy to areas heavily contaminated with cat faeces, like ewes housed in barns. Congenital transmission from ewe to lamb can also occur in a high percentage of healthy born lambs.

T. gondii is an important zoonosis. Toxoplasmosis is a major concern for people with immunodepression (HIV positive patients) and for pregnant women because tachyzoites can migrate across the placenta and cause birth defects in human babies. Infection of women with toxoplasmosis may occur by the methods mentioned above, and also through contact with infected materials/fluids produced in ovine abortion.

During 2013, *Toxoplasma* was diagnosed as the cause of abortion in 127 cases (out of 698 ovine fetuses submitted for examination) of ovine abortion in DAFM Regional Veterinary Laboratories and 66 cases of ovine abortion (out of 364 submitted cases) in AFBI veterinary laboratories. This confirms that toxoplasmosis remains an issue where sheep are lambing and it is a diagnosis readily considered by veterinary practitioners upon foetal loss.

Campylobacteriosis

Campylobacter jejuni is generally asymptomatic in animals, but it can cause gastrointestinal symptoms in humans. The disease is recognised as the most common cause of food-borne gastroenteritis in the world. As with most intestinal pathogens, faecal-oral spread and food- or waterborne transmission appear to be the principal avenues of infection. Asymptomatic carriers can shed the organism in their faeces for prolonged periods and contaminate food and water.

The diarrhoea appears to be most severe in young animals. In calves, signs vary from mild to moderate. Isolation of *C. jejuni* from diarrhoeic faeces is not,

in itself, an indication for antibiotic therapy but an indication of a zoonotic risk to anyone regularly handling that animal.

Campylobacteriosis in humans is typically characterised by abdominal pain, fever and diarrhoea. It lasts between 24 hours and one week and is usually self-limiting.

During 2013, DAFM laboratories confirmed *Campylobacter jejuni* in 398 cases out of 4206 faecal samples tested.

Listeriosis

Listeriosis is a sporadic bacterial infection that affects humans and a wide range of animals. One of the most pathogenic species is *Listeria monocytogenes*. The natural reservoirs of *L. monocytogenes* are soil and mammalian intestinal tracts, both of which contaminate vegetation.

Encephalitis or meningoencephalitis in adult ruminants are the most frequent forms of listeriosis. Aborted fetuses and necropsy of septicaemic animals present the greatest infection hazards to handlers. People have developed fatal meningitis, septicaemia, and papular exanthema on the arms after handling aborted material. Pregnant women should be protected from infection because of danger to the foetus, with possible abortion, stillbirth, and infection of neonates. While human listeriosis is rare, mortality can reach 50 *per cent*, particularly among elderly patients, pregnant women, or immunocompromised people.

During 2013, AFBI laboratories in Northern Ireland identified 23 cases of abortions or encephalitis associated with *Listeria* spp in sheep and cattle. In Ireland, *Listeria monocytogenes* was isolated in submissions representing 72 herds/flocks, including 57 cases of abortions (52 bovine and five ovine) and 15 cases of encephalitis.

Cryptosporidiosis

Cryptosporidia are protozoal organisms found worldwide that are parasitic in the intestine of mammals. *Cryptosporidium* spp. are found primarily in neonatal calves but also in lambs, kids, foals, piglets and humans. Cryptosporidiosis is considered a cause of varying degrees of diarrhoea in very young farm animals. Many reports associate infection in calves with diarrhoea occurring at five to 15 days of age. *C. parvum* is also a common enteric infection in young lambs and goats.

Infections in domestic animals may act as a reservoir for infection of susceptible humans. *Cryptosporidium* spp. is considered to be a relatively common non-viral cause of self-limiting diarrhoea in immunocompetent persons, particularly children. The infection is transmitted predominantly from person to person, but direct infection from animals and waterborne infection from contamination of surface water and drinking water by domestic or wild animal faeces can also be important. Animal handlers on a calf farm can be at high risk of diarrhoea due to cryptosporidiosis transmitted from infected calves.

In humans, cryptosporidiosis can be asymptomatic or may cause watery diarrhoea, stomach cramps and a mild fever. Symptoms of cryptosporidiosis can appear two to ten days after infection and usually last about two weeks.

During 2013, *Cryptosporidium* spp. oocyst antigen was detected in the intestinal contents of 170 calves with a history of diarrhoea sampled *post mortem* at DAFM Regional Laboratories. In addition, there were 858 positive isolates in 2706 bovine faecal samples submitted by practitioners to the RVL service. The majority of these samples were taken from diarrhoeic calves.

Q fever

Coxiella burnetii causes Q fever, a zoonotic bacterial infection associated primarily with parturient ruminants, especially sheep, goats and cattle. Infection in ruminants is usually subclinical but can cause infertility and sporadic abortion with a necrotizing placentitis in ruminants.

The greatest risk of transmission occurs at parturition by inhalation, ingestion, or direct contact with birth fluids or placenta. Farmers and veterinarians are most at risk during calving and lambing. The organism is also shed in milk, urine, and faeces. The majority of outbreaks in people have been associated with wind dispersal of desiccated reproductive products, contaminated with *C. burnetii*, from sites where sheep, goats, or cattle are kept. Ticks may transmit the disease among domestic ruminants, but are not thought to play an epidemiologically important role in transmission of disease to humans. Clinical presentation of Q fever in humans can range from a self-limiting influenza-like illness to pneumonia, hepatitis, and endocarditis.

During 2013, 13 submissions (comprised of 29 samples) out of 84 (464 samples) were found to be positive for Q fever in DAFM laboratories. Average sample prevalence, among positive results, was 33.1 *per cent*, whilst the highest prevalence in a single submission was 60 *per cent*, in a submission with five samples.

Salmonellosis

Salmonellosis is caused by many species of *Salmonellae* and characterized clinically by one or more of three major syndromes—septicaemia, acute enteritis, and chronic enteritis. Young calves, piglets, lambs, and foals usually develop the septicaemic form. Adult cattle, sheep, and horses commonly develop acute enteritis, and chronic enteritis may develop in growing pigs and occasionally in cattle. Pregnant animals may abort.

Asymptomatic carriers are a zoonotic risk in all host species.

The incidence of human salmonellosis has increased in recent years, and animals have been incriminated as the principal reservoir. Transmission to humans occurs via contaminated drinking water, milk, meat, and food mixes that use contaminated ingredients; poultry and eggs are particularly important sources of infection. While many other *Salmonella* species may cause disease, the more common ones are *Salmonella* Typhimurium and *Salmonella* Dublin in cattle and *S.* Typhimurium, *S.* Dublin and *Salmonella* Montevideo in sheep and goats.

Salmonellosis in humans presents as a gastro-enteritis with symptoms such as vomiting, diarrhoea and fever. Symptoms tend to be more severe in the very young, elderly, immunocompromised or those with underlying disease problems.

During 2013, there were 180 *Salmonella* isolates identified in Northern Ireland and 209 in Ireland from *post mortem* analysis of bovine and other bovine clinical submissions. Of these, *Salmonella* Dublin was identified in 156 and 169 samples in Northern Ireland and Ireland respectively and *Salmonella* Typhimurium was identified in 19 and 40 samples in Northern Ireland and Ireland respectively.

Salmonella Dublin was also isolated in 18 and 23 ovine submissions in Northern Ireland and Ireland respectively, and in two caprine submissions from Ireland. *Salmonella* Typhimurium was also isolated in five equine and 12 porcine submissions in Ireland.

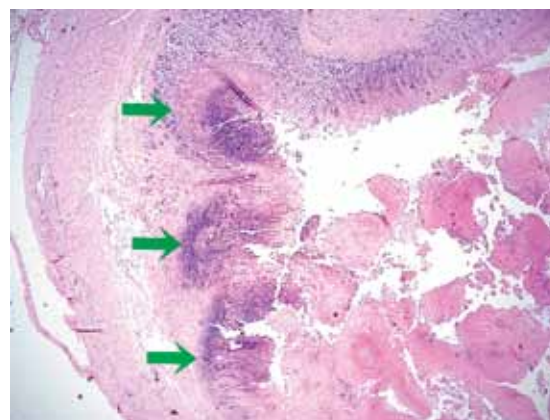


Figure 84: Photomicrograph showing multiple foci of mucosal necrosis, “button ulcers”, in the ileum of a weaner piglet, commonly associated with salmonellosis. (Photo: Cosme Sánchez-Miguel)

Leptospirosis

Leptospirosis is regarded as an economically important zoonosis and is caused by pathogenic spirochetes of genus *Leptospira*, which are maintained in nature by both wild and domestic animals and constitutes a source of infection for humans and other animals.

The disease is maintained in nature by chronic infection of the renal tubules of maintenance hosts. Livestock become infected by contact with pasture, water or feed which is contaminated by the urine of infected animals and also post abortion uterine discharge, infected placenta, sexual contact or *in utero* infection.

Cattle and sheep are recognised for maintaining serovar Hardjo (both types Hardjobovis and Hardjoprajitno), while pigs are most commonly maintenance hosts for serovars Pomona and Bratislava, and dogs for Canicola and Bratislava. All animals can be incidentally infected by other non-adapted strains.

Endemic infection of cattle and sheep with *Leptospira* Hardjo is now recognised in the UK and Ireland. It is economically and clinically important

due to reproductive problems. Infection can be responsible for infertility, abortion, the birth of weak calves or lambs and milk yield decline.

During 2013, specimens collected from 963 abortion and stillbirth cases were collected in Northern Ireland and tested using the fluorescent antibody test (LFAT) (Figure 85). *Leptospira* spp. were demonstrated in 5.9 *per cent* of bovine submissions (35 out of 590 cases) and 7.9 *per cent* of ovine submissions (28 out of 353). Twelve porcine cases and six equine cases were also tested and one case each were found to have *Leptospira* spp. in the foetal tissue.

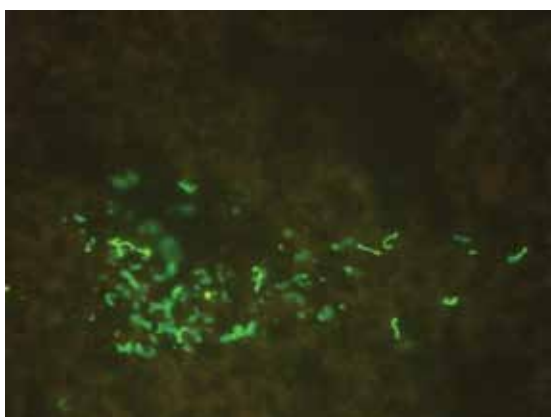


Figure 85: *Leptospira* spp. in lung tissue of an aborted bovine foetus, demonstrated using the fluorescent antibody technique.

Surveillance of epizootic diseases

As part of their obligations as OIE member countries, Ireland and Northern Ireland have to carry out surveillance and monitoring of some OIE listed animal diseases. It is a formal obligation of OIE member countries to compile and submit information on relevant animal diseases present in their countries. The OIE recognises the animal disease status of a country with regard to certain specific diseases which allows the country to demonstrate transparency and to maintain trust of trade partners and the international community through the promotion of animal health and public health worldwide. The vigilance of the surveillance networks which operate through DAFM in Ireland and AFBI in Northern Ireland are essential to the control and continued freedom from epizootic diseases on the island of Ireland.

Bluetongue

Surveillance for Bluetongue in Ireland and Northern Ireland is on-going and is conducted on cattle and sheep imported from countries that have not been declared disease-free by the EU, and in addition an annual survey in the national cattle herds is carried out to demonstrate freedom from the disease.

During 2013, DAFM virology division tested 686 samples for bluetongue antibody following importation while 141 samples were tested for bluetongue antigen by PCR. Of the total number of samples tested, 95 *per cent* were from cattle. Of those tested for bluetongue antibody, 2.8 *per cent* were positive (19 samples) while all of the PCR testing for bluetongue virus antigen were negative.

During 2013, DAFM laboratories tested 1190 cattle from 238 individual herds for bluetongue antibody as part of the monitoring program and all samples tested were negative.

During 2013 in Northern Ireland AFBI Immunodiagnostic Branch tested seven cattle following importation for bluetongue antibody with three (42.6 *per cent*) proving positive. A surveillance sample of 3,227 indigenous cattle was tested for Bluetongue antibody, none of which were positive. The Virology Branch of AFBI tested four cattle following importation, all of which proved negative for Bluetongue.

Avian Influenza

DAFM Virology Division tested 28321 samples during 2013 from commercial poultry flocks for avian influenza virus (AIV) antibodies as part of two major national surveys, and to satisfy requirements for movement and trade. In addition, 595 tests for avian influenza virus were tested using real time RT-PCR and 303 virus isolation tests were performed. A positive serological result for avian influenza H5 was obtained from a single flock but it was not considered an outbreak according to the EU/OIE definitions since no virus was isolated from the flock in question following a full epidemiological investigation. All results of surveillance testing were reported as required by the EU Commission regulations.

Newcastle disease

During 2013, 480 virus detection tests and 2,887 serological tests were performed for Newcastle disease virus by DAFM laboratories in Ireland. PMV-1 was isolated in one occasion from a commercial poultry flock but sequencing demonstrated that it was a lentogenic vaccinal virus. There was one virulent PMV-1 virus isolated from racing pigeons (PPMV-1) as part of scanning surveillance for this disease. This is the same aetiological agent as Newcastle disease in poultry, and the finding reinforces the requirement for continued surveillance and good biosecurity in commercial poultry flocks.

Bovine spongiform encephalopathy (BSE)

During 2013, BSE was confirmed in one animal in Ireland. The positive sample was identified through active surveillance in a rapid testing laboratory and the sample was confirmed positive in the National Reference Laboratory in DAFM Pathology division. The sample was identified as an atypical H- type BSE. Atypical BSE cases have been identified in small numbers in recent years in many countries. They are seen in older animals and are believed to be a sporadic form of BSE. During 2013, there were no confirmed BSE positives in Northern Ireland.

Samples from 12 clinical suspect cases (passive surveillance) were received for confirmatory diagnosis in the National Reference Laboratory, but none of these was confirmed as BSE positive (Table 16).

H&E Result	Number of Cases
Listerial Encephalitis	1
Non-suppurative Encephalitis	2
No Specific Findings	9
Total	12

Table 16: Histopathological diagnoses for BSE clinical suspects in Ireland's National Reference Laboratory during 2013.

Scrapie

During 2013, ten cases of scrapie were confirmed in Ireland by the National Reference Laboratory of Ireland. Seven of these cases were classified as classical scrapie and three were classified as atypical scrapie. All ten cases were identified through active surveillance. No cases of scrapie were confirmed in Northern Ireland during 2013.

A selection of abstracts from published scientific papers

Pre-calving and calving management practices in dairy herds with a history of high or low bovine perinatal mortality

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Reprinted from *Animals*, 3, 866-881 (2013)

Bovine perinatal mortality is an increasing problem in dairy industries internationally. The objective of this study was to determine the risk factors associated with high and low herd-level calf mortality. Thirty herds with a history of either high (case) or low (control) calf mortality were recruited. A herd-level questionnaire was used to gather information on management practices likely to impact bovine perinatal mortality. The questionnaire was divided into four subsections dealing with pre-calving (breeding, diet and body condition score, endemic infectious diseases) and

calving factors. Most of the significant differences between case and control herds were found in calving management. For example, in case herds, pregnant cattle were less likely to be moved to the calving unit two or more days and more likely to be moved less than 12 hours pre-calving, they were also less likely to calve in group-calving facilities and their calves were more likely to receive intranasal or hypothermal resuscitation. These management procedures may cause social isolation and periparturient psychogenic uterine atony leading to dystocia, more weak calves requiring resuscitation and high perinatal calf mortality. The key finding is that calving, not pre-calving, management appears to be the most important area of concern in herds with high perinatal mortality.

An international delphi study of the causes of death and the criteria used to assign cause of death in bovine perinatal mortality.

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³ Section of Herd Health & Animal Husbandry, School of Veterinary Medicine, University College Dublin, Dublin, Ireland

Reprinted from *Reproduction in Domestic Animals* 48:651-659 (2013) with permission from Elsevier

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***Fasciola hepatica*: Histological demonstration of apoptosis in the reproductive organs of flukes of triclabendazole-sensitive and triclabendazole-resistant isolates, and in field-derived flukes from triclabendazole-treated hosts, using *in situ* hybridisation to visualise endonuclease-generated DNA strand breaks**

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Reprinted from *Veterinary Parasitology* 191: 240-251 (2013), with permission from Elsevier

Investigation of the triclabendazole (TCBZ) resistance status of populations of *Fasciola hepatica* in field cases of fasciolosis, where treatment failure has been reported, can be supported by histological examination of flukes collected from recently treated hosts. In TCBZ-sensitive flukes (TCBZ-S) exposed to TCBZ metabolites for 1–4 days *in vivo*, but not in TCBZ-resistant flukes (TCBZ-R), morphological changes suggestive of apoptosis occur in cells undergoing meiosis or mitosis in the testis, ovary and vitelline follicles. In order to verify or refute the contention that efficacy of TCBZ treatment is associated with apoptosis in the reproductive organs of flukes, histological sections of TCBZ-S (Cullompton isolate) flukes and TCBZ-R (Sligo isolate) flukes were subjected to the TdT-mediated dUDP nick end labelling (TUNEL) *in situ* hybridisation method, a commercially available test specifically designed to label endonuclease-induced DNA strand breaks associated with apoptosis. Additionally, sections of *in vivo*-treated and untreated flukes originating from field outbreaks of suspected TCBZ-S and TCBZ-R fasciolosis were labelled by the TUNEL method. It was found that in treated TCBZ-S flukes, strong positive labelling indicating apoptosis was associated with morphologically abnormal cells undergoing mitosis or meiosis in the testis, ovary and vitelline follicles. Background labelling in the positive testis sections was attributed to heterophagy of cell debris by the sustentacular tissue. The triggering of apoptosis was probably related to failure of spindle formation at cell division, supporting the contention that TCBZ inhibits microtubule formation. In treated TCBZ-R (Sligo Type 1) flukes, and in treated flukes from field outbreaks of suspected TCBZ-R fasciolosis, no significant labelling was observed, while sections

of fluke derived from a field case of fasciolosis where TCBZ resistance was not suspected were heavily labelled. Light labelling was associated with the testis of untreated Cullompton (TCBZ-S) and Sligo Type 2 (TCBZR) flukes, which exhibit abnormal spermatogenesis and spermiogenesis, respectively. This was attributed to apoptosis and to heterophagy of effete germ line cells by the sustentacular tissue. It is concluded that demonstration of apoptosis by *in situ* hybridisation using the TUNEL method on sections of 1–4 days *in vivo* TCBZ-treated *F. hepatica* can contribute to the diagnosis of TCBZ resistance in field outbreaks of fasciolosis.

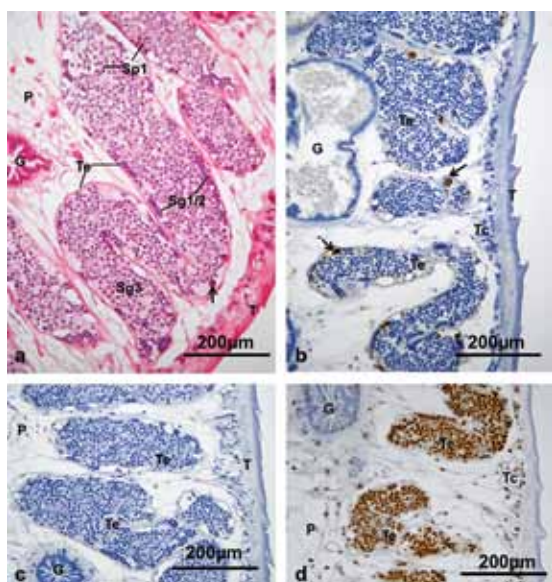


Figure 86: (a) *F. hepatica*, TCBZ-S Cullompton isolate, untreated, H&E stain. Clusters of primary and secondary spermatogonia (Sg1/2) occur at the periphery of the testis tubules (Te), while the most abundant cells present are tertiary spermatogonia (Sg3), which occupy most of the remaining space in the tubules. Abnormal primary spermatocytes (Sp1), often exhibiting pyknosis or karyorrhexis, are evident, but no secondary spermatocytes, spermatids or spermatozoa occur in flukes of this isolate. Occasional rounded eosinophilic bodies containing multiple dense nuclear fragments and probably representing apoptotic spermatocytes, occur throughout the tubules, often in peripheral

vacuoles (arrow). T = tegumental syncytium; G = gut; P = parenchyma. (b) *F. hepatica*, TCBZ-S Cullompton isolate, untreated, TUNEL reaction. Brown reaction product indicating sites of endonuclease-induced DNA strand breaks is associated with occasional large bodies (arrowed) that are mainly located in peripheral vacuoles of the testis tubules (Te). These apoptotic bodies correspond to rounded eosinophilic spermatocytes. G = gut; T = tegumental syncytium; Tc = tegumental cell bodies. (c) *F. hepatica*, TCBZ-S Cullompton isolate, untreated, TUNEL, negative control. No labelling is present over the testis tubules (Te), tegument (T), gut (G), parenchyma (P) or elsewhere. (d) *F. hepatica*, TCBZ-S Cullompton isolate, untreated, TUNEL, positive control. All nuclei in the section are labelled, including those of the testis (Te), gut (G), parenchyma (P) and tegumental cell bodies (Tc). The positive signal was generated by applying exogenous nuclease to the sections prior to labelling. (Photo: Bob Hanna, Reprinted from *Veterinary Parasitology* 191: 240-251 (2013), with permission from Elsevier).

Anthelmintic resistance in Northern Ireland (I): Prevalence of resistance in ovine gastrointestinal nematodes, as determined through faecal egg count reduction testing

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The prevalence of anthelmintic resistance in Northern Ireland sheep flocks was evaluated between July and October 2011. Sampling kits were sent to 172 flock owners and returns were received from 91. Within this survey population, 27 flock owners used benzimidazole products, 10 used levamisole products, 15 used avermectin products, 26 used milbemycin products and 4 flock owners used the amino acetonitrile derivative, Monepantel. The remaining 9 flock owners used combination drenches (broad spectrum wormer plus fasciolicide). However, 15 sets of samples were ineligible for faecal egg count reduction testing due to either too low an egg count or insufficient faecal volume. Treatment efficacy below 95%, indicating significant resistance, was detected in 81% (n=24) of flocks tested for benzimidazole resistance; in 14% (n=1) of flocks tested for levamisole resistance; and in 50% (n=7) and 62% (n=13) of flocks tested for avermectin and milbemycin resistance, respectively. Monepantel resistance was absent in all (n=3) flocks tested. Combination products (broad spectrum nematocide plus flukicide) containing levamisole were entirely effective, while treatment efficacy below 95% was detected in 60% (n=3) of flocks where the nematocide in the combination product was a benzimidazole. Where parasite identification based on coproculture was completed, *Trichostrongylus* was the dominant genus detected in all cases post-treatment, indicating the occurrence of anthelmintic-resistant *Trichostrongylus* spp. populations. Benzimidazole efficacy was highest in treating *Trichostrongylus* spp. (51%) and lowest when treating *Teladorsagia* spp. Levamisole was 100% effective in treating *Cooperia*, but ineffective (0%) in treating *Trichostrongylus* spp. Avermectin efficacy was highest when treating *Haemonchus contortus* (100%) and *Teladorsagia* spp. (73%), with a marginally lower efficacy against *Trichostrongylus* spp. (71%). Moxidectin efficacy was 33% against *Trichostrongylus* spp., 68%

against *Teladorsagia* spp., 97% against *Cooperia* spp. and 100% against *Haemonchus contortus* infections.

Anthelmintic resistance in Northern Ireland (II): Variations in nematode control practices between lowland and upland sheep flocks

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A questionnaire to obtain information on nematode control practices and sheep management was sent to over 1000 farmers in Northern Ireland. Replies were received from 305 flock owners, and data from 252 of them were analysed. Farms were divided into lowland and upland areas. Sizes of pasture and stocking rates on lowland and upland farms were 59.5 hectares, 6.99 sheep/hectare and 62.9 hectares and 10.01 sheep/hectare, respectively. Mean drenching rates for lambs and adults were 2.33 and 2.44, respectively, in lowland flocks and 2.73 and 2.71, respectively, in upland flocks. Between 2008 and 2011, the most frequently identified compounds in use were benzimidazoles and moxidectin in lowland flocks, and benzimidazoles and avermectins in upland flocks. Over the same period the most frequently identified commercial formulations were Tramazole®, Panacur® and Allverm® (white drench), Levacide® (yellow drench), Oramec®

(clear drench; avermectin), Cydectin® (clear drench; moxidectin) and Monepantel® (orange drench).

Most respondents (56.35%) treated their lambs at weaning and the most common time to treat ewes was identified to be pre-mating (67.86% of respondents).

The results of the questionnaire survey revealed that low and annual drench frequency was 2.33 and 2.44 in lambs and ewes, respectively, although drench frequencies were higher in upland flocks: 2.73 and 2.71 for lambs and ewes, respectively.

Annual drench rotation was practiced by 43.96% of flock owners, but whether this was true rotation or pseudo-rotation (i.e., substitution of one anthelmintic product by another product belonging to the same chemical group of anthelmintics) could not be explicitly determined.

Laboratories



Dublin



Stormont (Belfast)



Kilkenny



Athlone



Omagh



Sligo



Cork



Limerick

