An Roinn Talmhaíochta,
Bia agus Mara
Department of Agriculture,
Food and the Marine

AGRI-FOOD
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INSTITUTE

All-Island Animal Disease Surveillance Report

2023

This document has been compiled in collaboration with:

- Department of Agriculture, Food and the Marine of Ireland (DAFM)
- Agri-Food & Biosciences Institute, Northern Ireland (AFBI)
- Animal Health Ireland (AHI)

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Introduction

As we launch the All-Island Disease Surveillance Report, we find that animal disease surveillance has again, assumed increased importance and prominence on the island with Bluetongue cases detected in Great Britain, and yet another new Bluetongue virus serotype emerging on the near continent in the Netherlands. Epizootic Haemorrhagic Disease (EHD) continues to spread in France. At the same time we are reviewing the impact and spread of a modest resurgence in detection of another vector-borne virus, with Schmallenberg virus cases recurring in Ireland in 2023 as immunity waned after the last peak of detections in 2017/2018. While these diseases differ greatly in their clinical impact, mortality, morbidity and trade implications, they both serve to remind us of the mobility of viruses, especially vector-borne viruses in a globalised world. Awareness, vigilance, biosecurity and well-resourced surveillance systems are key to keeping our livestock safe, our export trade flowing, and our food chains secure. Underpinning all of this is enthusiastic stakeholder engagement. We need full participation by farmers and vets in all aspects of these control measures, and particularly in engaging fully with laboratory-based surveillance. Our scanning surveillance systems require judicious case selection and submission of quality *post mortem* material and samples, with the referring veterinarian playing a key role in ensuring that suspect cases are reported and tested, and that a good cross-section of all disease outbreaks presentations are referred for examination. A particular keystone submission class is the submission of foetuses (with placenta and maternal blood sample where possible) from abortion outbreaks. Abortion due to viraemia, septicaemia or pyrexia is a common outcome of many exotic diseases. Even if exotic disease is not involved, as is generally the case, the ever-increasing range of molecular firepower means we can screen for an ever-widening number of endemic pathogens, so that as well as early detection of incursion of exotic disease, foetal submissions have real potential to solve endemic disease puzzles, enhancing animal welfare and productivity. This is just one example of the range of diagnostic and surveillance activities across the two jurisdictions on the island that are ably summarised in this year's All-Island Disease Surveillance Report by the team of authors in Ireland and Northern Ireland, and we thank them for another fine publication.

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Preface

This All-Island Animal Disease Surveillance Report (AIADSR) marks the eighteenth edition of our annual report on animal disease surveillance, and the twelfth to be produced in collaboration with our partners at the Agri-Food and Bioscience Institute (AFBI), Northern Ireland, and Animal Health Ireland (AHI).

For the sixth consecutive year, we have relied primarily on R and LaTeX for data analysis and report compilation. These tools continue to serve as ideal platforms for processing, visualizing, and formatting complex datasets. For a second year, we've embraced Quarto—a modern, versatile evolution of R Markdown from Posit—which allows us to simultaneously produce both an HTML webpage and a PDF document with identical content. We trust that this approach helps showcase the surveillance efforts of the various institutions contributing to this report.

While the AIADSR is primarily aimed at Private Veterinary Practitioners, it is designed to serve a broader audience, providing essential animal health surveillance insights to a wide range of stakeholders. As in previous editions, we've made a concerted effort to present the data in an accessible manner, featuring numerous tables, vibrant charts, and photographs to clearly convey the information collected by the Veterinary Laboratory Service (VLS) of the Department of Agriculture, Food and the Marine (DAFM) and AFBI in Northern Ireland. The report captures only a small portion of the vast data generated by the collaborative work of the VLS, AFBI, and AHI.

The content presented here offers a representative snapshot of the critical animal disease surveillance work being conducted by the Veterinary Laboratory Services (DAFM), The Agri-Food and BioSciences Institute (AFBI), and Animal Helath Iraland (AHI) across the island of Ireland.

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Acknowledgements

The 2023 All-Island Animal Disease Surveillance Report (AIADSR) is the result of the collective efforts of a dedicated team from the Veterinary Laboratory Service (VLS) at the Department of Agriculture, Food and the Marine (DAFM) in Ireland, the Agri-Food and Bioscience Institute (AFBI) in Northern Ireland, and Animal Health Ireland (AHI). Alongside the veterinary officers, an invaluable network of colleagues, including laboratory technicians, clerical staff, and laboratory attendants, has provided essential support, making this report possible.

We would like to extend my sincere thanks to all those who contributed, both directly and indirectly, to the 2023 AIADSR. In particular, our gratitude goes to Alan Johnson (ex-Limerick RVL), Aideen Kennedy (Kilkenny RVL), and Ian Hogan (Limerick RVL) for their efforts in coordinating various sections of the report, offering invaluable advice, and meticulously proofreading the text. We also wish to thank Maria Guelbenzu and Liam Doyle from AHI, as well as Siobhan Corry and her team at AFBI, for their collaboration in this report.

Lastly, we wish to acknowledge the continuos support of Mícheál Casey (Director of the Regional Veterinary Laboratories) and our colleagues at the Cork Regional Veterinary Laboratory, Jim O'Donovan, Mercedes Gómez-Parada, and Ciara Hayes, whose encouragement and assistance have been vital throughout this project.

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Part I.

Cattle

1. Overview of Bovine Diseases

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1.1. Introduction

The Department of Agriculture, Food and the Marine (DAFM), through its laboratory network carries out part of its surveillance role by gathering data from carcass and clinical sample submissions made by farmers through the network of private veterinary practices. Data presented in this section relates to the most-common causes of death diagnosed in bovine carcasses submitted for *post mortem* examination during 2023. The data reflects those cases where the private veterinary practitioner has deemed it appropriate for the farmer to submit a carcass for *post mortem* examination and where the farmer has then taken the time to travel to the laboratory.

During 2023, 2356 bovine carcasses (excluding foetuses) were submitted for *post mortem* examination. The submitting herds have been categorised as 'dairy,' beef/suckler', and 'other' depending on their type (as defined in DAFM's Animal Health Computer System, the database used to manage animal welfare and disease monitoring and control). The 'other' category includes feedlot, dealer, and herds whose dominant enterprise is neither dairy, beef, nor suckler.

Information Note

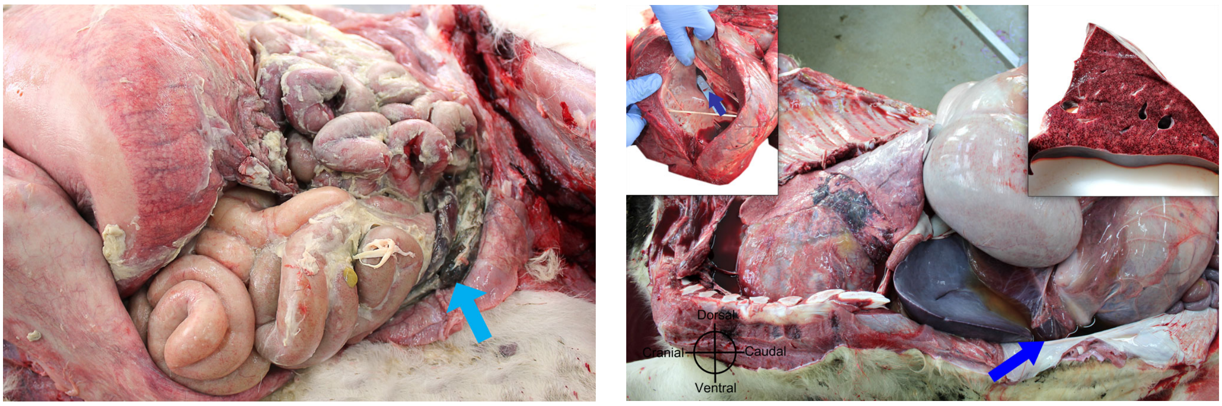
It should be noted that the examining pathologist can only assign one cause of death to each animal submission. In some cases, more than one system may be affected by disease e.g. a calf may have gross lesions of enteritis and pneumonia or joint ill end enteritis. If the lesions are not considered to be linked, as they might be in the case of a systemic infection (sepsis), then the pathologist assigns the cause of death to the condition considered to be the most significant

1.2. Neonatal Calves (birth to one month of age)

The most commonly diagnosed causes of death in this group are presented in Table 1.1 and Figure 1.3.

Gastrointestinal tract (GIT) infections continue to be the most commonly diagnosed cause of death in calves in 2023 at 25.6 *per cent* overall (Table 1.1 and Figure 1.3) which is marginally down on 2022 overall figure of 31.7 *per cent* which in turn is lower than the 2021 figure of 37.3 *per cent*. A closer look at the 2023 findings indicates that the rate of GIT infections for dairy calves was 32.8 *per cent* while for beef/suckler the figure was markedly lower at 19.4 *per cent* The common causes of the gastrointestinal infections are discussed in more detail in the chapter on neonatal enteritis.

As was the case in 2022, systemic infections were the next most common diagnoses after GIT infections. Such infections were associated with 20 *per cent* of the neonatal calf deaths. A systemic infection is spread via the haematogenous route and typically affects many organs. *E coli* septicaemias were the most commonly reported systemic infection, however *Salmonella spp.* and *Pasteurella spp.* infections were among the other pathogens detected. In 2023, systemic infections were marginally more common in dairy calves than beef calves (22 *per cent* dairy, 17.6 *per cent* beef/suckler)



(a) Omphalitis (navel-ill)

(b) Cardiac septal defect

Figure 1.1.: Fibrinous peritonitis (a) in a neonatal calf as a result of an umbilical infection (omphalitis, navel-ill). The arrow points to the swollen umbilical arteries. (b) Chronic passive congestion lesions caused be a cardiac septal defect in a neonatal calf (left inset). The liver is enlarged and has an accentuated lobular pattern (nutmeg pattern) shown in the right inset. There is also pulmonary oedema and ascitis (arrow). Photos: Cosme Sánchez-Miguel.

Colostrum management plays a vital role in calf health. Ensuring that the calf gets an adequate volume of high-quality colostrum in the first hours of life is an important management practice. Diseases associated with poor colostrum intake include navel ill/joint ill (Figure 1.1a, systemic infections, respiratory infections and CNS infections. Suckler calves were more likely to suffer from most of these conditions compared to dairy calves The divergence between the two groups of calves was most marked when it came to navel and joint ill (10.6 *per cent* beef/suckler, 2.1 *per cent* dairy). Suckler cows can be more difficult to hand-milk than dairy cows and moreover suckler cows tend to be less intensively managed and therefore it is unsurprising that the diseases associated with inadequate colostrum intake, poor absorption of colostrum antibodies and hypogammaglobulinaemia are more commonly seen in suckler calves.

In the hereditary and developmental abnormality category, 27 cases were recorded in the birth-to-one-month age category. Of these 27, 16 were circulatory in origin, mostly septal defects detected in the heart (Figure 1.1b). Five of the 27 were associated with the gastrointestinal tract (mostly atresia), three were neurological in origin (Figure 1.2) and two were abnormalities of the genito-urinary system.

Figure 1.2.: Congenital hydrocephalus in a neonatal calf. Note dilated thrid and lateral ventricles and the symmetrically enlarged and domed-shaped calvarium (inset). Photo: Cosme Sánchez-Miguel.

Table 1.1.: Conditions most frequently diagnosed on *post mortem* examinations of bovine neonatal calves in 2023 (n= 547).

Category	Beef/Suckler	Dairy	Other	Total	Percentage
GIT system infections	55	77	8	140	**25.6**
Systemic infections	50	52	5	107	**19.6**
Respiratory system infections	36	25	1	62	**11.3**
GIT ulcer, perforation and peritonitis	21	34	5	60	**11.0**
GIT torsion and obstruction	24	18	3	45	**8.2**
Navel and joint ill complex	30	5	1	36	**6.6**
Hereditary and developmental abnormalities	19	7	1	27	**4.9**
Other	11	5	1	17	**3.1**
Diagnosis not reached	9	5	0	14	**2.6**
Clostridial diseases	8	1	1	10	**1.8**
CNS conditions	5	2	2	9	**1.6**
Nutritional and metabolic conditions	4	4	0	8	**1.5**
Fractures and calving injuries	5	0	1	6	**1.1**
Urinary tract conditions	6	0	0	6	**1.1**

Note:
Categories that have less than five cases have been included in the 'Other' category.

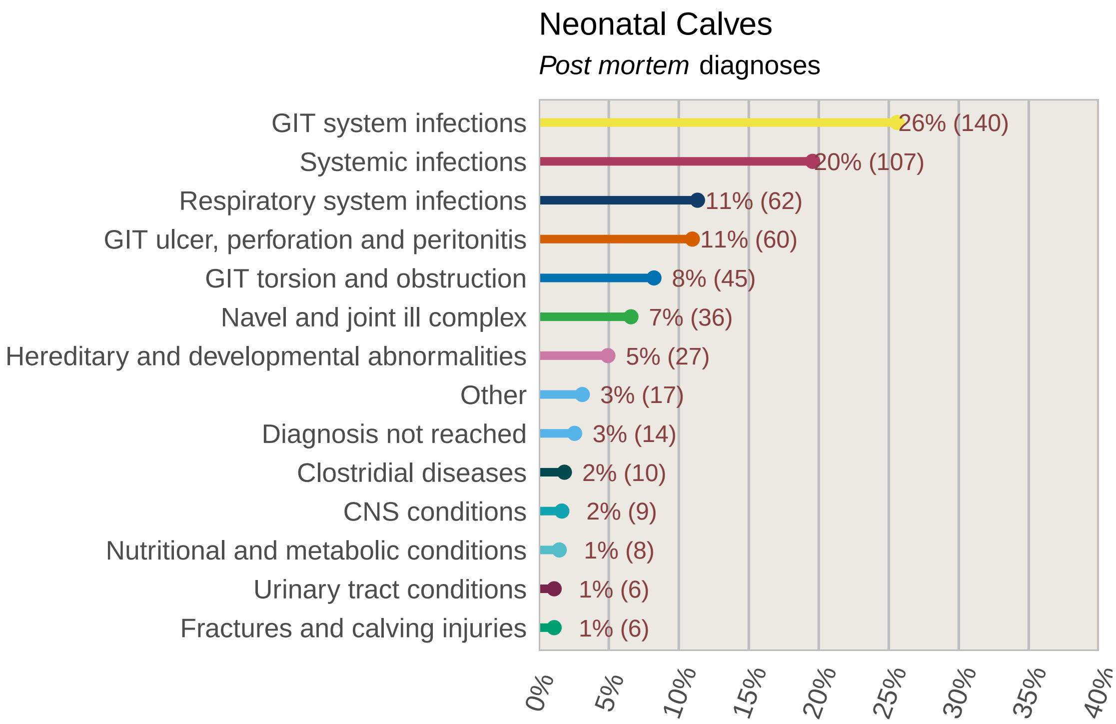
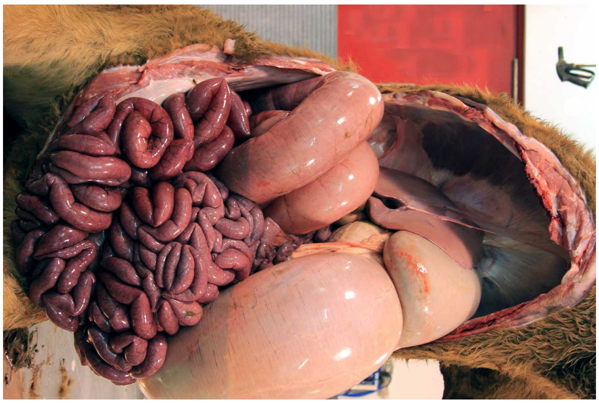


Figure 1.3.: Conditions most frequently diagnosed on *post mortem* examinations of bovine neonatal calves in 2023 (n=547). Note: Categories that have less than five cases have been included in the 'Other' category. The absolute number of cases is between brackets.

1.3. Calves (one to six months of age)

The most frequently diagnosed causes of death in this group are presented in Table 1.2 and Figure 1.6.

Respiratory infections were, by a considerable margin, the most common cause of mortality in the one-to-six-month-old calf age category in 2023. At 38.8 *per cent* (42 *per cent* beef/suckler and 34.6 *per cent* dairy), the figure was slightly higher that was seen in 2022 (34.2 *per cent*). The aetiology is discussed in more detail in the chapter



(a) Intestinal torsion

(b) Abomasal ulcer

Figure 1.4.: Gastro- Intestinal torsion/strangulation (a) in a young calf. Photo: Denise Murphy. Fatal peritonitis (b) as a result of a perforating abomasal ulcer (arrows) in a sukcler calf. Inset: abomasal mucosa. Photo: Cosme Sánchez-Miguel.

Table 1.2.: Conditions most frequently diagnosed on *post mortem* examinations of calves (1-6 months old) in 2023 (n= 738).

Category	Beef/Suckler	Dairy	Other	Total	Percentage
Respiratory system infections	178	94	14	286	**38.8**
GIT system infections	46	45	12	103	**14.0**
GIT torsion and obstruction	33	28	3	64	**8.7**
GIT ulcer, perforation and peritonitis	44	17	2	63	**8.5**
Systemic infections	24	13	2	39	**5.3**
Clostridial diseases	21	8	0	29	**3.9**
Diagnosis not reached	13	6	1	20	**2.7**
Nutritional and metabolic conditions	11	5	1	17	**2.3**
CNS conditions	7	7	1	15	**2.0**
Cardiac and circulatory conditions	11	1	1	13	**1.8**
GIT torsion/obstruction	1	12	0	13	**1.8**
Navel and joint ill complex	8	3	1	12	**1.6**
Tuberculosis	0	12	0	12	**1.6**
Urinary tract conditions	10	1	0	11	**1.5**
Hereditary and developmental abnormalities	4	5	0	9	**1.2**
Poisoning	3	6	0	9	**1.2**
Other	4	4	1	9	**1.2**
Liver disease	3	3	2	8	**1.1**
Tick-Borne Fever	5	1	0	6	**0.8**

Note:

Categories that have less than five cases have been included in the 'Other' category of Bovine Respiratory Diseases in Section 2.1

Gastro-intestinal infections (14 *per cent*) were the second most diagnosed cause of death in 2023, slightly down on 2022 (15.3 *per cent*). Of the 103 cases diagnosed, 18 were frequently associated with coccidiosis and 20 were associated with parasitic gastroenteritis. Cryptosporidiosis was found in 5 cases. *Salmonella spp.* was isolated from three cases and in 37 cases, though a gastro-intestinal infection was diagnosed as the cause of death, a specific infectious agent was not identified. This is not unusual and may be attributed to several reasons such as autolysis of the carcass or antimicrobial treatment of the calf prior to death.

(a) Yew (*Taxus baccata*) foliage

(b) Ragwort (*Jacobea vulgaris*) plant

Figure 1.5.: Fragment of a yew tree (a) found in the rumen of a weanling. These leaves are poisonous to cattle if ingested. Ragwort plant (b); Poisonous to cattle if ingested. Photo: Cosme Sánchez-Miguel.

Gastrointestinal torsions (Figure 1.4a) were diagnosed in 64 cases (8.7 *per cent* of the total). In such cases the history often describes the calves being found dead unexpectedly, with no prior clinical signs. GIT ulceration (Figure 1.4b) with or without perforation was diagnosed in 63 (8.5 *per cent*) calves. Once again, in many of these cases, the herdowner did not notice any unusual clinical signs prior to death and on *post mortem* examination a perforated abomasal ulcer with acute peritonitis and toxic shock was diagnosed.

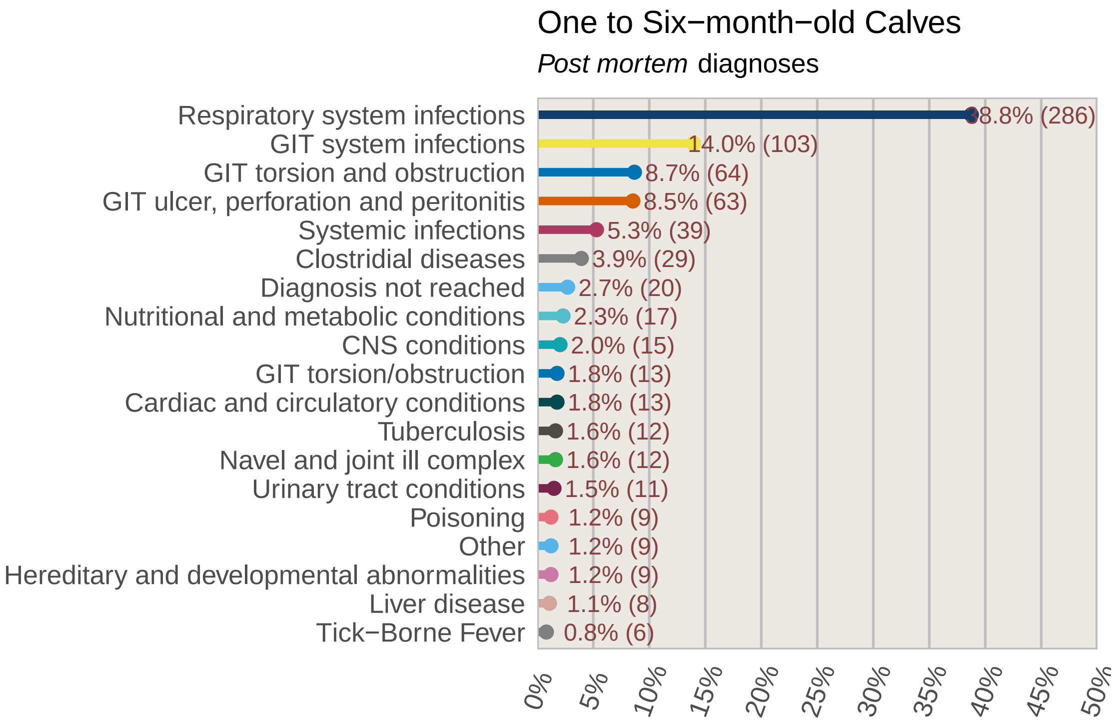


Figure 1.6.: Conditions most frequently diagnosed on *post mortem* examinations of calves (1–6 months old) in 2023 (n=738). Note: Categories that have less than five cases have been included in the ‘Other’ category. The absolute number of cases is between brackets.

Table 1.3.: Conditions most frequently diagnosed on *post mortem* examinations of weanlings (6-12 months old) in 2023 (n= 677).

Category	Beef/Suckler	Dairy	Other	Total	Percentage
Respiratory system infections	174	93	11	278	**41.1**
GIT system infections	62	63	9	134	**19.8**
Clostridial diseases	27	13	2	42	**6.2**
Systemic infections	25	17	0	42	**6.2**
Other	20	9	1	30	**4.4**
CNS conditions	22	7	0	29	**4.3**
GIT ulcer, perforation and peritonitis	14	9	1	24	**3.5**
Diagnosis not reached	15	7	1	23	**3.4**
Nutritional and metabolic conditions	17	3	0	20	**3.0**
GIT torsion/obstruction	5	8	3	16	**2.4**
Liver disease	3	8	1	12	**1.8**
Cardiac and circulatory conditions	6	3	1	10	**1.5**
Poisoning	8	1	1	10	**1.5**
Integument and musculoskeletal conditions	4	3	0	7	**1.0**

Note:
Categories that have less than five cases have been included in the 'Other' category.

Systemic infections were recorded in 39 cases (5.3 *per cent*). The leading causes of systemic infections recorded were *Salmonella spp.* in eight as the cause of death (*S.* Dublin in six cases & *S.* Typhimurium two cases). *Mannheimia haemolytica* was isolated in eight cases and *E. coli* infection was diagnosed in six cases. Among the other pathogenic agents found in systemic infections included *Histophilus somni*, *Pasteurella multocida* and *Trueperella pyogenes*.

Bovine tuberculosis was diagnosed in twelve calves examined during 2023. These calves were typically euthanased and submitted to the RVLs as part of investigations into large outbreaks of bovine tuberculosis.

There were nine poisonings recorded in this age group in 2023. Lead poisoning was diagnosed in four cases, yew tree (*Taxus baccata*) poisoning (Figure 1.5a) was found in three cases, copper poisoning was diagnosed in one case and selenium poisoning was found in one case.

1.4. Weanlings (six months to one year of age)

The most frequently diagnosed causes of death in this group are presented in Table 1.3 and Figure 1.8.

A total of 677 cattle in this age category (6—12 months old) were examined in 2023, a significant increase on the number of submissions in both 2022 (456) and 2021 (442). Respiratory infections were the most common cause of mortality in 2023. Overall, 41.2 *per cent* of deaths were caused by respiratory disease (43.2 *per cent* beef/suckler, 38.1 *per cent* dairy).

(a) Blackleg

(b) Reticuloperitonitis

Figure 1.7.: Heamorrhagic necrotising myositis (Clostridial myositis) (a) in the gluteal muscles of a weanling with Blackleg. Focal peritonitis (b) caused by perforating wire (inset) through the reticulum, causing traumatic reticuloperitonitis and chronic suppurative pericarditis (hardware-disease) in an adult bovine. Photos: Cosme Sánchez-Miguel.

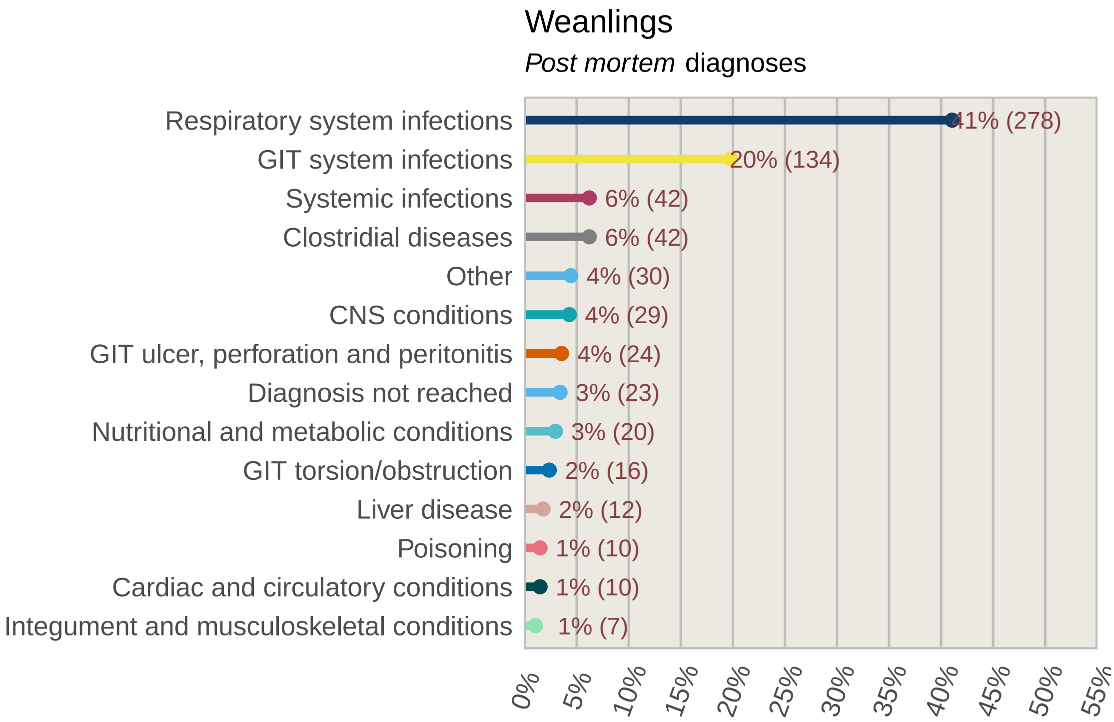


Figure 1.8.: Conditions most frequently diagnosed on *post mortem* examinations of weanlings (6–12 months old) in 2023 (n=677).Note: Categories that have less than five cases have been included in the 'Other' category. The absolute number of cases is between brackets.

Gastrointestinal infections accounted for 134 (19.8 *per cent*) of the deaths in this age category, a rate marginally higher than 2022 at 17.3 *per cent*. These include parasitic gastroenteritis (66 cases) and coccidiosis (7 cases).

Clostridial disease was the third most common diagnosis in this age category (42 cases, 6.2 *per cent*) Among the clostridial disease found, blackleg (Figure 1.7a) caused by *Clostridium chauvoei* was diagnosed in 23 cases and enterotoxaemia caused by *Clostridium perfringens* was diagnosed in nine cases.

Nine poisoning cases were diagnosed in weanling cattle in 2023, five of which were lead related, three were associated with copper toxicity while one was associated with ragwort.

CNS conditions were diagnosed as the cause of death in 29 weanling carcasses. The most diagnosed CNS

Table 1.4.: Conditions most frequently diagnosed on *post mortem* examinations of adult cattle (over 12 months old) in 2023 (n=463).

Category	Beef/Suckler	Dairy	Other	Total	Percentage
Respiratory system infections	44	27	4	75	**16.2**
GIT system infections	39	12	7	58	**12.5**
GIT ulcer, perforation and peritonitis	18	20	2	40	**8.6**
Diagnosis not reached	21	13	1	35	**7.6**
Cardiac and circulatory conditions	18	14	0	32	**6.9**
Systemic infections	14	14	2	30	**6.5**
Other	19	9	1	29	**6.3**
Nutritional and metabolic conditions	23	5	0	28	**6.0**
Babesiosis	19	4	1	24	**5.2**
Liver disease	11	8	3	22	**4.8**
Clostridial diseases	12	6	0	18	**3.9**
Poisoning	12	3	0	15	**3.2**
GIT torsion and obstruction	7	6	0	13	**2.8**
CNS conditions	5	2	1	8	**1.7**
Johne's Disease	5	3	0	8	**1.7**
Mastitis	3	4	0	7	**1.5**
Reproductive Tract Conditions	5	2	0	7	**1.5**
Trauma	2	5	0	7	**1.5**
Tumour	4	2	1	7	**1.5**

Note:
Categories that have less than five cases have been included in the 'Other' category.

condition was encephalitis/meningitis associated with bacterial infection which was found in 18 cases. Cerebrocortical necrosis (CCN) was the next most common diagnosis and was diagnosed in nine cases.

1.5. Adult Cattle (over 12 months of age)

The most frequently diagnosed causes of death in adult cattle are presented in Table 1.4 and Figure 1.9.

A cause of death was not established in 35 (7.5 *per cent*) of adult cattle carcasses examined during 2023. This may have been the result of autolysis affecting the quality of the *post mortem* examination or, as in the case of some metabolic conditions such as hypomagnesaemia, because the gross pathological changes may be minimal and biochemistry tests become increasingly unreliable at the time of *post mortem* examnation.

Respiratory infections were associated with 75 (16.2 *per cent*) of the deaths of adult cattle submitted during 2023, the rate of respiratory disease was slightly higher in dairy compared to beef suckler (15.6 *per cent* beef/suckler, 17 *per cent* dairy).

GIT system infection was the next most common cause of death, it was diagnosed in 58 cases (12.5 *per cent*). The most common diagnosis for GIT infections was parasitic gastroenteritis (26 cases, 45 *per cent*). Salmonellosis was the next single most diagnosed cause of GIT infections (five cases, 8.6 *per cent*).

GIT ulcer/perforation/peritonitis was the third most common cause of death in this category in 2023. Of the 40 deaths in this category, 11 were associated with traumatic reticulo-peritonitis (Figure 1.7b), a further ten were associated with abomasal ulceration.

Cardiac and circulatory conditions were the next most common cause of death in adults. A total of 32 deaths were recorded under this heading, a rate of 6.9 *per cent*. Seven of these deaths were caused by endocarditis (inflammation of the lining of the heart), three by myocarditis (inflammation of the heart wall), three by pericarditis (inflammation of the pericardial sac) and four by posterior vena caval thrombosis.

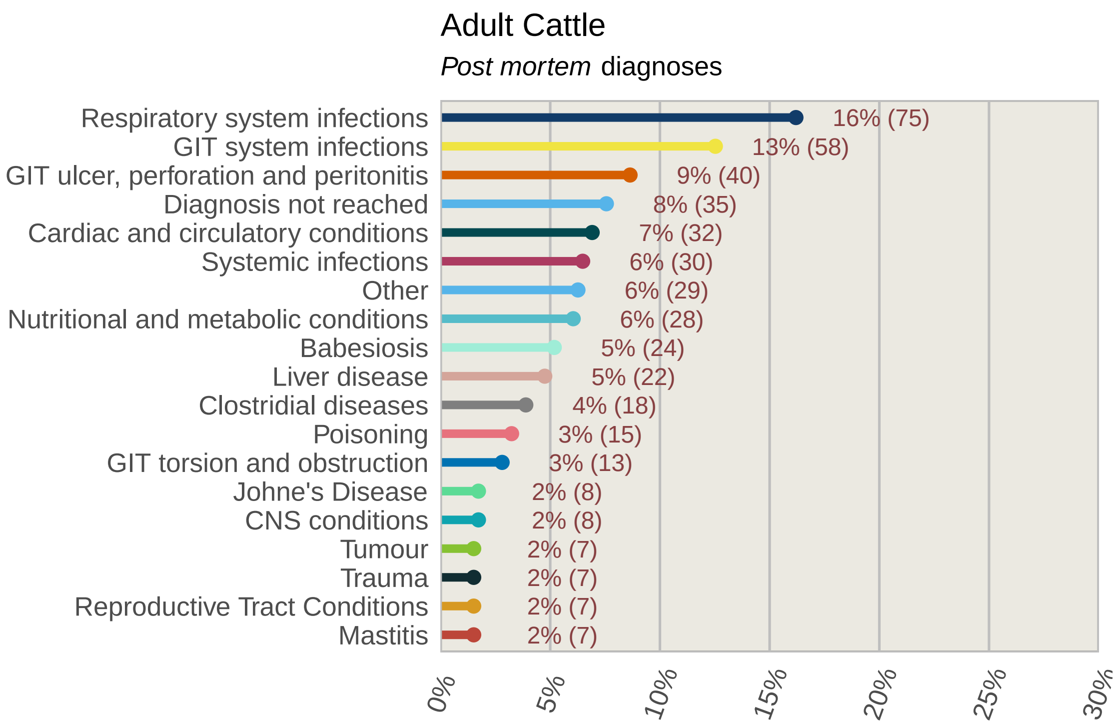


Figure 1.9.: Conditions most frequently diagnosed on *post mortem* examinations of adult cattle (over 12 months old) in 2023 (n=463). Note: Categories that have less than five cases have been included in the 'Other' category. The absolute number of cases is between brackets.

Nutritional/metabolic conditions were diagnosed in 28 (6.0 *per cent*) cases presented during 2023. Ruminal acidosis (16 cases) was the most common cause of death in this category, followed by hypomagnesaemia (eight cases), hypocalcaemia (two cases) fatty liver (one case) and bloat (one case).

Clostridial disease was diagnosed in 18 adult cattle (3.9 *per cent*), with most cases seen in beef/suckler cattle. Clostridial myositis (blackleg) caused by *Clostridium chauvoei* was diagnosed in nine cases, black disease caused by *Clostridium novyi* in five cases, botulism caused by *Clostridium botulinum* in two cases and malignant oedema in two cases. The cause of both cases of malignant oedema was found to be *Clostridium novyi*, the literature reports that malignant oedema may be due either to *Clostridium novyi* or *Clostridium septicum*.

CNS conditions were diagnosed in eight cases (1.7 *per cent*), a drop compared to the rate of CNS conditions found in 2022 (3.7 *per cent*). Of these, there were four cases of meningitis (*Listeria spp.* infection confirmed in 3/4 cases). There were three cases of encephalitis (One caused by *Listeria spp.*, one caused by *Histophilus somni*, while viral encephalitis was suspected in the third based on histology). One case of CCN was found in adult cattle.

Of the 15 cases (3.2 *per cent*) of poisoning recorded in adult cattle during 2023, six were linked with lead, six with ragwort (Figure 1.5b) and one with selenium. There were an additional two cases where neurohistopathology of tissues raised the suspicion of closantel poisoning.

Lead poisoning can have significant implications for a farm, and in particular dairy farms, where milk is being collected regularly. Entry of lead to the food chain (via milk or meat) must be avoided for public health reasons. When a case of lead poisoning is diagnosed a risk assessment is carried out on the farm to determine the risk of entry of lead-contaminated food products into the food chain. Steps are then taken which may involve the dairy inspectorate, district veterinary office, milk processor and the laboratory service to ensure that the risk is minimized. Movement restrictions may be placed on animals in the herd until it is determined that lead levels have returned to a safe level.

2. Bovine respiratory disease

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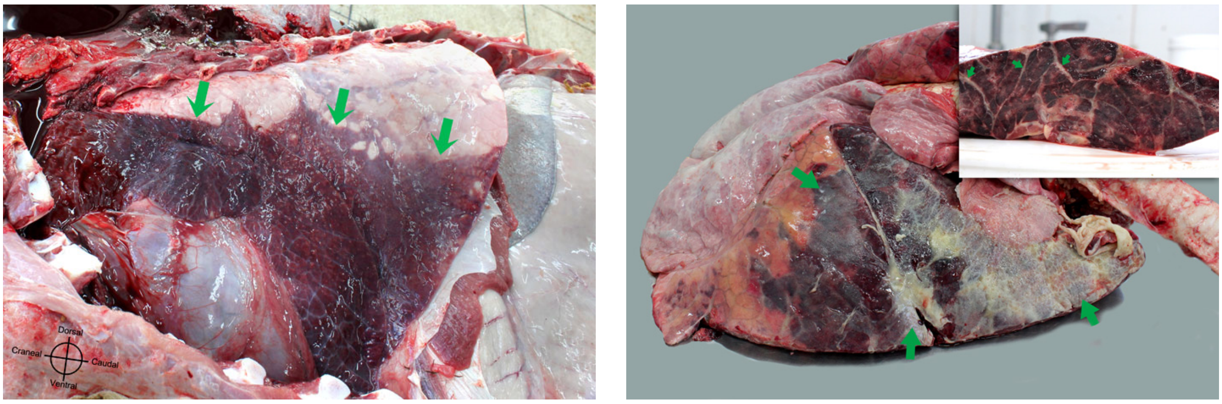
2.1. Overview

Bovine respiratory diseases (BRD) form a broad group of diseases with multiple aetiologies, some usually overlapping in the same animal. It is one of the most common diagnoses in the bovine submissions to the Regional Veterinary Laboratories, representing approximately 21 *per cent* of the annual bovine submissions (ranging from 16 *per cent* to 27 *per cent* in the last ten years). This group includes diseases causing pneumonia primarily as the main pathology and some causing pathology somewhere in the respiratory tract (upper respiratory tract conditions). Systemic diseases causing an indirect respiratory system involvement have been excluded in this category.

BRDs are usually the result of complex interactions between different agents and circumstances; therefore, selecting a single aetiological diagnosis is always difficult. The pathologist must record the final diagnosis considering the gross lesions and the final results; however, the multi-factorial nature of BRD and the challenges of classifying them into a single aetiology must be considered by the reader and view the figures presented in this chapter cautiously. In addition, the chronic progression of some respiratory diseases with likely secondary bacterial invasion may lead to an overrepresentation of bacterial causes (Table 2.1 and Table 2.2).



(a) Suppurative bronchopnemonia (b) Fibrinous bronchopneumonia

Figure 2.1.: Theses two types of pneumonia are the most common in cattle in Ireland: (a) suppurative cranioventral bronchopneumonia, and (b) fibrinous bronchopneumonia. The inset shows the cut surface, the pulmonary parenchma apperar dark (coagulative necrosis) and the interlobular septa distended by proteinaceous fluid and fibrin.Photos: Cosme Sánchez-Miguel.

In most instances, BRD is presented as a herd problem, and the diagnostic investigation of the outbreak requires a comprehensive approach involving sampling multiple animals, adequate sampling, and careful clinical history documentation. Success also depends on factors such as timely sampling, representative animals, and preventing interference from vaccination or maternal antibodies.

Post mortem examinations are crucial for identifying lesion patterns and potential causes, while laboratory testing, including serology aids in confirming diagnoses and assessing disease severity. *Post mortem* examinations provide comprehensive insights and robust diagnoses, though they may be limited by the representativeness of

Table 2.1.: Number of cases by a broad aetiology in the diferent group ages. (n=696).

Aetiology	Neonatal (0-1 month old)	Calves (1-6 months old)	Weanling (6-12 months old)	Adult Cattle (over 12 months old)	Total
Bacterial	34 (57.6)	209 (73.3)	154 (55.4)	47 (63.5)	**444 (63.8)**
Parasitic	0 (0.0)	36 (12.6)	77 (27.7)	15 (20.3)	**128 (18.4)**
Viral	15 (25.4)	29 (10.2)	35 (12.6)	5 (6.8)	**84 (12.1)**
No agent identified	10 (16.9)	11 (3.9)	12 (4.3)	7 (9.5)	**40 (5.7)**

the sampled animals and the timing of the disease course. Overall, a meticulous approach incorporating clinical, *post mortem*, and laboratory assessments is essential for effective diagnosis and management of bovine respiratory disease.

2.2. Classification of Pneumonia

Pneumonia in cattle can be broadly categorised into several pathology types based on their gross and microscopic lesions, the most common in catter are:

Bronchopneumonia is the most common form in cattle (Figure 2.1a). It typically results from inhalation of infectious agents such as bacteria or viruses and is characterised by inflammation of the bronchi and bronchioles, often extending into adjacent alveoli. Lesions are usually multifocal with craneoventral distribution and involve various pulmonary lobes (bilateral). Bacterial bronchopneumonia is commonly caused by organisms like *Mannheimia haemolytica*, *Pasteurella multocida*, and *Histophilus somni*.

Interstitial Pneumonia involves inflammation primarily in the interstitial tissue of the lungs, which includes the connective tissue between the alveoli and the blood vessels. They are diffuse, affected lungs may appear 'meaty', firm and rubbery, with areas of consolidation and thickening of interstitial tissue. The may progress to a bronchointerstitial pneumonia. This type of pneumonia can result from viral infections such as bovine respiratory syncytial virus (BRSV), parainfluenza (PI3) and IBR (BHV-1) and is also seen focally in lungworm pneumonia.

Fibrinous Pneumonia (Figure 2.1b) is characterised by the deposition of fibrin within the alveoli, leading to the formation of a fibrin exudate. Fibrinous pneumonia can lead to the development of consolidated areas within the lungs (lytic necrosis). This type of pneumonia can result from severe inflammation and vascular damage. It is often associated with certain bacterial infections, such as those caused by *Mannheimia haemolytica* or *Pasteurella multocida*.

Granulomatous pneumonia, less common, is characterised by the formation of granulomas, discrete nodules within the lung parenchyma. These granulomas consist of aggregates of macrophages, surrounded by a rim of lymphocytes. They are normally seen in fungal pneumonia and as a result of TB (*Mycobacterium bovis*)

Embolic pneumonia refers to random multifocal nodules caused by septic emboli characterised by firm white foci surrounded by halo of congestion that may develop into small abscesses (Figure 2.2a). They are originated by embolism or bacteremia from the heart (endocarditis), liver (hepatic abscess into the caudal vena cava), jugular veins (thromboflevitis), navel (omphalophebatis), hoof (chronic hoof infections) and uterus (metritis). The organisms isolated are suppurative nature, *T. pyogenes*, *Streptococus spp*, etc.

2.3. Parasitic bovine respiratory disease

Parasitic pneumonia is due to lungworms (*Dictyocaulus viviparus*) in cattle (Figure 2.2b). The clinical and pathologic manifestations of dictyocaulosis depend on the stage of infection, the host's immunity level, and the number

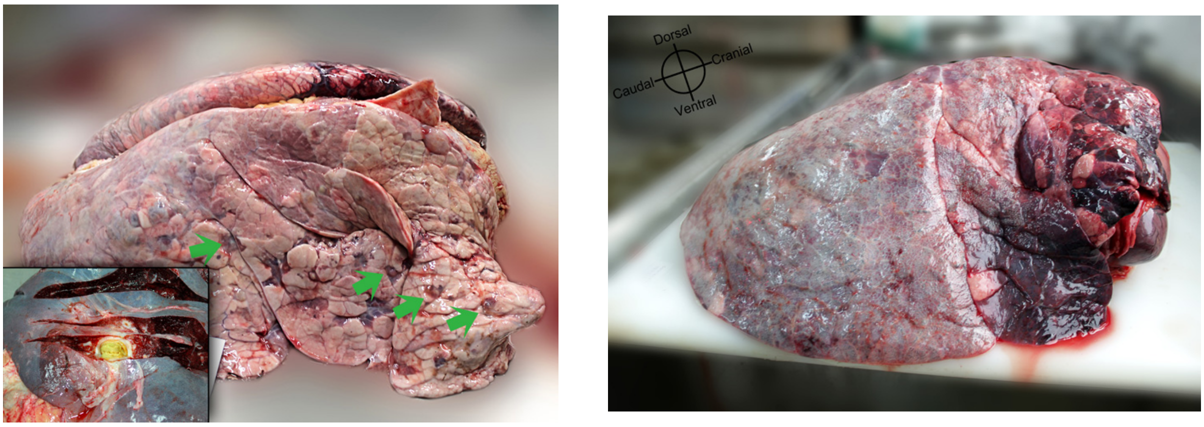
Table 2.2.: Number of cases and relative frequency of the top ten pathogenic agents detected in BRD cases diagnosed on *post-mortem* examination by herd category across all age groups (n= 696).

Organism	Dairy	Beef/Suckler	Other	No. of cases	Percentage
Dictyocaulus spp	46	73	9	128	**18.4**
Mannheimia haemolytica	46	65	4	115	**16.5**
Histophilus somni	31	76	2	109	**15.7**
Pasteurella multocida	36	46	7	89	**12.8**
Mycoplasma bovis	19	45	0	64	**9.2**
RSV	19	35	0	54	**7.8**
Other minor organisms	5	38	4	47	**6.8**
No agent identified	16	23	1	40	**5.8**
Trueperella pyogenes	4	8	2	14	**2.0**
IBR virus	4	7	0	11	**1.6**
PI3	5	5	1	11	**1.6**

Table 2.3.: Count and percentage by age goup of the general specific organisms detected in BRD on *post mortem* examination, (n=696).

Aetiology	Neonatal (0-1 month old)	Calves (1-6 months old)	Weanling (6-12 months old)	Adult Cattle (over 12 months old)	Total
Pasteurella multocida	11 (18.6)	39 (13.7)	31 (11.2)	8 (10.8)	**89 (12.8)**
Mycoplasma bovis	2 (3.4)	41 (14.4)	19 (6.8)	2 (2.7)	**64 (9.2)**
RSV	6 (10.2)	18 (6.3)	27 (9.7)	3 (4.1)	**54 (7.8)**
Bibersteinia trehalosi	1 (1.7)	1 (0.4)	2 (0.7)	1 (1.4)	**5 (0.7)**
Other minor organisms	5 (8.5)	24 (8.4)	11 (4.0)	7 (9.5)	**47 (6.8)**
No agent identified	10 (16.9)	11 (3.9)	12 (4.3)	7 (9.5)	**40 (5.7)**
BVD virus	2 (3.4)	0 (0.0)	0 (0.0)	1 (1.4)	**3 (0.4)**
Mycobacterium bovis	0 (0.0)	1 (0.4)	1 (0.4)	0 (0.0)	**2 (0.3)**
Salmonella spp.	0 (0.0)	0 (0.0)	2 (0.7)	0 (0.0)	**2 (0.3)**
Trueperella pyogenes	2 (3.4)	6 (2.1)	2 (0.7)	4 (5.4)	**14 (2.0)**
Dictyocaulus spp	0 (0.0)	36 (12.6)	77 (27.7)	15 (20.3)	**128 (18.4)**
Mannheimia haemolytica	4 (6.8)	48 (16.8)	44 (15.8)	19 (25.7)	**115 (16.5)**
IBR virus	5 (8.5)	3 (1.1)	2 (0.7)	1 (1.4)	**11 (1.6)**
PI3	1 (1.7)	5 (1.8)	5 (1.8)	0 (0.0)	**11 (1.6)**
Histophilus somni	9 (15.3)	51 (17.9)	43 (15.5)	6 (8.1)	**109 (15.7)**
Pasteurella spp	1 (1.7)	0 (0.0)	0 (0.0)	0 (0.0)	**1 (0.1)**
Salmonella dublin	0 (0.0)	1 (0.4)	0 (0.0)	0 (0.0)	**1 (0.1)**

of invading larvae. In May & June the parasite can cause acute *pre-patent* disease due to larval migration, normally seen in dairy calves at grass. The lungs are diffusely red, oedematous, and firm, indicating interstitial pneumonia. Over the summer, it progresses to the patent stage and adult larvae may be present in the caudal bronchi; the lungs show lobular atelectasis, and emphysema, especially in dorsocaudal areas. This will be followed by a *post-patent* phase with secondary infection setting in some of the original lesions, leading to bronchopneumonia and permanent lung injury. Few or no adult worms are detected in this phase.



(a) embolic/septic pneumonia

(b) Parasitic pneumonia

Figure 2.2.: Random haemorrhagic foci (arrows) scattered throughout the pulmonary lobes representing septic emboli (embolic pneumonia) (a) caused by a liver abscess (inset) that eroded into the caudal vena cava (vena caval thrombosis). Diffuse emphysema and multifocal atelectasis in a bullock as a result of parasitic pneumonia. Photos: Cosme Sánchez-Miguel.

Diagnosis of *pre-patent* infection relies on epidemiological information (time of the year, age of the animals, breed, management practices, temperatures, rainfall,etc.) and histopathology of the lesions; the larvae are not normally seen in histological sections and aere not *patent* in the parasitological preparation of intestinal content. Once the patent phase is established, the adult larvae can be identified in the bronchi. Figure 2.3 shows the annual distribution of cases.

Though the Baermann test is carried out to detect the larvae in faeces, its sensitivity is low (ranging from 58.7 per cent to 80 *per cent* depending on the season (Ploeger et al. 2012), and it is not effective in *pre-patent* or *post-patent* stages. It is essential to be aware that a negative Baermann test result doesn't represent the absence of *D. viviparous* based on the test sensitivity and the phase of infection.

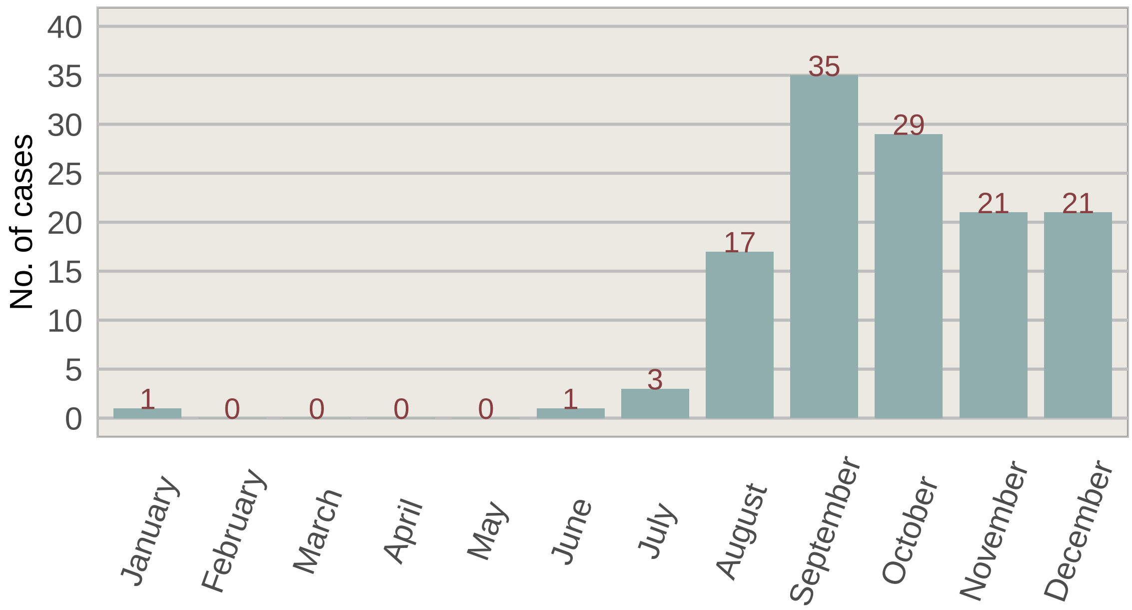


Figure 2.3.: Number of diagnoses of parasitic pneumonia by month during 2023 (n=128).

3. Bovine Abortion

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3.1. Introduction

Bovine abortion, stillbirth and perinatal mortality are common issues in cattle populations worldwide. A widely accepted definition of abortion is foetal death after 42 days and before 260 days' gestation. Stillbirth is defined as birth of a dead, full term (i.e. more than 260 days in gestation) calf. Perinatal mortality encompasses death of a calf during parturition or up to 48 hours afterwards, so there is some overlap between this and stillbirth. These distinctions can be important factors when considering the aetiology of these conditions.

An abortion rate of 3–5 *per cent* may be considered 'normal'. Above this, or if a number of abortions occur within a herd over a short space of time, investigation is warranted. Laboratory-based diagnostics play a vital role in the diagnosis and mitigation of abortion, stillbirth and perinatal mortality issues. However, they are only one part of the investigative process, which should also include thorough history taking, assessment of cow management and environment and peripartum management, as appropriate. Although the findings reported here are primarily the results of testing for infectious disease, it is important to note that not all foetal or perinatal death is due to infectious agents. There are a wide range of non-infectious causes, including dystocia, dam nutrition, plant and mycotoxin ingestion, hormonal, physical and genetic factors.

Zoonotic risks

Many of the pathogens that cause abortion in cattle can also cause serious disease in humans. Some can even be shed during apparently normal parturition. Appropriate protective measures, including personal protective equipment and disinfection, should be put in place. This refers not only to aborted and stillborn cases, but when assisting any calving.

There were 1266 bovine abortion, stillbirth and perinatal mortality cases submitted to the Veterinary Laboratory Service (VLS) in 2023. This figure includes whole carcasses, part carcasses (e.g. foetal stomach contents only), and placentas submitted without a carcass.

3.2. Non-Diagnostic Rate

Of all bovine abortion, stillbirth and perinatal mortality cases submitted, 696 (55 *per cent*) were not diagnosed. This figure reflects the difficulty in achieving a diagnosis in cases of this type and is comparable to other international studies (Wolf-Jäckel et al. 2020). As mentioned, many cases of abortion, stillbirth and perinatal mortality are not associated with infection. These can be difficult to diagnose in a laboratory context.

Table 3.1.: Frequency of detection of *Neospora caninum* in 2023.}

Pathogen	Total No. Tests	No. Positive	Percentage Positive
Neospora caninum	763	64	**8.4**

3.3. Protozoal pathogens

Neospora caninum is the primary protozoal pathogen associated with bovine abortion, stillbirth and perinatal mortality. It is one of the most common causes of both sporadic foetal deaths and abortion storms in cattle, and may be the most common in the world (Mee et al. 2023). The life cycle is indirect, with canids and bovines the definitive and intermediate hosts, respectively. Cattle can be infected through ingestion of oocysts in feed or water contaminated with dog faeces. However, the major route through which infection is maintained in a herd is vertical, with infection passing from dam to calf in utero.

A PCR test for *N. caninum* is now available in the RVL service and is carried out on swabs of brain tissue. *N. caninum* DNA was found in 8.4 *per cent* of tests carried out (Table 3.1), making it one of the most common abortifacients identified during 2023. There is no effective treatment or vaccine for *N. caninum* currently available. Control is dependent on identification of infected cows through serology, applying culling or selective breeding policies, and limiting access of dogs to cattle areas and material associated with calving (e.g placenta).

3.4. Routine Culture Results (excluding *Salmonella spp.*)

Material from all suitable cases is subjected to routine culture methods. As some cases had more than culture carried out, 1447 routine culture results were available for the 1266 cases. Coliforms were the most common culture result at 14.7 *per cent*. Although these bacteria can cause sporadic foetal death and are a common cause of infection in neonatal calves, their significance in individual cases can be difficult to determine. This is because their presence may be due to faecal contamination, which is common in foetal submissions.

Trueperella pyogenes was the next most common bacterial species identified in cultures from Dairy (8.6 *per cent*) and Other (8.8 *per cent*) herds. It is a common finding in purulent infections of cattle, and is assumed to reach the foetus haematogenously from another focus of infection in the dam. In Beef/Suckler herds, *Bacillus licheniformis* was more common than *T. pyogenes* at 5.7 *per cent* of all foetus culture results from this herd type.

Other bacteria isolated from cases in 2023 are listed in Table 3.2. The significance of some of these isolates can be difficult to determine. Some, as for coliforms, may be the result of faecal or environmental contamination of the sample. Others may be secondary pathogens which have had the opportunity to cross the placenta due to compromise for another reason. Species such as *Proteus spp.* proliferate rapidly *post mortem*, and may obscure the presence of the pathogen actually responsible for foetal or perinatal death. *Aspergillus spp.* were the most common fungal pathogen isolated at one *per cent* of all culture results.

3.5. *Salmonella* Culture Results

Salmonella culture involves a different process to routine culture, and so the results are considered separately here. 1234 *Salmonella* culture results were available for the 1266 foetal and perinatal cases submitted. Of these, 41 (3.3 *per cent*) were positive. The vast majority of these were *Salmonella* Dublin. Of the remainder, *Salmonella* Typhimurium was cultured from one foetus and *Salmonella* Kottbus from another (Table 3.3)

Table 3.2.: Frequency of detection of non-*Salmonella* bacterial species in routine cultures carried out on bovine foetal material in 2023.

Culture Result	No. Positive Culture Results from Beef/Suckler Herds	Positive Culture Results as a Percentage of Total Culture Results from Beef/Suckler Herds	No. Positive Culture Results form Dairy Herds	Positive Culture Results as a Percentage of Total Culture Results from Dairy Herds	No. Positive Culture Results from Other Herds	Positive Culture Results as a Percentage of Total Culture Results from Other Herds	Total No. Positive Culture Results	Positive Culture Results as a Percentage of Total No. of Culture Results
No Significant Growth	221	63.3	578	60.1	79	58.1	878	60.7
Coliforms	63	18.1	135	14.0	15	11.0	213	14.7
Trueperella pyogenes	14	4.0	83	8.6	12	8.8	109	7.5
Bacillus licheniformis	20	5.7	36	3.7	9	6.6	65	4.5
Listeria monocytogenes	8	2.3	29	3.0	2	1.5	39	2.7
Streptococcus spp.	6	1.7	26	2.7	6	4.4	38	2.6
Aspergillus spp.	7	2.0	10	1.0	3	2.2	20	1.4
Bacillus spp.	1	0.3	15	1.6	1	0.7	17	1.2
Other minor organisms	2	0.6	12	1.2	2	1.5	16	1.1
Staphylococcus spp.	2	0.6	12	1.2	2	1.5	16	1.1
Streptococcus spp	1	0.3	10	1.0	1	0.7	12	0.8
Pseudomonas spp.	0	0.0	6	0.6	2	1.5	8	0.6
Yeasts and Fungi	2	0.6	6	0.6	0	0.0	8	0.6
Listeria spp.	2	0.6	1	0.1	0	0.0	3	0.2
Mannheimia haemolytica	0	0.0	3	0.3	0	0.0	3	0.2
Bibersteinia trehalosi	0	0.0	0	0.0	1	0.7	1	0.1
Pasteurella multocida	0	0.0	0	0.0	1	0.7	1	0.1
Total	349	-	962	-	136	-	1447	100.0

Table 3.3.: Number of *Salmonella*-positive cultures as a percentage of total *Salmonella* cultures carried out on bovine foetal material in 2023.

Herd Type	Total No. of Cultures	No. Positive Cultures	Percentage Positive
Beef/Suckler	303	**5**	1.6
Dairy	817	**31**	3.8
Other	114	**5**	4.4
Total	1234	**41**	3.3

Table 3.4.: Frequency of detection via PCR of selected bacterial agents in bovine foetal material during 2023.

Pathogen	Total No. Tests	No. Positive	Percentage Positive
Anaplasma phagocytophilum	888	8	**0.9**
Campylobacter fetus	887	2	**0.2**
Chlamydia spp.	887	5	**0.6**
Coxiella burnetii	893	49	**5.5**
Leptospira pathogenic serovars	887	9	**1.0**
Listeria monocytogenes	887	37	**4.2**
Salmonella spp.	887	28	**3.2**

Table 3.5.: Frequency of detection via PCR of viruses in foetal material in 2023.

Virus	Total No. Tests	No. Positive	Percentage Positive
BHV-1	38	1	**2.6**
SBV	61	1	**1.6**
Pestivirus	82	0	**0.0**
BTV	34	0	**0.0**
BHV-4	927	18	**2.0**

3.6. Bacterial PCR results

PCR can allow detection of specific pathogens not usually identifiable through routine culture methods. Bacterial pathogens for which there are PCR tests available within the Veterinary Laboratory Service include *Anaplasma phagocytophilum*, *Campylobacter foetus*, *Chlamydia spp.*, *Coxiella burnetii*, *Leptospira spp.* pathogenic serovars, *Listeria monocytogenes* and *Salmonella spp.*. These tests are generally applied as a package, which also includes BHV-4 (see below). There is some overlap between the tests included in the package and those which can be detected via culture methods.

The most common bacterial pathogen identified via PCR in foetal and perinatal cases was *Coxiella burnetii* (5.5 *per cent*)(Table 3.4). However, this can be shed by infected cows during normal parturition, so its presence alone cannot be considered conclusive proof that it was the cause of foetal death. This finding must be considered alongside histopathology of the placenta, individual animal and bulk milk serology and herd history in evaluating its significance. *C. burnetii* can cause a dangerous zoonotic disease called Q Fever, and it is important that appropriate protective measures are taken by anyone assisting calvings in infected herds.

3.7. Viral PCR Results

Viruses associated with bovine foetal death include bovine herpesvirus-1 (BHV-1), bovine herpesvirus-4 (BHV-4), bovine virus diarrhoea virus (BVD), Schmallenberg virus (SBV) and Bluetongue virus (BTV). BHV-1, BHV-4 and SBV were detected in small numbers (Table 3.5). The greater number of BHV-4 tests carried out reflects its inclusion in the PCR package mentioned above. The role of BHV-4 in reproductive disorders of cattle is currently unclear. The single positive SBV result is of note, as it coincides with increased detection in ovine foetuses this year.

4. Bovine Neonatal Enteritis

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4.1. Overview

Diarrhoea resulting in dehydration, electrolyte depletion and metabolic acidosis remains the main cause of mortality in neonatal calves.

Several infectious agents have been associated with diarrhoea in calves less than four weeks old (Figure 4.1). Frequently combinations of these agents can occur with the co-infections often appearing more severe. Animal Health Ireland's website provides several useful *Calf Care*[1] information leaflets including management of the scouring calf.

To facilitate appropriate management and prevention, accurate identification of the underlying aetiological agent is required. Many of the agents however are only transiently present which hinders diagnosis, therefore ideally submissions of carcasses for postmortem along with samples from multiple untreated animals in the early stages of the disease, and representative of the herd problem should be submitted. Non-infectious causes of diarrhoea should also be considered such as nutritional or management problems. Failure of passive transfer of immunoglobulins is a key risk factor in developing neonatal enteritis, and investigations of outbreaks should always include an assessment of passive transfer.

It should also be noted that some of the pathogens causing neonatal enteritis pose a potential zoonotic risk.

[1] https://animalhealthireland.ie/programmes/calfcare/

Table 4.1.: Number of tests and relative frequency of enteropathogenic agents identified in faecal samples of calves up to one month of age in 2023.

Organism	No. of Tests	Positive	Percentage
Rotavirus	1166	248	**21.3**
Cryptosporidia	1200	188	**15.7**
Campylobacter jejuni	939	94	**10.0**
Giardia	801	31	**3.9**
E.Coli K99	811	19	**2.3**
Salmonella Dublin	1143	15	**1.3**
Coronavirus	1142	11	**1.0**

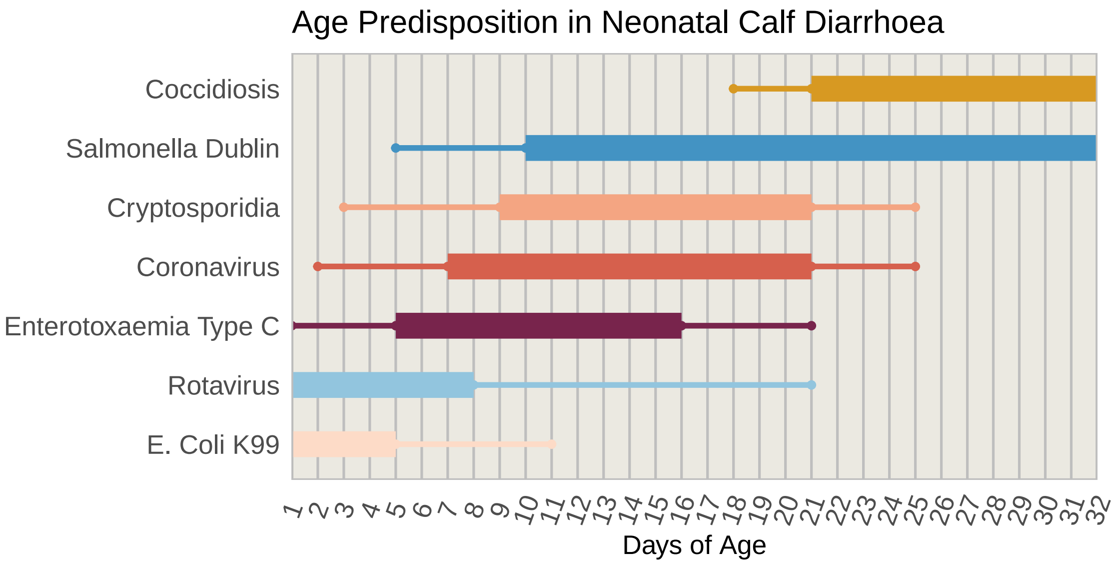


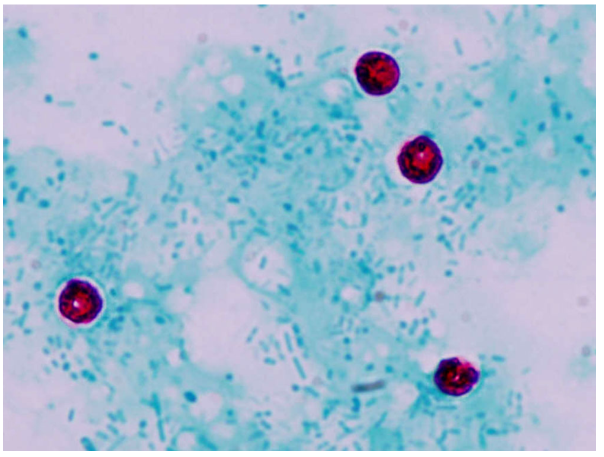
Figure 4.1.: Agent and age predisposition in neonatal calf diarrhoea, the thick area represents the most likely period of disease.

4.2. Rotavirus

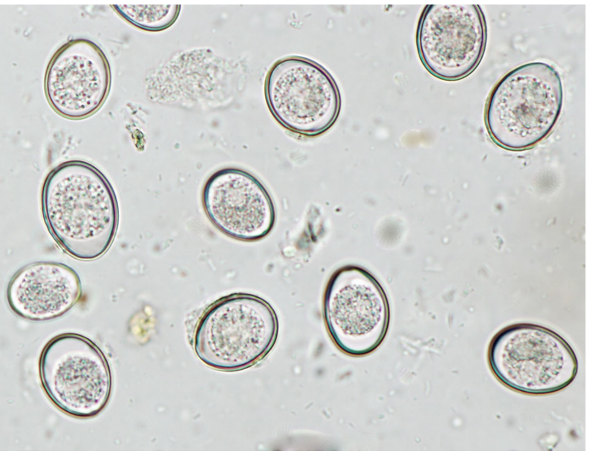
Rotavirus remained the most prevalent agent detected in neonatal enteritis cases in 2023. It was detected in 21.3 *per cent* of samples, a reduction from the 27 *per cent* reported in 2022 (Figure 4.3). Calves are most susceptible to rotavirus enteritis between one and three weeks of age (Figure 4.1). Adult animals are the primary source of rotavirus infection for calves. The severity of clinical signs depends on many factors including the immune status of the calf. Diarrhoea usually lasts between four to eight days. Fever can be present and the calves are usually dull and reluctant to drink. Rotavirus targets the villi in the upper small intestine causing shortening and fusion of villi which results in malabsorption leading to diarrhoea. Death may ensue due to acidosis, dehydration and starvation. Control is directed towards preventative measures such as hygiene and adequate colostrum management; specific control measures include vaccination of cows pre-calving, a method which is extremely reliant on the transfer of immunity via colostrum.

4.3. *Cryptosporidium parvum*

Cryptosporidium parvum (Figure 4.2a) was detected in 15.7 *per cent* of samples in 2023, a reduction from 20 *per cent* reported in 2022. The parasite causes damage to the epithelial cells of the lower small intestine resulting in mild to severe enteritis. Transmission between animals is by the faecal-oral route, often via a contaminated environment. Affected calves excrete large numbers of oocysts which are highly resistant and can survive in the environment up to several months under favourable conditions. Control of the parasite is best achieved by strict maintenance of good calf housing hygiene practices and avoiding mixing animals of different ages. Ammonia-based disinfectants are most effective. Affected animals should always be isolated from healthy animals. Calf rearing houses should be cleaned on a regular basis, and an all in all out policy should be used The prophylactic use of drugs such as halofuginone lactate may also be useful. Vaccines are also in development. In addition to causing disease in animals, *Cryptosporidium spp.* have the potential to cause zoonotic disease especially in immunocompromised people.



(a) Cryptosporidia



(b) Coccidia

Figure 4.2.: Cryptosporial oocysts (a) in the faecal sample on modified Ziehl-Neelsen staining in a neonatal calf. Coccidial ocysts (b) in a neonatal calf with enteritis (sugar flotation). Photos: Cosme Sánchez-Miguel.

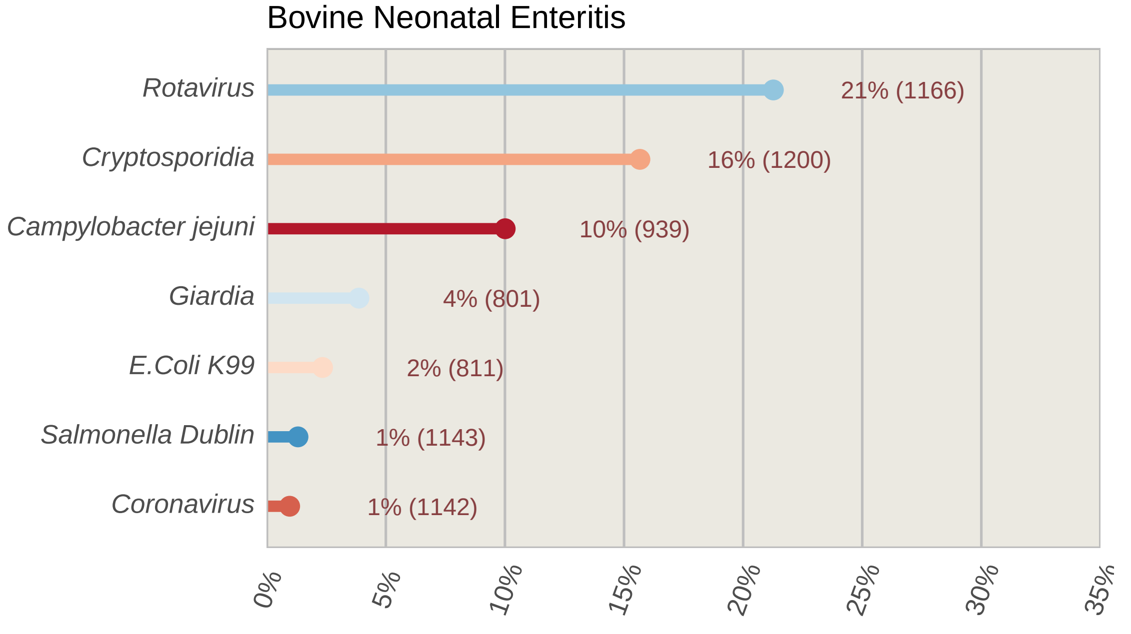


Figure 4.3.: Relative frequency of enteropathogenic agents identified in calf faecal samples (neonatal enteritis package) tested in 2023. Percentage of positive results. Total samples examined varies with the agent, see Table 4.1 .

4.4. *Escherichia coli* K99

E. coli K99 is an enterotoxigenic *E. coli* (ETEC) and is an important cause of neonatal enteritis in very young calves, typically less than three days of age as ETEC adhesin receptors are only present on enterocytes for a few days. These strains of *E. coli* preferentially colonise the lower small intestine and produce toxins that cause secretion of water and electrolytes from the intestinal mucosa, resulting in rapid dehydration.

E. coli K99 was detected in 2.3 *per cent* of samples, the percentage prevalence of *E. coli* K99 would likely be higher if testing for this enteric pathogen was restricted to animals less than one week old. Control by vaccination of cows pre-calving is common; this is again reliant on good colostrum management. Maintenance of a hygienic environment to prevent build-up of pathogenic *E.coli* strains is also important.

4.5. *Salmonella enterica* subspecies *enterica* serovar Dublin

Salmonella was again detected at low levels in this age group (1.3 *per cent*). Enteritis with septicaemia is the usual syndrome in newborn calves. When systemic disease occurs it is typically in immunodeficient calves. Illness may be acute, with depression, fever, and death in 24–48 hours. Neurologic signs and pneumonia may be seen. Again, it is a potential zoonosis.

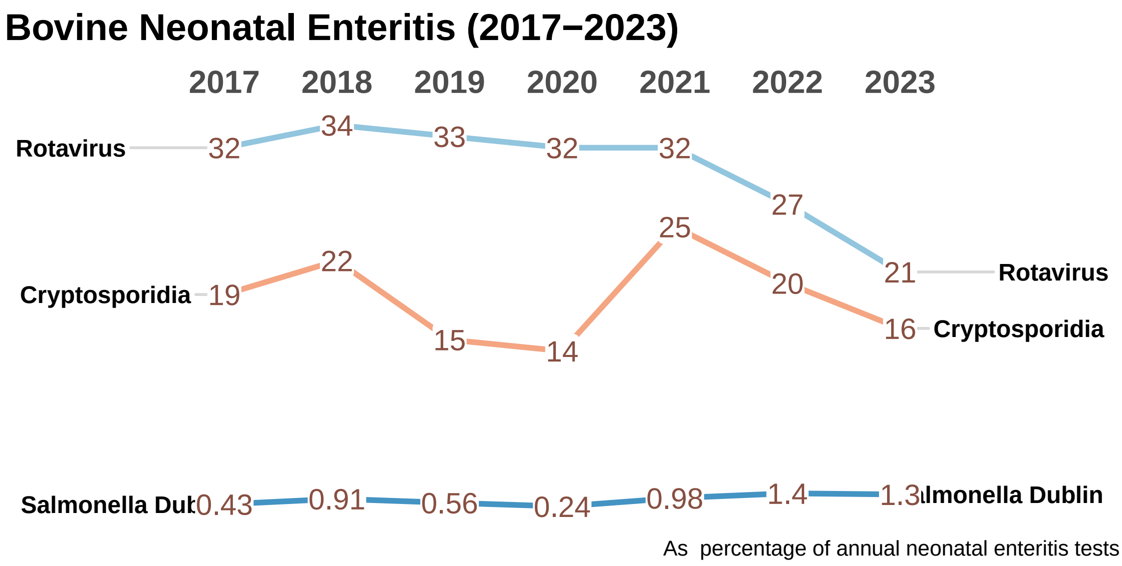


Figure 4.4.: Trends in the incidence of Rotavirus, Cryptoporidia and *Salmonella* Dublin enteritis in calves less than one month of age.

4.6. *Campylobacter jejuni* and *Giardia*

Campylobacter jejuni was detected in 10 *per cent* of samples in 2022. The significance of *Campylobacter jejuni* as a cause of calf/ lamb enteritis is doubtful; however, *C. jejuni* is a common cause of gastroenteritis in humans.

Giardia spp. an intestinal protozoan parasite was detected in 3.9 *per cent* of samples. In recent years giardiosis has been recognised as a potential cause of enteritis in calves. The route of transmission is faecal-oral. *Giardia spp* are potentially zoonotic and standard hygiene measures should be advised.

4.7. Coronavirus

Coronavirus was detected in one *per cent* of cases in 2022. Calves typically show clinical signs of the disease between five and 30 days of life. Clinical signs begin approximately two days after exposure and continue for three to six days. Typically, coronavirus infection causes profuse watery diarrhoea, suckling reflex is weak, and dehydration can develop rapidly. Decreased food intake, fluids, and electrolyte loss can result in dehydration, metabolic acidosis, and hypoglycaemia.

4.8. Coccidiosis

Eimeria spp. (Figure 4.2b) typically cause clinical disease in calves from three weeks to nine months of age, therefore coccidiosis will feature in other chapters in this report. 21 *per cent* of samples from calves under one month of age were tested positive for coccidia. The damage to the gut lining in heavy infections in non-immune calves leads to diarrhoea, dehydration, dysentery, tenesmus and loss of condition and deaths can occur.

These organisms are host specific i.e. coccidia from one animal cannot affect another species. Therefore birds do not transmit coccidiosis to cattle. There are over a dozen *Eimeria* species that can infect cattle, but only three species are considered to be pathogenic: *Eimeria bovis*, *E. zuernii* and *E. alabamensis*. Due to the potential presence of many non-pathogenic species of coccidia in faecal samples from calves, caution should be exercised when interpreting positive results. Diagnosis is based on the clinical history, the age of the animal and faecal sampling.

It is important to remember that the absence of oocysts is not evidence of the absence of pathogenic coccidia. Peak of clinical signs may not coincide with peak oocyst shedding. Multiple animals should be sampled when coccidiosis is being investigated. Clinical signs of diarrhoea may proceed oocyst output and/ or may continue after the number of oocysts decrease.

Important Points in Neonatal Enteritis

- Multiple faecal samples from untreated calves early in the course of infection.
- Feeding an adequate quantity of good quality colostrum is essential for calves to develop immunity to enteropathogens.
- Maintaining hygiene of calf rearing facilities is imperative to reduce environmental contamination and breaks the transmission cycle of enteropathogens
- Many of the pathogens affecting this age group pose a potential zoonotic risk.

5. Zinc Sulphate Turbidity Test

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The Zinc Sulphate Turbidity (ZST) test is a useful diagnostic tool used to evaluate the quality of colostrum ingested by neonatal calves and to ensure successful passive transfer of immunity. This test works by adding a zinc sulphate solution to a serum sample from the calf, which causes immunoglobulins (primarily *IgG*) to precipitate, creating turbidity. The degree of turbidity, measured in ZST units, reflects the concentration of immunoglobulins present in the serum.

Immunoglobulins are essential antibodies that calves must acquire through colostrum within the first few hours of life. This passive transfer of immunity is crucial as calves are born without significant levels of antibodies and rely on colostrum to provide the necessary immunity against pathogens during their early life. Adequate colostrum intake is typically defined as a ZST value of greater than 20 units, indicating sufficient immunoglobulin levels.

ZST Interpretation

A ZST value of 20 units or greater is considered optimal, a value between 19 and 12.5 units is considered adequate but sub-optimal, and values of 12 units or below are considered inadequate.

In practice, the ZST test is utilised to identify calves at risk of Failure of Passive Transfer (FPT), which occurs when serum *IgG* concentrations are insufficient. FPT can lead to increased morbidity and mortality due to increased susceptibility of calves to infections during the neonatal period including septicaemia, enteritis and pneumonia.

Optimal management practices for colostrum feeding include ensuring that calves receive 10–12 *per cent* of their body weight in high-quality colostrum within the first two hours of birth. The colostrum should be harvested from cows within the first few hours post-partum, as *IgG* concentrations decline rapidly subsequently. Additionally, good hygiene should be practiced during colostrum collection and storage to prevent bacterial contamination, which can interfere with the absorption of immunoglobulins.

Table 5.1.: Zinc Sulphate Turbidity Test Results in 2023.

Status	No. of samples	Mean	Percentage
Diagnostic Samples			
Optimal	225	29.5	**55**
Adequate	117	16.2	**29**
Inadequate	68	7.8	**17**
Carcass Samples			
Optimal	56	26.8	**23**
Adequate	55	16.0	**23**
Inadequate	131	6.4	**54**

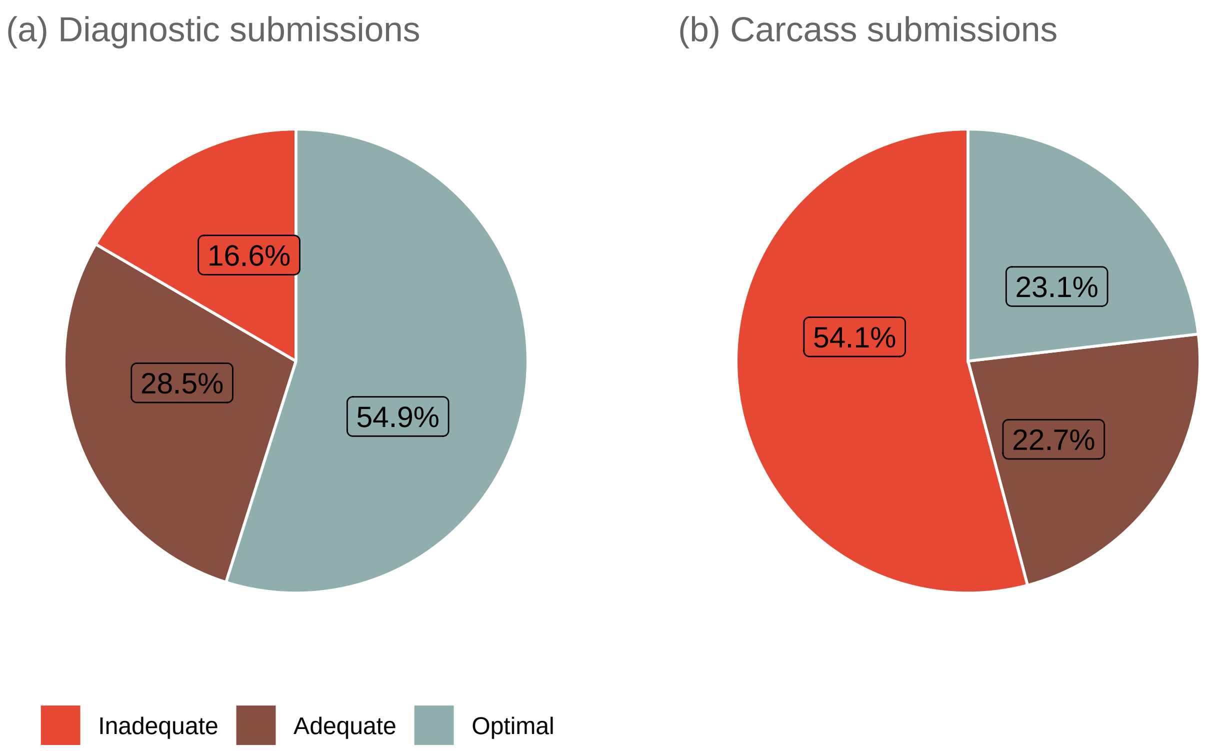

Figure 5.1.: Results of ZST from bovine blood samples obtained from diagnostic (a) and carcases (b) submissions to RVLs in 2023 (n=348).

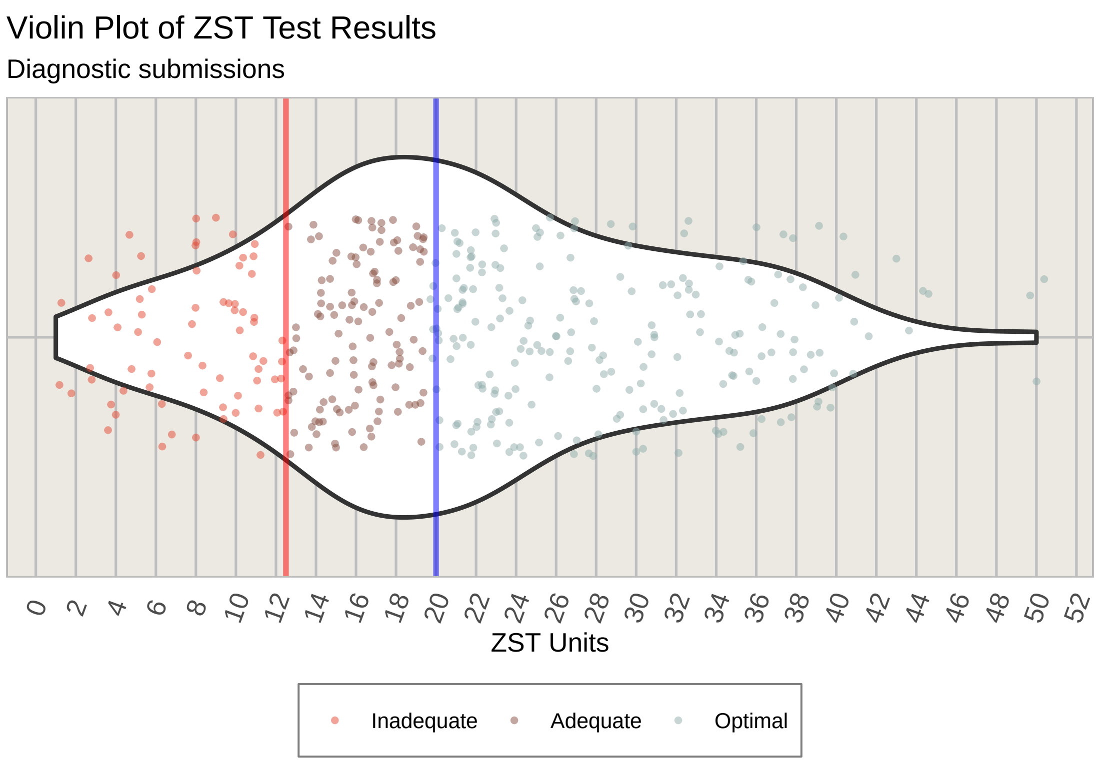

Figure 5.2.: Distribution of ZST test results during 2023. Optimal colostral immunity is defined as greater than 20 units (blue line), adequate between 12.5 and 20 units and inadequate less than 12.5 units (red line). The width of the white area at each point of the x-axis is proportional to the number of samples returning a ZST result of that value (n=410).

The ZST test, therefore, serves as an indirect but effective measure of colostrum intake and quality and serves as a guide for farmers and vets to ensure neonatal calves receive the necessary antibodies to support early immune function. Results of ZST testing carried out by RVLs on diagnostic (postal) and carcass submissions during 2023 are demonstrated in Figure 5.1 (a) and (b) and Figure 5.2.

A single ZST test provides limited information on the efficacy of colostrum management practices within a herd. To best determine whether there is adequate transfer of passive (colostral) immunity, it is recommended that multiple samples, up to twelve, are taken from two to 10 day old healthy calves.

One-day-old calves are not suitable for ZST testing as circulating levels of immunoglobulin peak 36 hours after colostral ingestion. The ZST test is also not useful in calves older than 14 days old as the test does not distinguish between colostral and endogenous immunoglobulins. Testing healthy calves is preferable as immunoglobulin concentration levels decrease during illness due to antigen binding and/or loss through kidney/intestine. In dehydrated calves, ZST levels can be increased due to haemoconcentration.

Benefits of Colostrum

• Provides essential immunoglobulins and immune factors to calves to reduce their susceptibility to infectious diseases.
• Contains considerably more fat than milk, essential for maintaining body temperature in new-born calves.
• Contains essential fat-soluble vitamins that cannot be absorbed across the placenta.
• Acts as a heat source when fed at the correct temperature (~38.5-39 °C).
• Hydrates the calf, increases blood volume and improves circulation resulting in improved survival.

6. Clostridial Diseases in Bovine and Ovine

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6.1. Overview

Clostridia species are gram positive, obligate anaerobic bacteria. They are ubiquitous, many are saprophytes inhabiting soil and decomposing organic material, while others inhabit the intestinal tract of animals. Typically, clostridial disease presents acutely or as a sudden death, with mortality approaching 100 *per cent* in most cases.

Diagnosis of most clostridial diseases is based on anaerobic culture, the fluorescent antibody technique (FAT) on impression smears of tissues, the detection of toxins in cases of suspected enterotoxaemia and histopathological examination of tissues.

There are a large number of syndromes associated with clostridial disease in cattle and sheep, each with distinct factors, clinical signs and control options. In general, pathogenic clostridia can be considered in three groups: histotoxic clostridia which produce exotoxins at sites other than the alimentary tract, enterotoxaemias and other alimentary tract infections and neurotoxic clostridia. Table 6.1 summarizes the clostridia species and associated syndromes detected in Regional Veterinary Laboratories (RVLs) in 2023.

6.2. Histotoxic clostridial diseases

Clostidrial myositis (blackleg)

Clostridial myositis (blackleg), remains the most commonly diagnosed clostridial disease in cattle submitted to RVL's in 2023 (n=63) (Table 6.2 and Figure 6.2). Disease can also occur in sheep although less common (n=3). Ingested spores of *C. chauvoei* migrate to various tissues and are liberated under favourable conditions such as trauma, which triggers bacterial proliferation and toxin production, causing a severe necrotizing myositis and systemic toxaemia.

Table 6.1.: Main clostridial diseases detected in RVLs during 2023

Clostridial Disease	Causative Agent	Species affected
Histotoxic		
Blackleg	*C. chauvoei*	Mainly cattle
Malignant Oedema	*C. septicum, C. sordellii, C. chauvoei, C. novyi*	Cattle and sheep
Black Disease	*C. novyi*	Cattle and sheep
Enterotoxaemic		
Pulpy Kidney Disease (PKD)	*C. perfringens*	Mainly sheep
Enterotoxaemia (excl. PKD)	*C. perfringens, C. sordelli, C. septicum*	Cattle and sheep
Neurotoxic		
Botulism	*C. botulinum*	Mainly cattle

(a) Blackleg: clostridial myositis

(b) Blackleg: pericarditis

Figure 6.1.: Necrohaemorrhagic inflammation and emphysema (a) in a weanling calf with clostridial myositis (blackleg). Fibrinous epicarditis (b)(arrow) occasionally associated with blackleg. Photos: Cosme Sánchez-Miguel.

Table 6.2.: Clostridial disease diagnosed in bovine carcasses in 2023 (n= 99).

Disease	No. of Cases	Percentage
Blackleg	63	**63.6**
Clostridial Enterotoxaemia	23	**23.2**
Black Disease	8	**8.1**
Malignant Oedema	3	**3.0**
Botulism	2	**2.0**

The majority of cases occur at grass with a peak in detection of cases in August (n=13) (Figure 6.3). On *post mortem* examination, lesions have a typical rancid odour and usually affect the large limb muscle groups but smaller muscle groups such as the tongue and heart may also be involved.

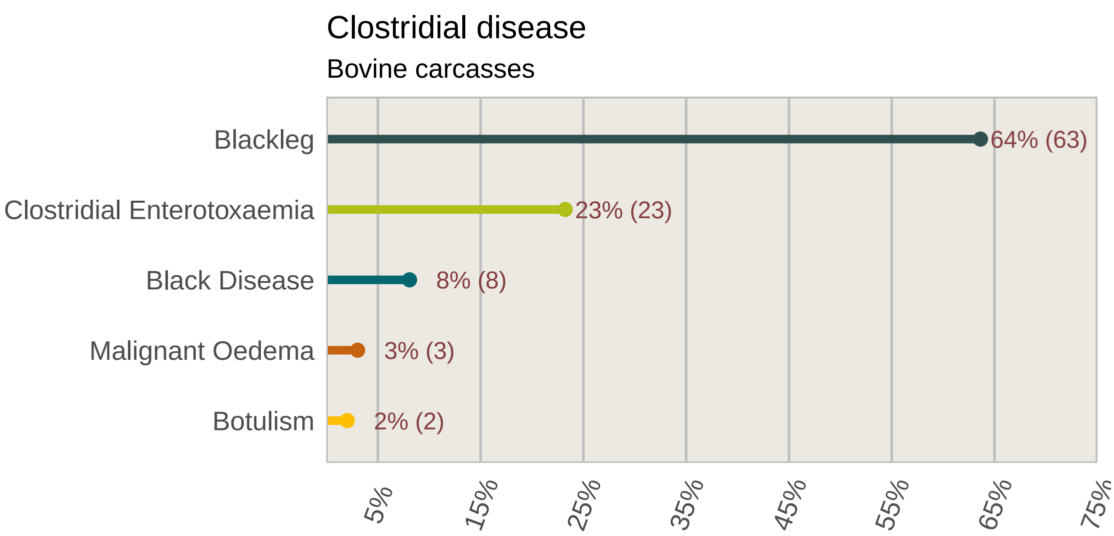

Figure 6.2.: Clostridial disease diagnosed in bovine carcases in 2023 (n=99).

Black disease

Infectious necrotising hepatitis is caused by *C. novyi* Type B infection and affects sheep and cattle. Anaerobic conditions, typically associated with *Fasciola hepatica* migration, allow *C. novyi* to proliferate. On *post mortem* examina-

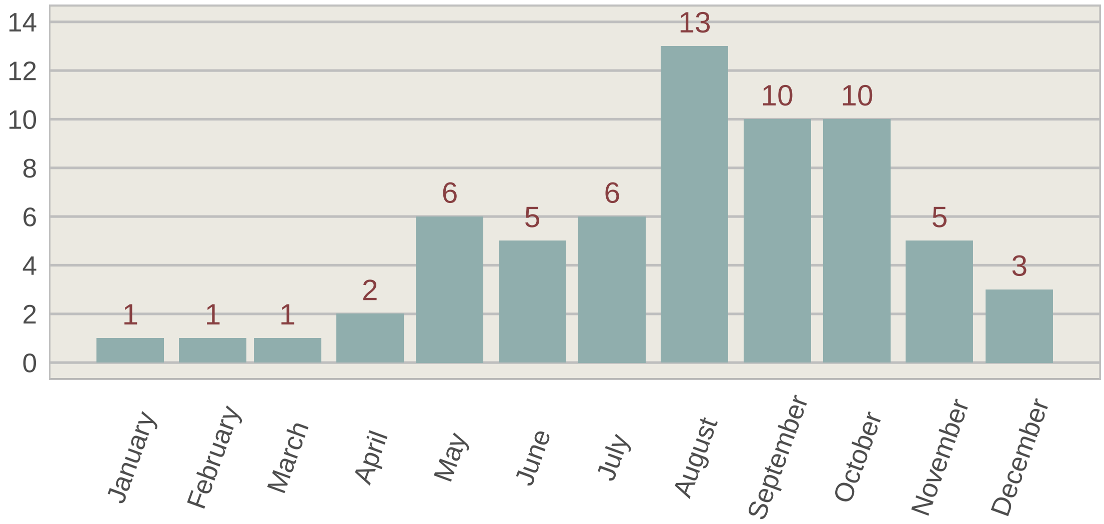

Figure 6.3.: Occurrence of blackleg diagnoses in RVLs in 2023, by calendar month (n=63).

tion, the typical hepatic lesions consist of one or more necrotic areas, which are pale yellow to white, surrounded by a ring of hyperaemia.

Malignant oedema

C. septicum is primarily associated with malignant oedema/gas gangrene in sheep and cattle, although *C. novyi*, *C. sordelli* and *C. chauvoei* may also be implicated. Cellulitis is the main clinical sign and bacteria are usually introduced via a wound, trauma, or intramuscular injections.

6.3. Enterotoxaemia and other alimentary tract infections

Clostridial enterotoxemia

C. perfringens is a normal inhabitant of the gastrointestinal flora so diagnosis of disease due to this pathogen, typically involves gross pathology changes coupled with detection of toxins. *C. perfringens* Type A produces α toxin which causes *yellow lamb* disease in sheep and may be implicated in cases of enteritis in cattle. *C. perfringens* Type B produced α, β and ϵ toxins and is responsible for lamb dysentery. *C. perfringens* Type C causes struck in adult sheep and may be involved in cases of enteritis in calves (Figure 6.4a).

6.4. Abomasitis

C. sordellii has been implicated in cases of abomasitis in sheep and cattle causing emphysema and oedema of the mucosa.*C. septicum* is also associated with abomasitis (braxy), typically seen in animals after grazing frozen/snow covered pasture, causing necrosis, ulceration, and emphysema of the abomasal wall.

6.5. Pulpy Kidney

Pulpy kidney/over-eating disease caused by *C. perfringens* Type D, is the most common clostridial disease of sheep submitted to RVL's in 2023 (n=47)(Table 6.3 and Figure 6.5), with peak detection of cases in August

Table 6.3.: Clostridial disease diagnosed in ovine carcasses in 2023 (n= 94).

Disease	No. of Cases	Percentage
Pulpy Kidney Disease	47	**50.0**
Clostridial Enterotoxaemia	40	**42.5**
Blackleg	3	**3.2**
Black Disease	2	**2.1**
Malignant Oedema	2	**2.1**

(n=13)(Figure 6.6). It occurs occasionally in cattle. Sudden changes in diet or diets high in fermentable carbohydrates usually precipitate disease, allowing clostridia to proliferate and produce α, and ϵ toxins.

(a) Enterotoxaemia

(b) Pericardial effusion

Figure 6.4.: Hemorrhagic (a) enteritis in a lam with Type C *C. perfringens* endotoxaemia. (b) Pericardial effusion (arrow) with gelatinous fibrin in a lamb with *C. perfringens* type D enterotoxaemia. Photos: Cosme Sánchez-Miguel.

Typical *post mortem* lesions include soft, friable kidneys, glucosuria. A hydropericardium, containing a fibrin clot may also be present. Brain lesions may occur in subacute or chronic enterotoxaemia, and these include herniation of the cerebellar vermis and focal symmetrical encephalomalacia. Histologic changes in the brains of sheep are pathognomonic and present in most cases. Perivascular proteinaceous oedema is the most consistent change.

6.6. Neurotoxic clostridial disease

Botulism

Two cases of botulism were diagnosed in cattle in 2023. Cases are usually linked with the spreading of poultry litter on pasture or the inclusion of carrion in forage. Clinical signs are related to a progressive muscle weakness or flaccid paralysis. There are no specific gross lesions observed on *post mortem*. Diagnosis is based on history, clinical signs and exclusion of other potential causes of weakness/recumbency. To confirm a diagnosis, testing for toxins of *C. botulinum* by mouse bioassay is carried out, however sensitivity is low to moderate depending on sample quality, so failure to detect toxins does not exclude a diagnosis.

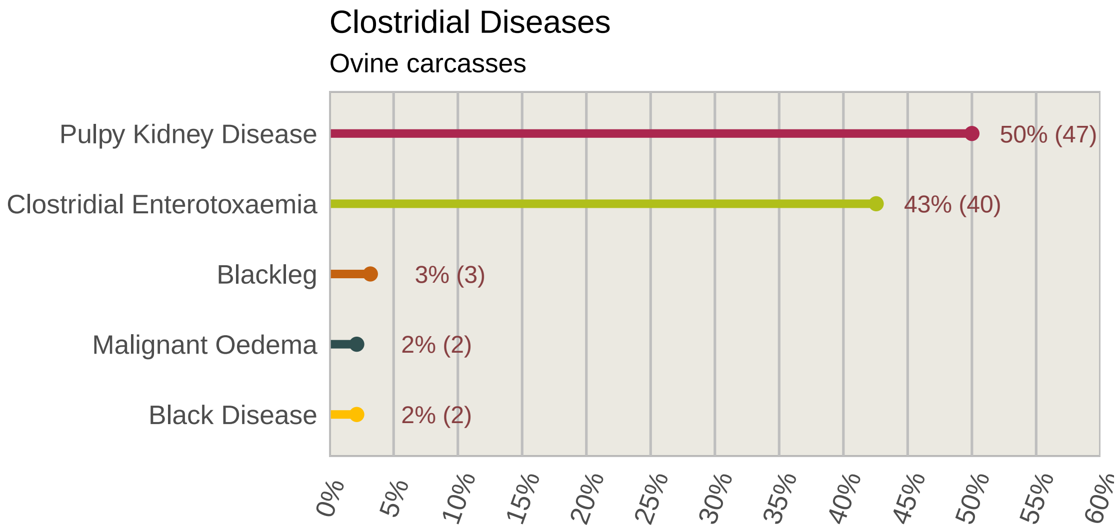

Figure 6.5.: Clostridial disease diagnosed in ovine carcases in 2023 (n=94).

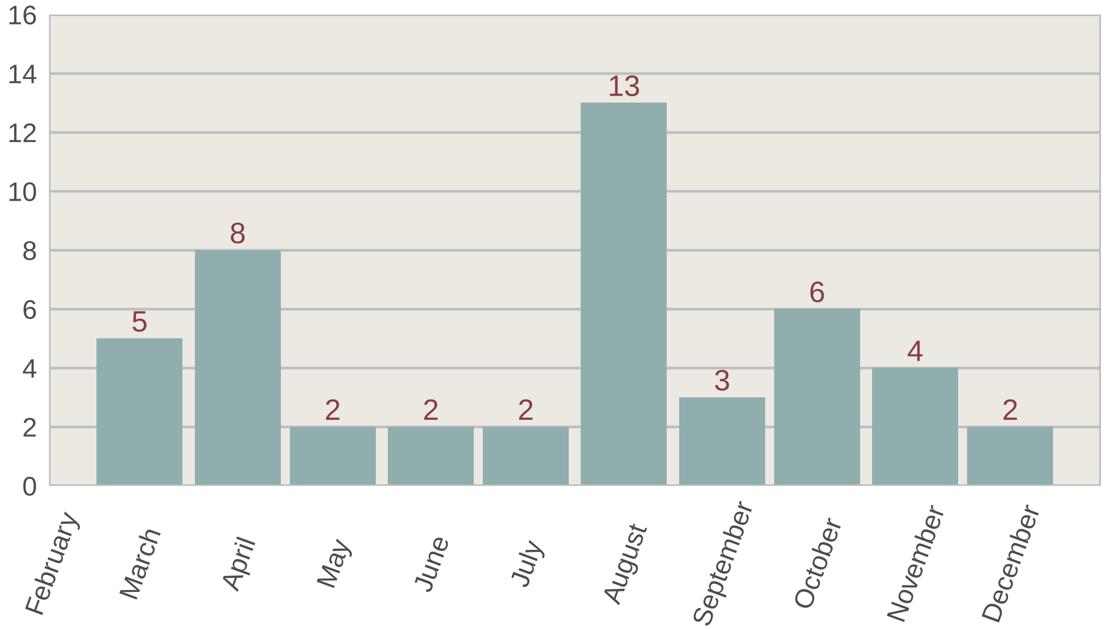

Figure 6.6.: Occurrence of diagnosis of pulpy kidney disease in RVLs in 2023, by calendar month (n=47).

7. Bovine Mastitis

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7.1. Overview

Mastitis is a highly prevalent disease characterised by inflammation of the parenchyma of the mammary gland, predominantly caused by bacterial pathogens, with considerable economic and welfare implications for the dairy industry. Bovine mastitis is classified based on the duration of infection and the degree of inflammation. Clinical mastitis is associated with visibly abnormal milk (watery with flakes or clots present) often accompanied by swelling, heat, pain and redness of the udder. In severe cases, milk and mammary gland changes are accompanied by systemic signs of illness. In contrast, subclinical mastitis is characterised by a lack of apparent local or systemic inflammation. Instead, subclinical mastitis manifests as a decline in milk production accompanied by an increased somatic cell count (SCC). As a result, subclinical mastitis represents a diagnostic challenge for farmers and vets.

Mastitis pathogens are broadly categorised as *contagious* or *environmental*, depending on their mode of transmission and the reservoir of infection. Contagious mastitis is spread between cows primarily during the milking process with infected mammary glands acting as the reservoir of infection. *Staphylococcus aureus*, *Streptococcus agalactiae* and *Mycoplasma bovis* are important contagious mastitis pathogens. In contrast, with environmental mastitis, the predominant reservoir of pathogens is a contaminated environment. Common sources of these pathogens include faeces, bedding and soil. As a result, it is impossible to eliminate environmental pathogens as they are ubiquitous in the cow's environment and can only be controlled through improved hygiene and cleanliness of cows and their surroundings. The predominant environmental mastitis pathogens are coliforms including *E. coli*, *Klebsiella spp.* and *Enterobacter*. *Streptococcus uberis* and *Streptococcus dysgalactiae* are also considered to be environmental mastitis pathogens but can be transmitted between cows at milking. *E. coli* infections tend to occur immediately before and after calving and thus, housing conditions and management practices of parturient cows should be optimised to minimise exposure to coliforms.

Judicious use of antimicrobials is essential for successful mastitis treatment programs. By identifying the causal pathogen through culture of mastitic milk samples, antibiotic therapy can be targeted with an associated

Table 7.1.: Relative frequency of mastitis isolates in milk samples submitted to RVLs in 2023 (n=2120)

Result	No. of cases	Percentage
Contaminated	540	**25.5**
Staphylococcus aureus	462	**21.8**
No Significant Growth	299	**14.1**
Streptococcus uberis	257	**12.1**
E. coli	211	**9.9**
Other Isolates	124	**5.8**
Non-aureus staphylococci	91	**4.3**
Bacillus spp.	69	**3.2**
Streptococcus dysgalactiae	49	**2.3**
Trueperella pyogenes	16	**0.8**
Streptococcus agalactiae	2	**0.1**

Table 7.2.: Relative frequency of most common mastitis isolates in the 'Other Organisms' group in milk samples submitted to RVLs in 2023 (n=2120)

Result	No. of cases
Other	27
Streptococcus spp	21
Aerococcus viridans	16
Enterococcus faecalis	15
Pasteurella multocida	8
Proteus spp	8
Pseudomonas spp	7
Aerococcus spp.	6
Corynebacterium spp	6
Aeromonas hydrophilia	5
Enterococcus durans	5

reduction in antibiotic use without compromising cow welfare.

Recent changes to EU legislation to address growing issues with antimicrobial resistance have had considerable implications for mastitis therapeutics (*Regulation EU 2019/6*). Prophylactic and metaphylactic use of antimicrobials associated with blanket dry cow therapy has been restricted, with farmers required instead to implement selective dry cow strategies. Additionally, high priority critically important antimicrobials can no longer be used for first line mastitis treatment or prophylaxis. The control of mastitis is therefore becoming more dependent on preventative measures, rapid detection of clinical cases, identification of involved pathogens and targeted antimicrobial treatment. Milk culture and sensitivity testing services are available through DAFM laboratories and several private laboratories (AHI Cellcheck Partner Laboratories).

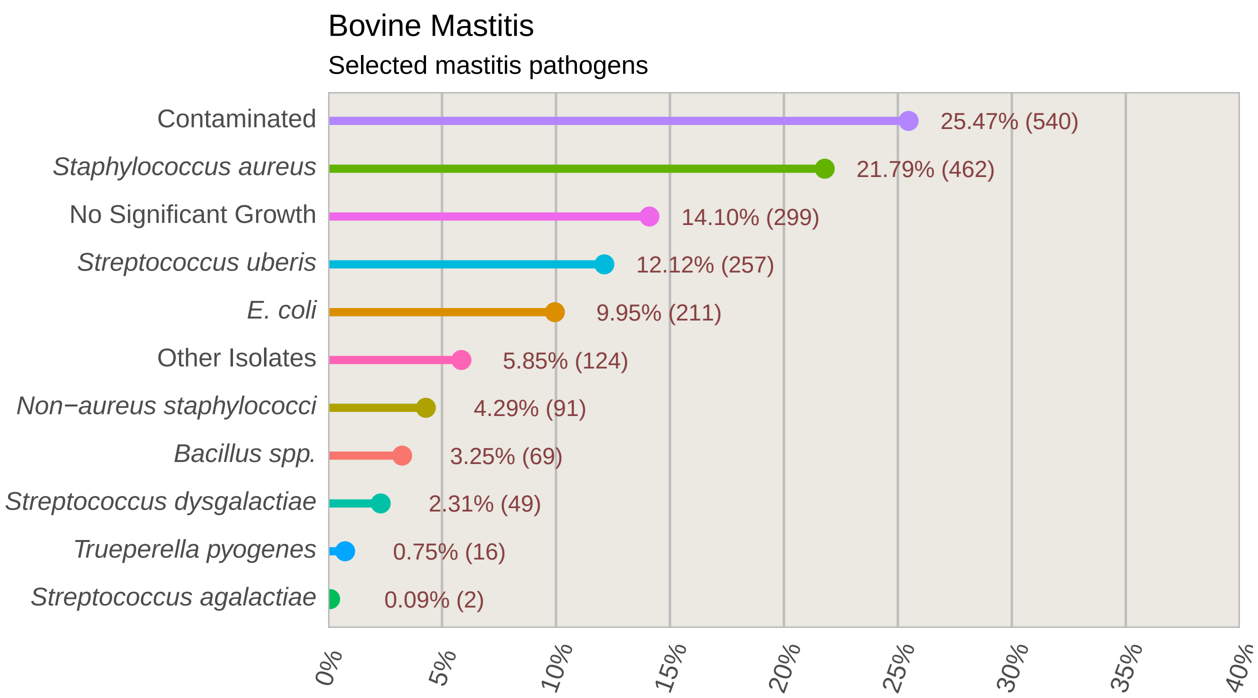

Figure 7.1.: Relative frequency of mastitis isolates in milk samples submitted to RVLs in 2023 (n=2120).

7.2. Milk submissions in 2023

Mastitis culture was performed on 2120 milk sample submissions during 2023. The relative frequency of detection of the most common mastitis pathogens is outlined in Table 7.1 and Figure 7.1.

7.3. Contaminated samples

In 2023, 25.5 *per cent* of milk samples were classified as *contaminated*. Samples are considered contaminated when there is no predominant organism, and there may be several dissimilar bacterial colony types. Contaminants include skin and environmental bacteria that enter the sampling container due to improper sampling technique or by using non-sterile sampling containers. By implementing stringent aseptic techniques during sample collection, the incidence of contamination can be minimised, allowing for accurate identification of mastitis causing pathogens and targeted therapeutic interventions.

> **Quality of milk samples**
>
> The quality of milk samples taken for laboratory examination is extremely important. An aseptic technique for sample collection is a necessity. Contaminated samples lead to misdiagnosis, confusion and frustration.

7.4. *Staphylococcus aureus*

In 2023, *S. aureus* was the most frequently isolated mastitis-associated pathogen in milk sample submissions, accounting for almost 22 *per cent* of isolates. This marks a slight increase in its detection frequency compared to 2022 (18.1 *per cent*) but is broadly consistent with the overall trend of *S.aureus* detection observed between 2018 and 2023 (Figure 7.2).

S. aureus is a highly contagious mastitis pathogen associated with substantial economic losses due to decreased milk yield, increased culling rates and veterinary costs. Transmission between cows primarily occurs during milking through contaminated equipment and suboptimal hygiene practices. Once *S. aureus* infection becomes established in a herd, it can be difficult to eradicate due to its ability to induce chronic subclinical infections, with persistently high SCCs with intermittent clinical flare-ups. Several *S.aureus* virulence factors allow this pathogen to evade the immune response and contribute to antimicrobial resistance. Chronically infected cows should be identified, segregated and culled to prevent transmission within the herd.

7.5. No significant growth

When there is a lack of colonies or only a few varied colony types, milk culture results are classified as having "no significant growth". In 2023, 14.1 *per cent* of milk submissions showed no growth, indicating an absence of bacteria or the presence of bacteria below detectable levels. Several factors could explain this outcome: the cow's immune system may have resolved the infection, sampling may have taken place after antibiotic treatment, improper sample handling or transport could have decreased the number of viable pathogens or samples may have been taken after milking or there may be intermittent pathogen shedding. To increase the chances of detecting clinically relevant pathogens, it is essential to collect samples aseptically before milking.

7.6. *Streptococcus uberis*

S. uberis was the second most frequently detected mastitis-associated pathogen in 2023, accounting for 12.1 *per cent* of isolates in milk sample submissions. These findings broadly align with those of previous years, albeit at a slightly lower detection rate than in 2022 (13.8 *per cent*). *S. uberis* is an environmental pathogen, commonly found in organic matter, including bedding, soil and faeces. Its ability to thrive in various environments makes it a persistent challenge for dairy farmers, particularly in poorly managed or dirty environments. This bacteria spreads to uninfected cows through environmental contact. As a result, maintaining a clean and dry lying environment for cows is essential to reduce transmission between cows. New infections with *S. uberis* can occur at any stage of lactation or during the dry period. However, the early dry period represents the period of greatest risk of *S. uberis* infection, as the cessation of daily milking eliminates daily flushing of the mammary gland, heightening the risk of mastitis. Cows in the early stages of lactation are also susceptible to new infections, due to the stress and immunosuppressive effects of parturition.

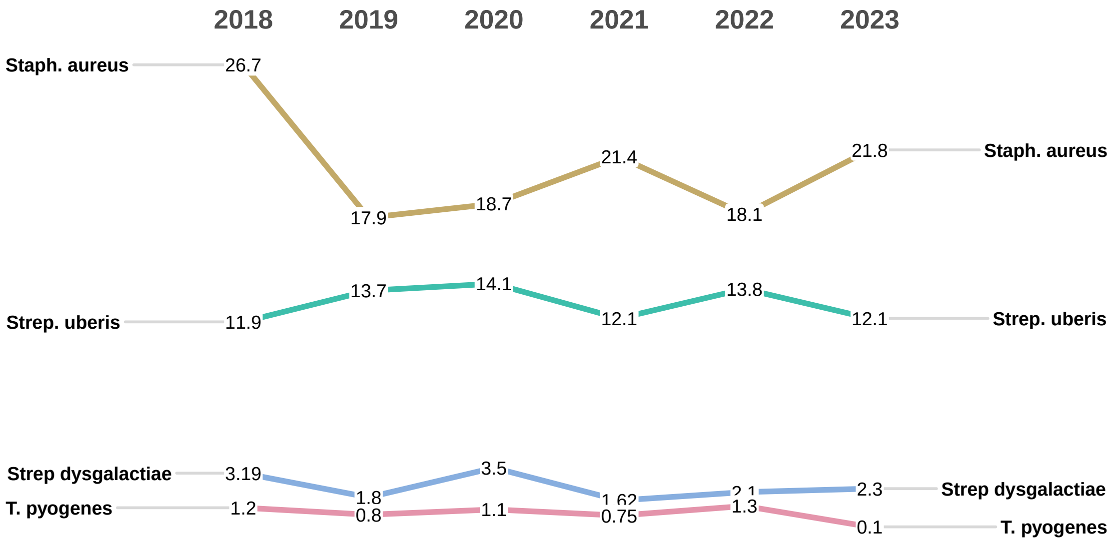

Figure 7.2.: Mastitis-associated organisms isolated in milk based on bovine milk samples submitted to RVLs between 2018 and 2023.

7.7. *Escherichia coli*

E. coli was cultured in almost 10 *per cent* of milk submissions during 2023, representing a slight decline compared to 2022 detection levels (11.2 *per cent*). *E. coli* is an important environmental mastitis-associated pathogen, characterised by sudden onset and potentially severe clinical signs. *E. coli* is pervasive in dairy environments, particularly in faeces, bedding and other organic materials. *E. coli* mastitis can manifest suddenly with varying severity of clinical signs. Severe infections are commonly associated with systemic illness with affected cows potentially exhibiting fever, inappetence, localised udder inflammation and a significant drop in milk production. The greatest risk period for *E. coli* mastitis is during the early and late phases of the dry period with infections typically remaining subclinical until the post-partum period. Interpreting a positive *E. coli* culture result requires careful consideration to differentiate true infection from contamination. Clinical signs, SCC and environmental factors should be used in conjunction with culture results to inform a diagnosis of coliform mastitis.

7.8. Non-*aureus* staphylococci (NAS)

During 2023, non-aureus staphylococci species were isolated in 4.3 *per cent* of milk sample submissions, an increase of almost 1.5 *per cent* on their detection rate in 2022. Non-aureus staphylococci (NAS) are a heterogenous group of bacteria that, unlike *Staphylococcus aureus*, are coagulase-negative and are increasingly recognised as significant pathogens in bovine mastitis. NAS species are generally considered to be less virulent than *S. aureus* but these opportunistic pathogens can still cause subclinical and clinical mastitis. NAS species may also play a role in development of antimicrobial resistance.

7.9. Other mastitis pathogens

Mastitis-associated pathogens detected at low relative frequencies in 2023 include *Streptococcus dysgalactiae* (2.3 *per cent*), *Bacillus* species (3.2 *per cent*), *Trueperella pyogenes* (0.8 *per cent*), and *Streptococcus agalactiae* (0.1 *per cent*).

Milk Sample Collection for Bacteriology: Sampling Technique

1. Take the sample before milking and before any treatment is given.
2. Label the tubes prior to sampling with name/creamery number/herd number, cow number, quarter and date.
3. Using a hand or paper towel brush any loose dirt, straw or hair from teat or underside of the udder. Washing should be avoided if possible. However, if teat is soiled it should be washed and carefully dried with paper towels.
4. Put on gloves.
5. Soak a number of cotton wool balls in alcohol.
6. Clean teat thoroughly with alcohol soaked cotton wool or the medicated wipes until it is thoroughly clean.
7. Remove cap from sampling tube. Place cap on a clean surface with closing side up. Hold open tube at an angle of 45° (holding it straight up will allow dust etc. to fall inside). Using your other hand, discard first few streams of milk on to the ground before collecting three or four streams in the tube.
8. Replace cap on sampling tube.
9. If you feel that some contamination has occurred, discard sample and use a new tube.
10. Place labelled tube in a fridge and cool to 4°C. This is very important.
11. Sample should be taken to the laboratory as quickly as possible. If sample is handed to milk tank driver for delivery, ensure that it is placed in a cool box.
12. If sample is not going to a laboratory immediately, it must be refrigerated until delivery

8. Toxicology

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8.1. Lead poisoning

As part of DAFM's disease surveillance role the Veterinary Laboratory Service provides diagnostic support for suspect toxicities and investigates incidents. Lead incidents, involving poisoning or excessive exposure, are important animal health and food safety concerns, especially where milking cows or animals close to finishing weight are exposed. Risk management measures such as removing animals from the source of lead, further blood sampling as a marker of carcase lead residues and bulk tank milk monitoring where there is evidence of exposure of milking cows etc. may be required.

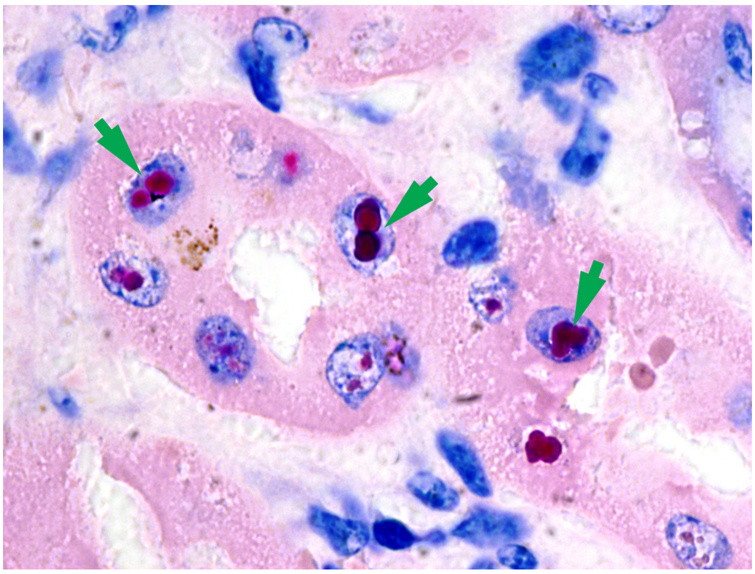

Figure 8.1.: Eosinophilic intranuclear inclusion bodies (arrows) in the cortical renal tubular epithelium of a weanling with lead nephrotoxicity (Ziehl Neelsen stain). Photo: Cosme Sánchez-Miguel.

In 2023 18 separate incidents of lead toxicity were confirmed and investigated following the submission of carcases or receipt of clinical samples for investigation. This represents an increase compared to the previous year when 13 confirmed cases were recorded. All 18 cases in 2023 were diagnosed in cattle, mostly during spring and summer after turn out to pasture (Figure 8.2). None of these cases involved milking cows and most cases were reported in cattle older than one year. Discarded batteries were the most common source of lead although lead-based paints and old electrical cables were occasionally implicated. Animals usually presented with clinical signs of acute lead poisoning i.e., sudden death or blindness, staggering, head pressing and convulsions followed by death or subacute lead poisoning i.e., blindness, teeth grinding, dullness with death or survival after several days.

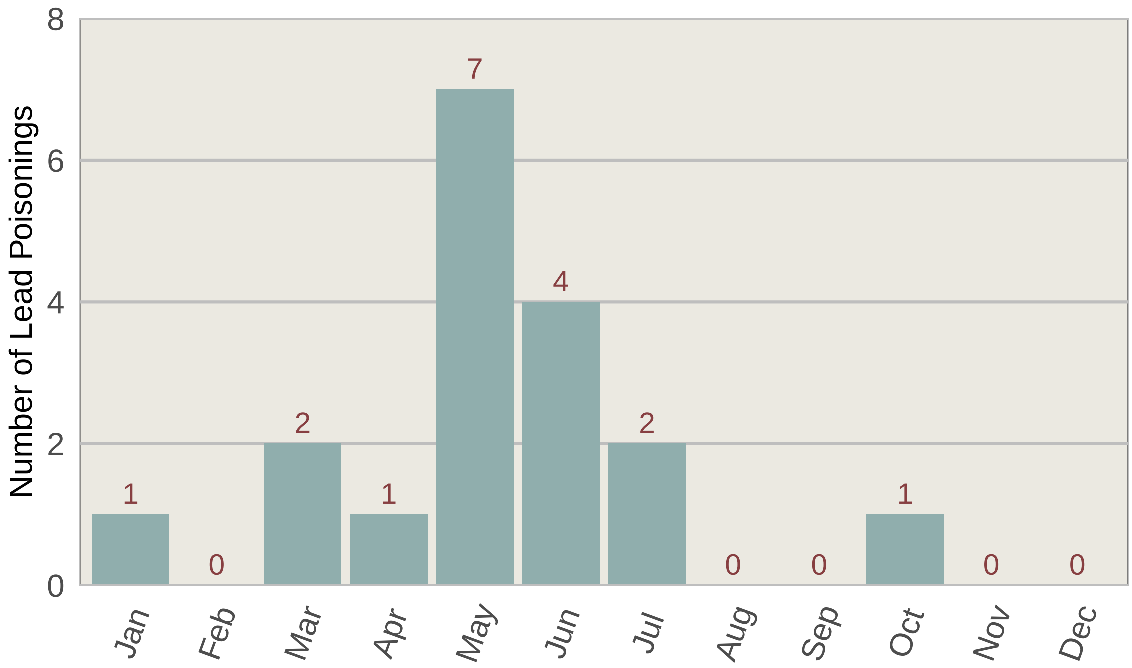

Figure 8.2.: Number of fatal lead toxicity cases in cattle by month in 2023 (n = 18)

9. Bovine Parasites

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9.1. Overview

Parasitic disease is a prevalent and significant contributor to both clinical illness and suboptimal performance in cattle in Ireland, often due to subclinical infections. The RVL network conducts parasite testing on faecal samples submitted by private veterinary practitioners (PVPs) and on intestinal contents obtained from animal carcasses during necropsy. Additionally, parasitic diseases may be identified during necropsy through the observation of gross and histopathological lesions. Other laboratory tests can further aid in diagnosing parasitic infections in live animals.

Control of nematodes has traditionally focused on the use of anthelmintics. However, the increasing evidence of anthelmintic resistance has necessitated the development of grazing systems aimed at minimising the risk of parasitic disease. These systems, combined with strategic anthelmintic use when necessary, aim to prevent the buildup of anthelmintic-resistant worm populations on pasture and to reduce the exposure of younger, more vulnerable animals to heavy worm challenges.

Parasitic diseases can be caused by nematodes (parasitic gastroenteritis (PGE) due to *Trichostrongylidae*), coccidia (various species of *Eimeria*), and trematodes (the liver fluke *Fasciola hepatica* and the rumen fluke *Calicophoron daubneyi*).

9.2. *Trichostrongylidae*

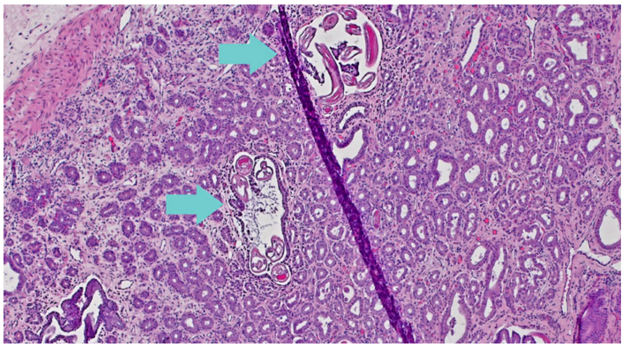
The *Trichostrongylidae* superfamily includes genera such as *Ostertagia*, *Cooperia*, *Teledorsagia*, *Trichostrongylus*, *Haemonchus* and *Nematodirus*. The most prevalent nematodes or roundworms affecting cattle in Ireland are *Ostertagia ostertagi* and *Cooperia oncophora* (Murphy et al. 2006). These nematodes infect the small intestine and (in the case of *O. ostertagi*) the abomasum, causing parasitic gastroenteritis which results in diarrhoea, weight loss, and poor performance. Table 9.1 shows the number of bovine faecal samples tested for Trichostrongylidae eggs in 2023 and the results by percentage and Figure 9.2 the annual distribution of positive results.

O. ostertagi can cause another distinct syndrome in weanlings known as ostertagiasis *Type 2*. This condition is more commonly seen in housed cattle in late winter and early spring, and is caused by larvae having become

Table 9.1.: Number of bovine faecal samples tested for Trichostrongylidae eggs in 2023 and results by percentage (n=6499).

Result	No. of samples	Percentage
Negative	4874	**75.0**
Low (50-200 epg)	868	**13.4**
Medium (200-700 epg)	429	**6.6**
High (>700 epg)	328	**5.0**

(a) *Morocco leather appearance pattern*



(b) Abomasal mucosa section*

Figure 9.1.: *Morocco leather* appearance pattern of the abomasal mucosa due to parasitic gastroenteritis. (b) Cross section of nematodes (arrows) fragments in the abomasal mucosa of a weanling. Photos: Aideen Kennedy.

hypobiotic, or dormant, within the abomasal mucosa (Figure 9.1a and Figure 9.1b). Milder weather will cause these larvae to emerge together leading to sudden onset of disease. It is less often seen in recent years and only one diagnosis of ostertagiasis *Type 2* was made at necropsy in 2023. Control of this condition must take place around the time of housing; selection of anthelmintics is important as some will not be effective against hypobiotic larvae.

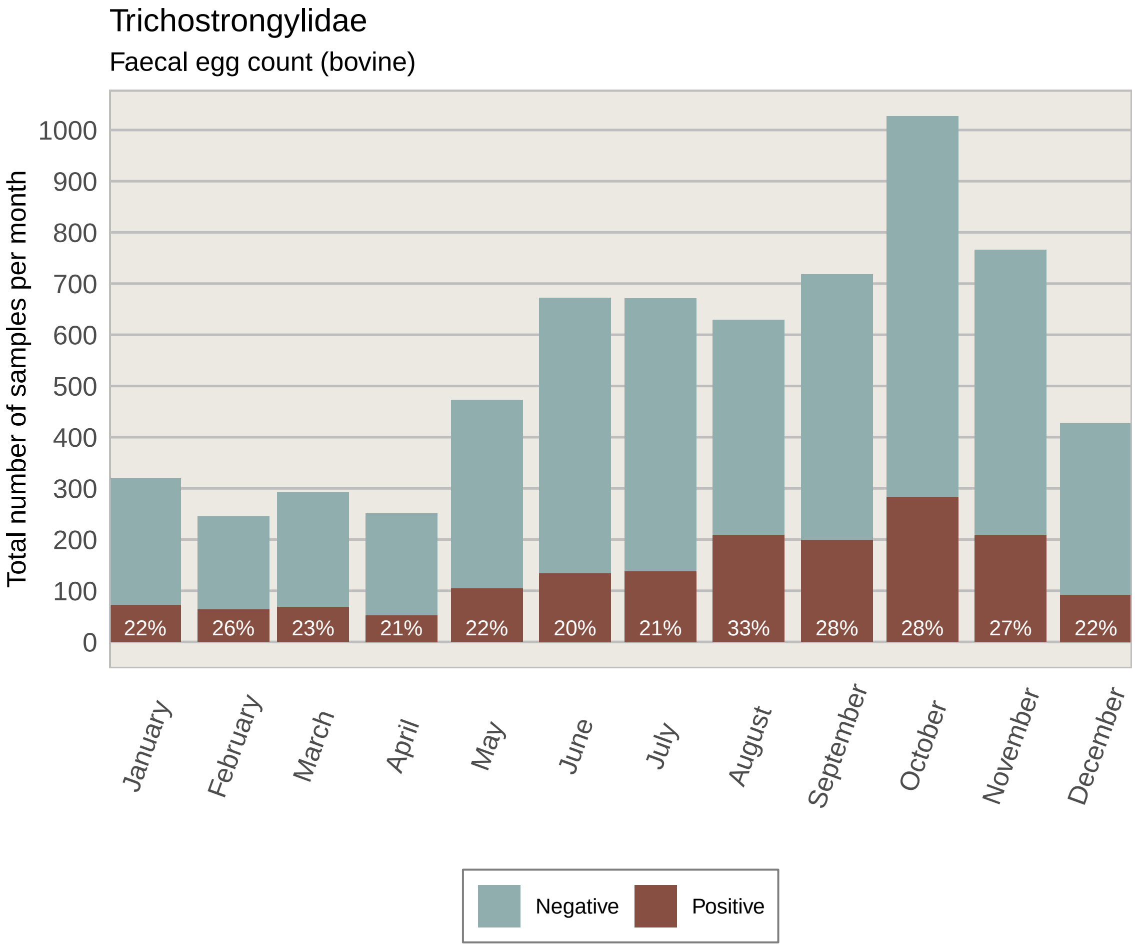


Figure 9.2.: Stacked count of bovine faecal samples (all ages) tested per month for Trichostrongylidae during 2023. The percentage in each bar represents positive samples (n=6499).

Samples of faeces and intestinal contents are examined for *Trichostrongylidae* eggs using the McMaster test, which provides a faecal egg count measured in eggs per gram (EPG). Submissions were received throughout the

Table 9.2.: Number of bovine faecal samples tested for Nematodirus eggs in 2023 and results by percentage (n=6499).

Result	No. of samples	Percentage
Negative	6411	**98.6**
Low (50-200 epg)	60	**0.9**
Moderate (200-700 epg)	25	**0.4**
High (>700 epg)	3	**0.0**

year, with a peak in the autumn months (September to November) and a smaller peak during early summer (June–July) (Figure 9.2). The greatest number of positive results from faecal sampling occurred in August and September, likely due to a build-up of pasture contamination over the course of the grazing season.

9.3. *Nematodirus spp.*

Nematodirus battus is an important pathogen of sheep in Ireland, and while it has been reported to cause disease in cattle, it is not considered to play a significant role in PGE in cattle in Ireland (McMahon et al. 2017). In 2023, as in previous years, the majority of bovine samples did not contain *Nematodirus spp.* eggs (Table 9.2).

9.4. Coccidia spp

Only three species— *Eimeria bovis*, *Eimeria zuernii*, and *Eimeria alabamensis*—are considered pathogenic to cattle (Figure 9.3). These protozoan organisms can cause disease in calves, which presents as diarrhoea, tenesmus, acute weight loss and poor growth rates in subclinical cases. Coccidiosis in older animals is less common. Coccidial oocysts can be detected in faeces using two methods: the McMaster test, which is also used to detect nematode eggs, or by modified Ziehl-Neelsen staining. Table 9.3 and Figure 9.4 demonstrate the distribution of bovine fecal samples tested in 2023 for coccidial oocysts, showing the number and percentage of samples in each infection category.

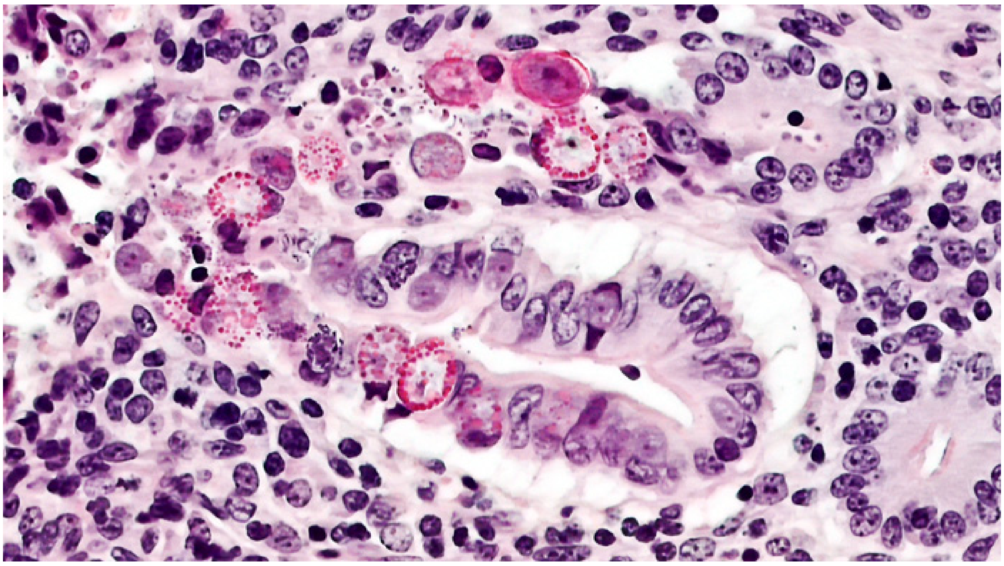


Figure 9.3.: Multiple protozoal life stages in the intestines in a case of coccidiosis in a calf. Photo: Rebecca Froehlich-Kelly.

It is important to note that oocyst production declines in the later stages of the disease. Additionally, sampling animals less than three weeks of age may result in false negatives due to the prepatent period of 21 days. Therefore, sampling the most recently affected animals is more likely to effectively detect the pathogens.

Table 9.3.: Number of bovine faecal samples submitted in 2023 (all ages) for detection of coccidial oocysts and results by percentage, (n=6694).

Result	No. of samples	Percentage
Not Detected	5399	**81**
Light Infection	1053	**16**
Moderate Infection	141	**2**
Heavy Infection	53	**1**
Severe Infection	48	**1**

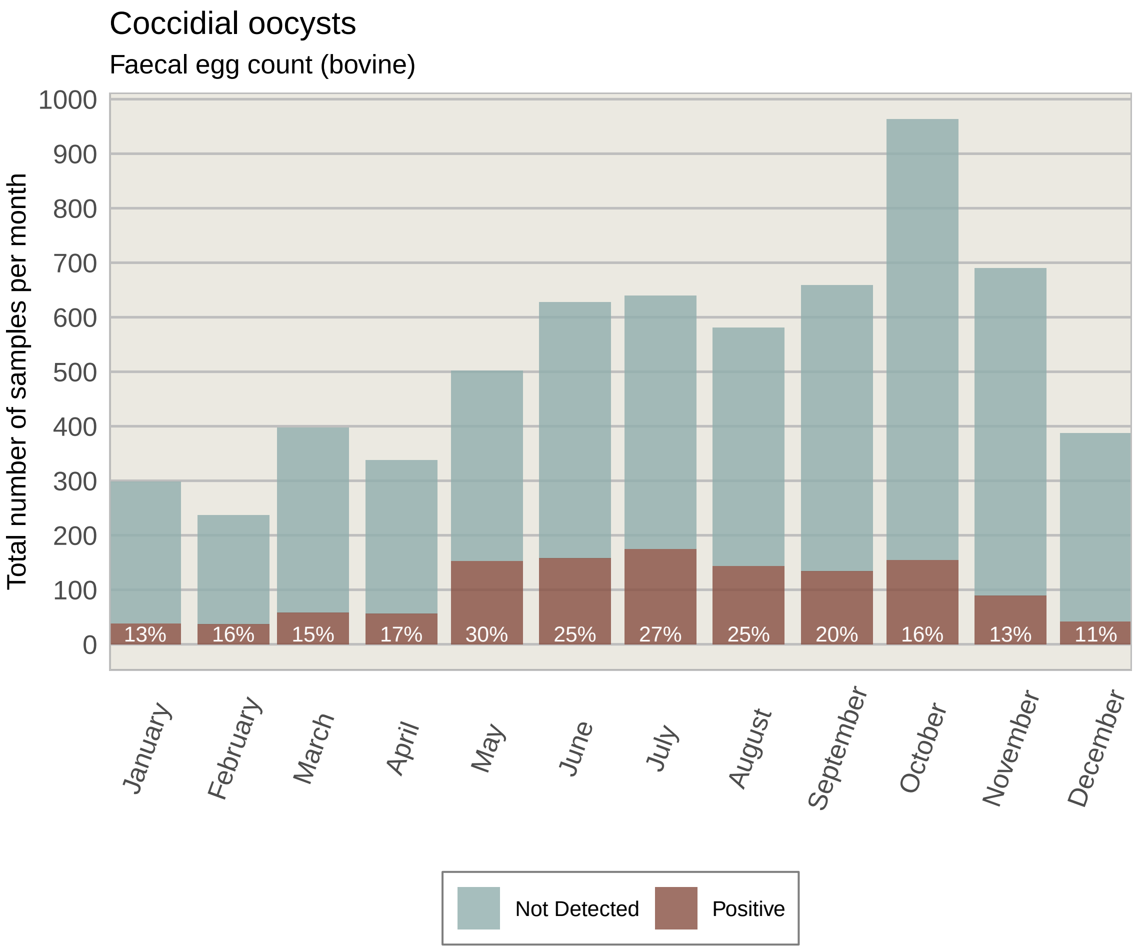


Figure 9.4.: Stacked number of bovine faecal samples (all ages) tested for coccidial oocysts in 2023. The percentage in each bar represents the number of positives (n=6694).

Treatment of animals with anticoccidial remedies after the onset of clinical signs is usually ineffective. Coccidiostats are most effective when used prophylactically, so controlling this disease should be an integral part of a herd health plan. Effective control of this parasite in calves necessitates rigorous hygiene practices, including providing dry bedding, preventing the accumulation of water and faeces in calf sheds and ensuring feed and water troughs remain free from fecal contamination. Maintaining appropriate stocking rates and using disinfectants that are effective against *Eimeria spp.* are also essential components of an effective control strategy.

9.5. Liver Fluke

Two species of trematodes are significant in the cattle herds of Ireland: the liver fluke *Fasciola hepatica* and the rumen fluke *Calicophoron daubneyi*. Eggs from these trematodes are detected in feces and intestinal contents using sedimentation or sugar flotation tests. Because these parasites shed eggs intermittently, a low egg count in

Table 9.4.: Number of bovine faecal samples submitted in 2023 (all ages) for detection of liver fluke eggs and breakdown of positive and negative results (n=5823).

Result	No. of samples	Percentage
Liver fluke eggs not detected	5705	**98**
Liver fluke eggs detected	118	**2**

faeces does not necessarily indicate a low level of fluke infection in the host.

While liver fluke can cause acute infections in animals like sheep, the chronic form of the disease is more significant in cattle. Liver flukes penetrate the intestinal wall and migrate through the liver to the bile ducts and gall bladder. The damage they cause to the liver during this process leads to weight loss, diarrhoea, and hypoproteinemia. The proportion of fecal samples testing positive for liver fluke eggs remains low; in 2023, liver fluke eggs were detected in approximately 2 *per cent* of samples, consistent with 2022, and a slight increase from around 1 *per cent* four years earlier (Figure 9.5) .

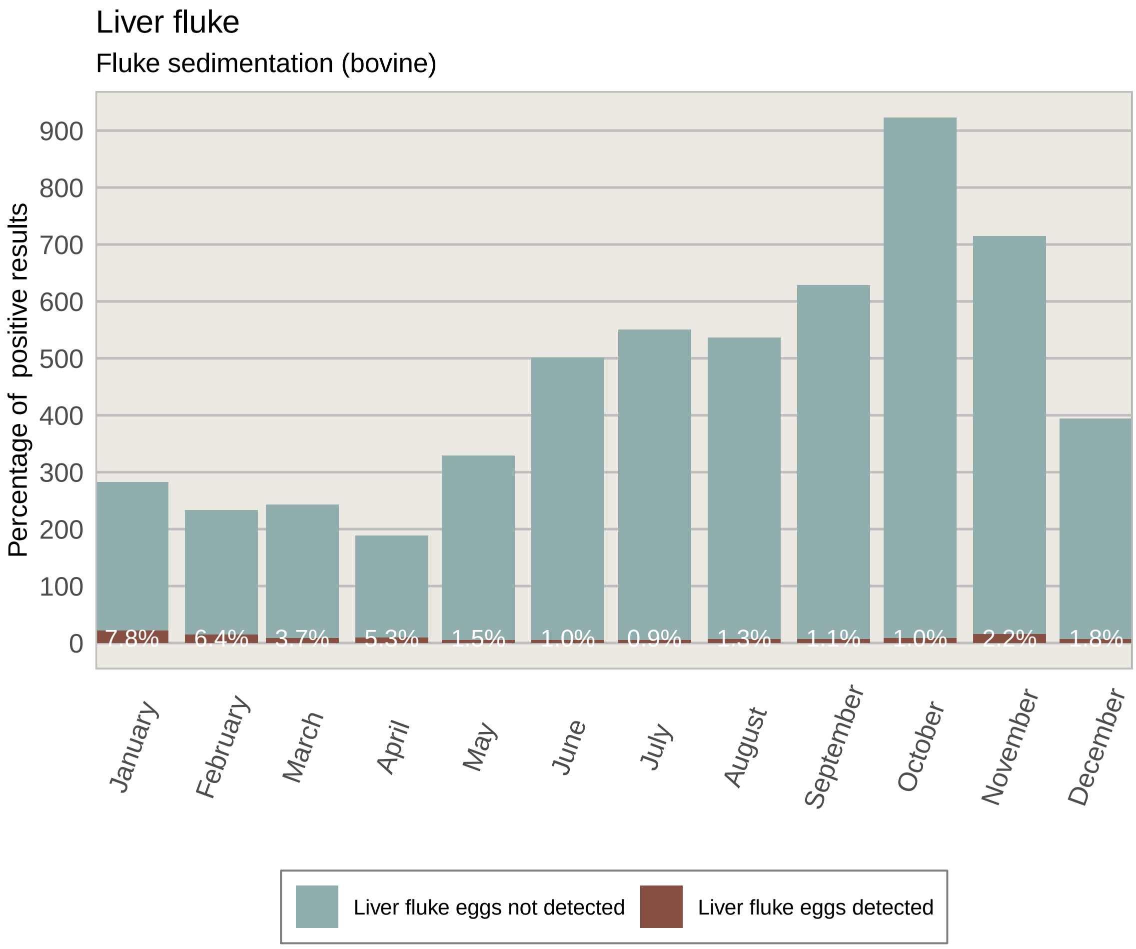


Figure 9.5.: Stacked number of bovine faecal samples (all ages) tested for liver fluke in 2023. The percentage in each bar represents the number of positive samples per month (n=5823).

Effective control strategies for liver fluke must be designed to minimise the emergence of anthelmintic resistance within fluke populations. Preventing cattle from accessing pastures contaminated by the intermediate host, *Galba truncatula*, through measures such as field drainage and fencing off consistently wet areas, can help control both liver and rumen fluke. In herds with a known high risk of liver fluke, a strategic dosing program can be implemented. It is crucial to consider the efficacy of selected flukicides against different stages of the fluke life cycle; dosing may need to be delayed or repeated if flukicides ineffective against immature fluke are used. Table 9.4 shows the number of bovine faecal samples submitted in 2023 (all ages) for detection of liver fluke eggs and breakdown of positive and negative results. Figure 9.5 presents the stacked number of bovine faecal samples (all ages) tested for liver fluke in 2023 and the percentage of positive samples per month.

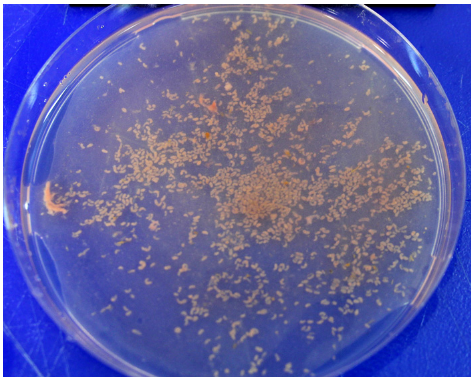
Table 9.5.: Number of bovine faecal samples submitted in 2023 (all ages) for detection of rumen fluke eggs and breakdown of positive and negative results (n=5823).

Result	No. of samples	Percentage
Rumen fluke eggs not detected	3844	**66**
Rumen fluke eggs detected	1979	**34**

9.6. Rumen fluke

Paramphistomes, or rumen fluke, infect cattle through ingestion. During the larval stage, they attach to the duodenal wall, which is the primary pathogenic phase. If large numbers are ingested, the resulting damage to the duodenal mucosa (Figure 9.7) can lead to severe diarrhoea and hypoproteinaemia, sometimes causing recumbency and death (O'Shaughnessy et al. 2017; Toolan et al. 2015). As the trematode matures, it migrates to the rumen, where it subsists on rumen contents. The predominant rumen fluke species in Ireland is *Calicophoron daubneyi*, and its life cycle involves the same intermediate host as liver fluke, the mud snail *Galba trunculata*. Table 9.5 shows the number of bovine faecal samples submitted in 2023 (all ages) for detection of rumen fluke eggs and breakdown of positive and negative results. Figure 9.7 presents the stacked number of bovine faecal samples (all ages) tested for rumen fluke in 2023 and the percentage of positive samples per month.

(a) Haemorrhagic duodenal mucosa



(b) Larvae of *Calicophoron daubney*

Figure 9.6.: Haemorrhagic duodenal mucosa (arrow) due to infection with larval *Calicophoron daubneyi*. Photo: Brian Toland. (b) Larvae of *Calicophoron daubneyi* which have been strained from intestinal contents of an animal with acute paramphistomosis. Photo: Denise Murphy.

In 2023, the detection of rumen fluke eggs in fecal samples consistently exceeded that of liver fluke eggs, continuing a trend observed in previous years (Table 9.5 and Figure 9.7). Additionally, diagnoses of acute larval paramphistomosis at necropsy significantly increased, with at least 21 cases identified in the RVLs, compared to just one case in 2022. This increase is likely due to the wetter weather conditions in 2023, with July 2023 being the wettest on record, see The Irish Meteorological Service webpage[1]

[1] https://www.met.ie/climate-statement-for-august-2023#:~:text=Hot%20June%2C%20wet%20July%2C%20stormy,caused%20flash%20and%20coastal%20flooding.

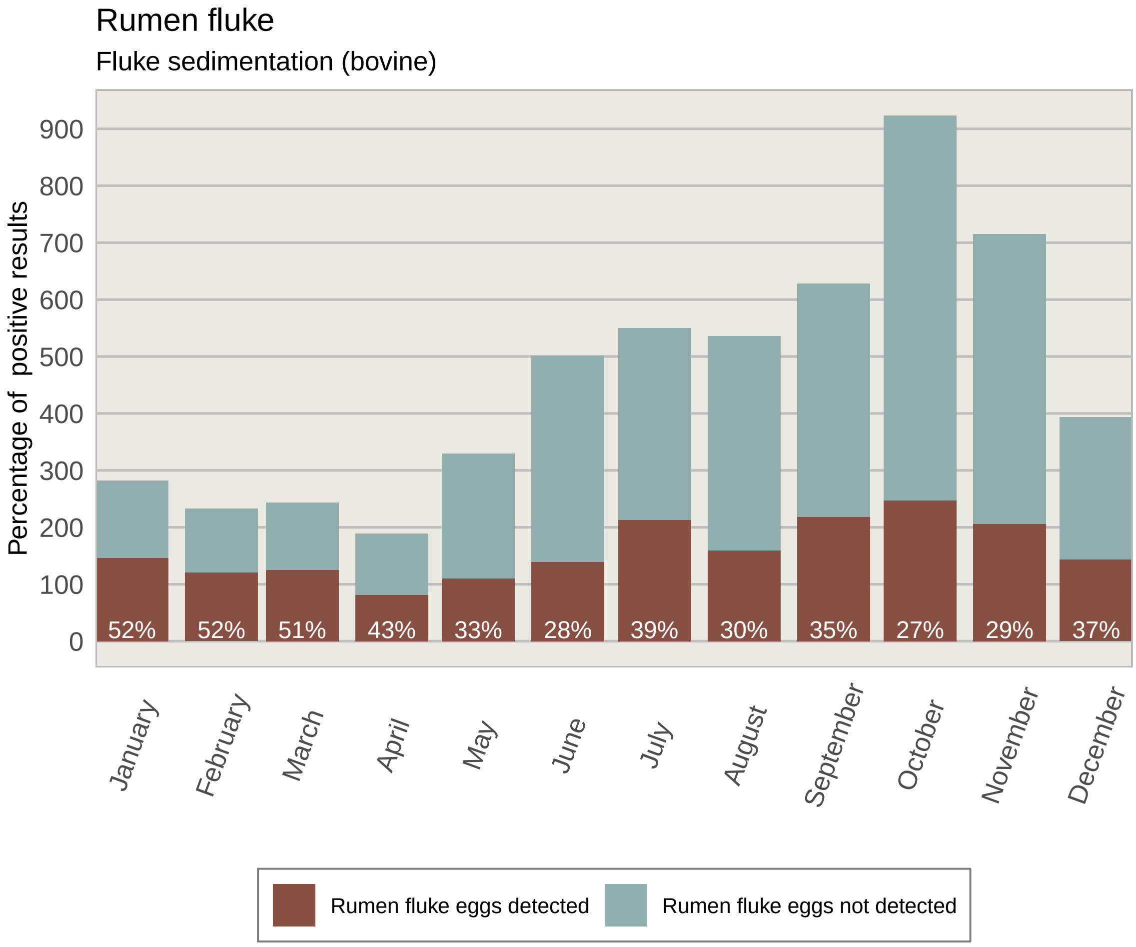


Figure 9.7.: Stacked count of bovine faecal samples (all ages) tested for rumen fluke in 2023. The percentage in each bar represents positive samples (n=5823).

There is currently no licensed flukicide specifically for paramphistomes in Ireland; however, oxyclozanide and closantel have demonstrated some efficacy in reducing faecal egg counts. For severe acute rumen fluke infections, repeated dosing with oxyclozanide at three-day intervals has been suggested. It is advised that treatment for rumen fluke should only be administered when clinical disease is confirmed; the presence of paramphistome eggs in the faeces of healthy, well-performing animals does not necessarily warrant treatment.

Part II.

Sheep

10. Ovine Diseases

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10.1. Overview

In 2023, the national sheep population was estimated as 3.99 million, representing a slight decline (0.6 *per cent*) on 2022 population estimates (CSO, 2023[1]). The majority of sheep enterprises are located in the west and north-west of the country. Accordingly, Sligo and Athlone RVLs receive the majority of ovine carcase submissions for *post mortem* examination.

During 2023, 1334 ovine carcases were submitted to the Regional Veterinary Laboratory service for *post mortem* examination. This consisted of 595 adult sheep (older than 12 months of age) and 739 lambs (under 12 months of age). This represents a slight increase in total ovine carcase submissions compared to 2022 (1254). As the range of diagnoses is age dependent, the *post mortem* results in this section are presented by age category. Conditions have been grouped into broader diagnostic categories according to the affected system to facilitate presentation and comparison with previous reports.

10.2. Lambs

Mortality in lambs during 2023 (28.7 *per cent* of cases) (Table 10.1 and Figure 10.3). Within this category, parasitic-gastroenteritis (PGE) associated with strongyle infection represents the most frequently reported condition, accounting for 57 *per cent* (n=121) of cases within this category. A diagnosis of coccidiosis was recorded in 41 lambs, accounting for 19.3 *per cent* of diagnoses within the GIT subcategory.

Systemic infections were reported as the cause of death in 13.1 *per cent* of lamb submissions in 2023. Systemic infections include bacteraemia, septicaemia and toxaemia. In agreement with previous years, the pathogens most frequently implicated in these infections were *Biberstenia trehalosi* (n=38) and *E.coli* (n=22).

Respiratory infections were recorded as the cause of mortality in 11.6 *per cent* of lamb submissions. *Mannheimia haemolytica* was the most frequently diagnosed aetiological agent, present in almost 35 *per cent* of pneumonia cases. *Biberstenia trehalosi* was the second most commonly isolated pathogen (24.4 *per cent* of cases). *Trueperella pyogenes* was isolated in a small number of pneumonia cases.

Clostridial diseases were recorded as the cause of mortality in 11.1 *per cent* of lamb carcase submissions. Pulpy kidney/enterotoxaemia associated with *Clostridium perfringens* type D infection was the most frequently diagnosed condition within this subcategory (91.5 *per cent* of cases). *C. perfringens* may be part of the normal microflora of the gastrointestinal tract of sheep. Clinical disease typically occurs in un-weaned or recently weaned lambs on a high plane of nutrition and is normally associated with overconsumption of milk or concentrates and subsequent rapid proliferation of *C. perfringens* and elaboration of epsilon toxin. Overgrowth of *C. perfringens* can also occur in immunocompromised lambs or those with a heavy gastrointestinal parasite burden. *C. perfringens* toxins increases intestinal permeability, resulting in oedema in several organs including the lungs, kidney and brain.

[1] https://data.cso.ie/

Table 10.1.: Conditions most frequently diagnosed on *post mortem* examinations of lambs in 2023 (n=739).

Disease	No. of Cases	Percentage
GIT Infections	212	**28.7**
Systemic Infections	97	**13.1**
Respiratory Infections	86	**11.6**
Clostridial disease	82	**11.1**
Nutritional/metabolic conditions	38	**5.1**
GIT torsion/obstruction	37	**5.0**
Other	30	**4.1**
Neurological conditions	24	**3.2**
Diagnosis not reached	23	**3.1**
Liver disease	18	**2.4**
Tick-Borne Fever	18	**2.4**
GIT ulcer/perforation/foreign body	17	**2.3**
Trauma	16	**2.2**
Reproductive Tract Conditions	13	**1.8**
Navel Ill/Joint Ill	11	**1.5**
Urinary Tract conditions	11	**1.5**
Cardiac/circulatory conditions	6	**0.8**

Note:
The 'Other' grouping is a combination of multiple minor categories that have less than five cases.

Hyperglycaemia and glucosuria result from episilon toxin mediated release of hepatic glycogen. Treatment is typically unrewarding. Enterotoxaemia can be cheaply prevented by effective clostridial vaccination.

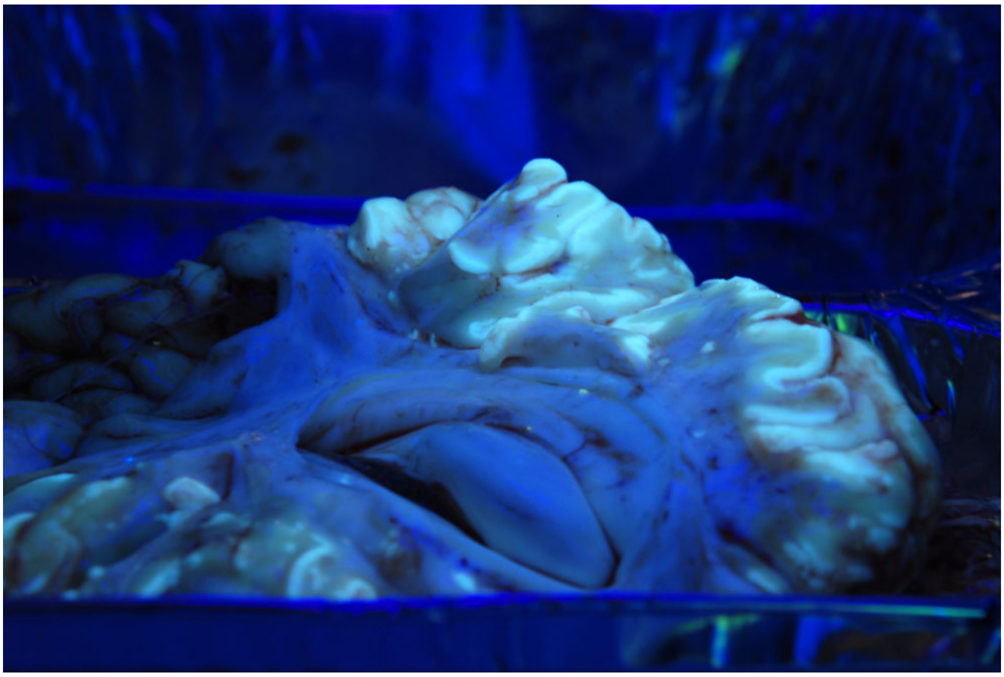

Figure 10.1.: Bilateral symmetric laminar autofluorescence under the ultraviolet light in an animal with thiamine deficiency (cerebrocortical necrosis or polioencephalomalacia). Photo: Cosme Sánchez-Miguel

Nutritional and metabolic conditions were diagnosed in 5.1 *per cent* of lamb carcases in 2023. Ruminal acidosis was the most frequently reported condition within this subcategory (accounting for 58 *per cent* of cases). Ruminal acidosis results from excessive consumption of rapidly fermentable carbohydrates resulting in excessive production of lactic acid. This results in a drop in rumen pH, increased ruminal acidity and osmolality which inhibits the rumen microflora with resultant metabolic disturbances. Diets lacking in fibre and those composed of a large proportion of concentrates induce less salivation and rumination at ingestion, reducing salivary buffering capacity and overgrowth of lactobacilli. In acute cases, death occurs rapidly without obvious clinical signs. Malnutrition was the reported cause of mortality in almost 40 *per cent* of cases within this subcategory.

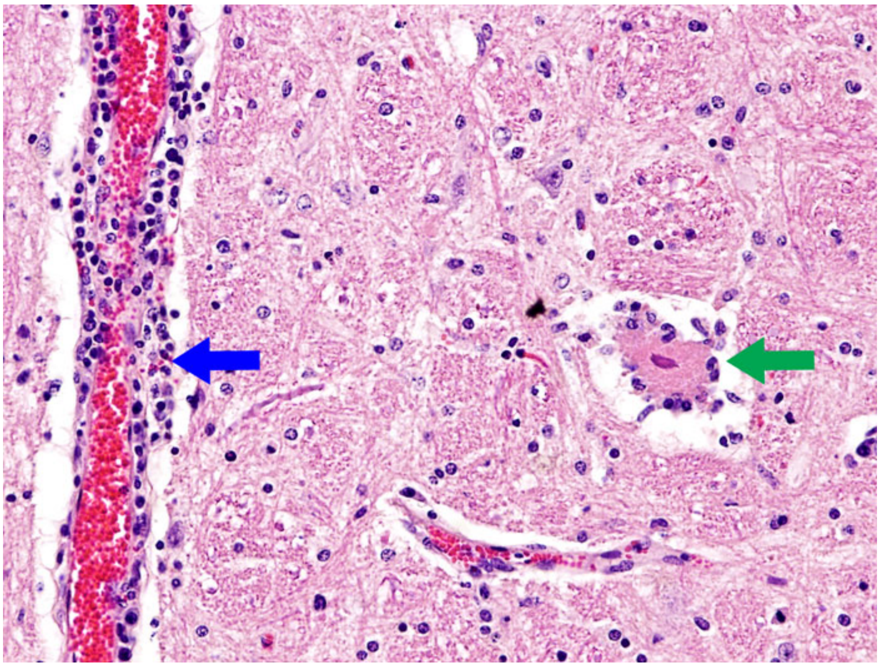

Figure 10.2.: Midbrain of a sheep showing characteristic microscopic lesions of viral encephalitis (louping-ill, Flavivirus) consisted of mononuclear perivascular cuffing (blue arrow) and neuronal satellitosis (green arrow) and neurophagia Photo: Cosme Sánchez-Miguel

Neurological conditions were recorded as the cause of mortality in 3.2 *per cent* of lamb cases. Cerebrocortical necrosis (CCN) was the most frequently diagnosed condition within this subcategory (29 *per cent* of cases). This condition results from thiamine (vitamin B1) deficiency. Deficiency can be caused by reduced production of thiamine by rumen microbes or degradation of thiamine by thiaminases. These can be ingested or can be produced by gut bacteria. Thiamine is a component of several coenzymes that assistin glucose metabolism. As a result, thiamine deficiency inhibits carbohydrate metabolism, increasing blood lactate concentration. Sources of ingested thiaminases include plants such as Bracken fern. Diagnosis of CCN is based on clinical signs and a history of thiamine deficiency or thiaminase activity. Gross lesions at *post mortem* examination are variable and depend on the stage of disease.

Prevention of CCN is best achieved through provision of adequate quantities of fibre in the diet. Dietary changes should be introduced slowly and carbohydrate levels should be gradually increased. Louping ill was diagnosed in 25 *per cent* of cases. Louping ill virus is a flavivirus associated with acute, fatal encephalomyelitis (Figure 10.2)in sheep transmitted by ticks (*Ixodes ricinus*). Initial clinical signs of infection are non-specific and include fever, anorexia and depression. Neurological signs typically develop as the infection progresses. Affected animals are ataxic and may exhibit tremors and opisthotonos. Infection develops weeks or months after sheep have grazed tick infested pastures. The severity of outbreaks is dependent on weather conditions, tick population dynamics and the immune status of the flock.

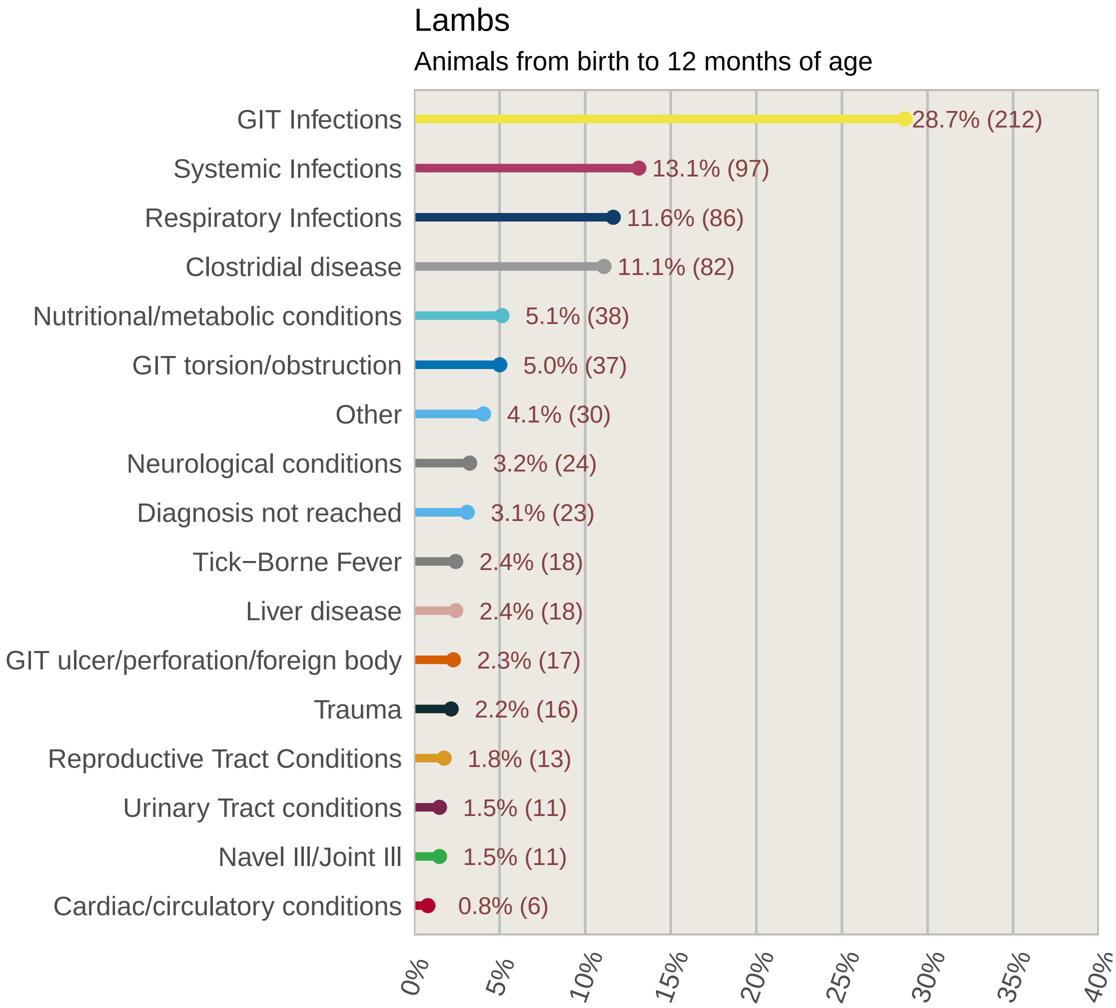

Figure 10.3.: Conditions most frequently diagnosed on *post mortem* examinations of lambs in 2023 (n=739). Only categories with n value greater than 8 are shown. Note: the 'Other' grouping is a combination of multiple minor categories that have less than five cases.

(a) Acute liver fluke

(b) Heamglobinuric nephrosis

Figure 10.4.: Acute liver fluke in a sheep (a). Note the numerous migration tracts with deposition of black pigment (hematin). Photo: Shane McGettrick. (b) Heam0globinuric nephrosis due to acute haemolysis from copper poisoning. Photo: Cosme Sánchez-Miguel

10.3. Adult sheep

As with in previous years, respiratory disease was the leading cause of mortality in adult sheep during 2023 (16 *per cent* of cases) (Figure 10.5). Pneumonia was the most frequently diagnosed condition within this category with *Bibersteinia trehalosi* and *Mannheinmia haemolytica* the pathogens most commonly implicated in these infections.

Gastrointestinal infections remain the second most frequently diagnosed group of conditions during 2023 (15.8 *per cent* of cases). Within this category, parasitic gastroenteritis was the most common infection, accounting for almost 75 *per cent* of diagnoses. Liver disease was diagnosed in 11.4 *per cent* of adult sheep submissions in 2023. This represents an increase of more than 4 *per cent* compared to 2022 levels. Fascioliasis was the most common condition within this category. Acute fasciolosis (Figure 10.4a) was diagnosed in 63 *per cent* of cases and a further 25 *per cent* cases were attributed to chronic fascioliasis. Liver abscessation and bacterial hepatitis diagnoses accounted for the remaining liver disease cases in 2023.

Systemic infections were diagnosed in almost 7 *per cent* of adult carcase submissions in 2023. As in previous years, *Biberstenia trehalosi* was the pathogen most frequently implicated in these infections. Neurological conditions accounted for 5.4 *per cent* of *post mortem* diagnoses in adult sheep during 2023. Listeriosis was the most frequently diagnosed condition within this category, accounting for 53 *per cent* of all cases. Listeric encephalitis primarily affects housed sheep during the winter and spring. The less acidic pH of poorly preserved silage promotes the growth of *Listeria monocytogenes* and outbreaks of listeriosis typically occur approximately 10 days after ingestion of contaminated silage.

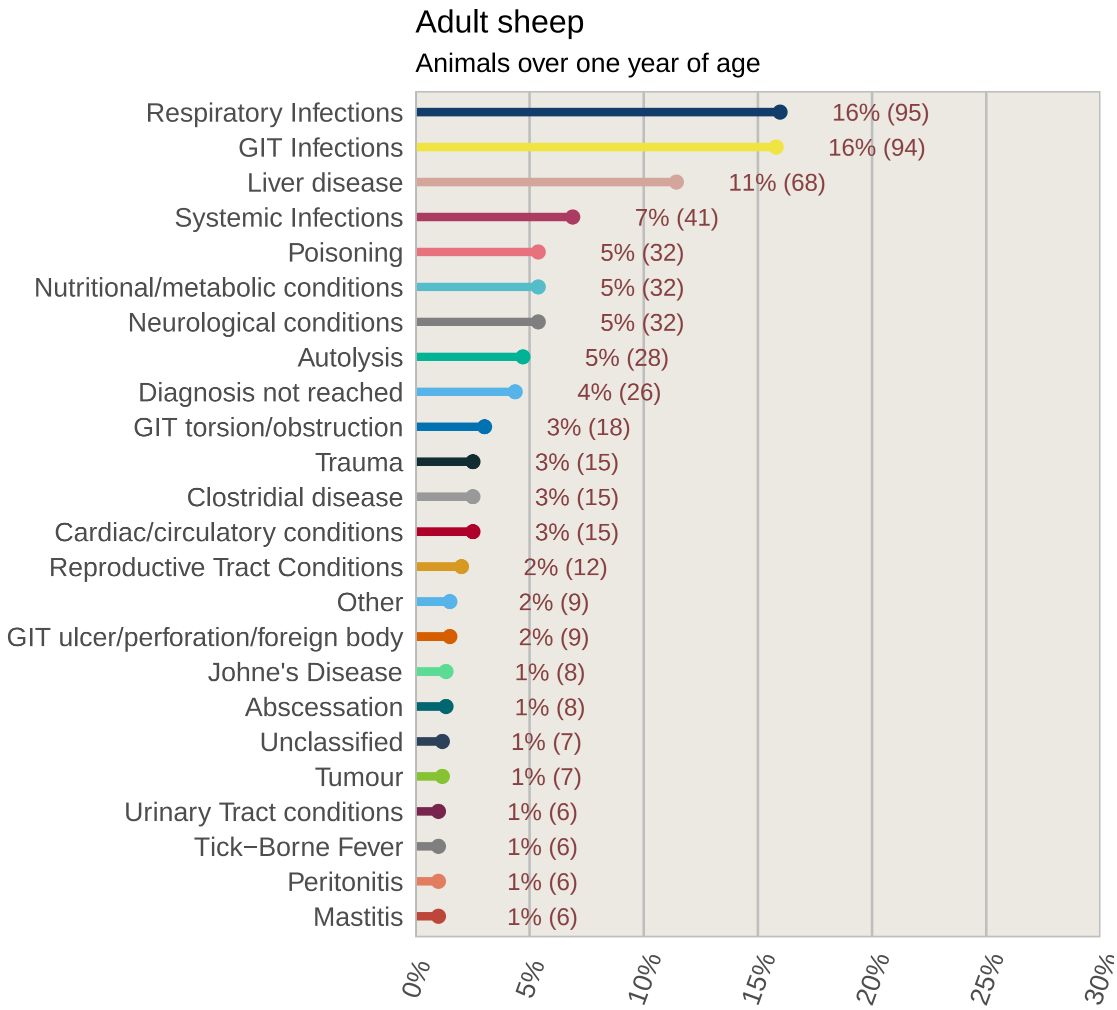

Figure 10.5.: Conditions most frequently diagnosed on *post mortem* examinations of adult sheep (over one year of age) in 2023 (n=595). Note: the 'Other' grouping is a combination of multiple minor categories that have less than five cases.

Table 10.2.: Conditions most frequently diagnosed on *post mortem* examinations of adult sheep (over one year of age) in 2023 (n=595). Note: the Other grouping is a combination of multiple minor categories that have less than five cases.

Disease	No. of Cases	Percentage
Respiratory Infections	95	**16.0**
GIT Infections	94	**15.8**
Liver disease	68	**11.4**
Systemic Infections	41	**6.9**
Neurological conditions	32	**5.4**
Nutritional/metabolic conditions	32	**5.4**
Poisoning	32	**5.4**
Autolysis	28	**4.7**
Diagnosis not reached	26	**4.4**
GIT torsion/obstruction	18	**3.0**
Cardiac/circulatory conditions	15	**2.5**
Clostridial disease	15	**2.5**
Trauma	15	**2.5**
Reproductive Tract Conditions	12	**2.0**
Other	9	**1.5**
GIT ulcer/perforation/foreign body	9	**1.5**
Abscessation	8	**1.3**
Johne's Disease	8	**1.3**
Tumour	7	**1.2**
Unclassified	7	**1.2**
Mastitis	6	**1.0**
Peritonitis	6	**1.0**
Tick-Borne Fever	6	**1.0**
Urinary Tract conditions	6	**1.0**

Nutritional and metabolic conditions were diagnosed in 5.4 *per cent* of adult ovine submissions, representing a decline of almost 4 *per cent* compared to 2022. Hypocalcaemia, pregnancy toxaemia (twin lamb disease) and grass tetany were the most frequently diagnosed conditions within this category. These conditions occur around the periparturient period and are associated with a lack of nutrient availability or reduced intake combined with an increased nutrient demand. Prevention of these conditions is thus focused on provision of adequate feed and avoidance of stressful situations in late pregnancy and early lactation.

The percentage of cases of poisoning in adult sheep increased from 1.7 *per cent* in 2022 to 5.4 *per cent* in 2023. Of the 32 poisoning cases, 15 of these were attributed to copper toxicosis (Figure 10.4b). Two types of copper toxicosis can occur in sheep, depending on whether the exposure is chronic or acute. Chronic toxicosis (the most prevalent form) develops after a prolonged subclinical period during which copper accumulates in the liver. When the liver's capacity to store copper is overwhelmed, it releases copper into the bloodstream, resulting in severe haemolysis often with fatal consequences. Acute copper toxicosis is rare and typically results from accidental ingestion or administration of large quantities of copper. In cases of parenteral administration, collapse and death can occur rapidly. Acute oral exposure can lead to severe gastroenteritis, followed by shock and death.

11. Ovine Abortion

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11.1. Overview

While spontaneous abortion can occur in sheep, an abortion rate in excess of two *per cent* may suggest an infectious cause and veterinary investigation is warranted. The main focus of laboratory investigations when presented with aborted lambs is to determine if an infectious abortion causing agent is present. The importance of submission of the foetus plus the placenta, when available, should be stressed. International studies have reported investigations that included placental tissue samples were more than twice as likely to have a diagnosis compared to investigations without placenta (Clune et al. 2021).

In 2023, 426 *post abortion* specimens (foetuses and/or foetal membranes) were submitted to the Regional Veterinary Laboratory service for examination. As with previous years, toxoplasmosis and enzootic abortion of ewes (EAE) represented the most frequently diagnosed pathogens in cases of ovine abortion. The remaining diagnoses were largely attributed to bacterial pathogens.

11.2. *Toxoplasma gondii*

In 2023, 21.4 *percent* of ovine foetuses examined by Toxoplasma PCR were positive (Table 11.1). Similarly 22 *percent* tested positive by foetal serum agglutination tests (Table 11.2). *Toxoplasma gondii* is a protozoan parasite. Cats serve as the main reservoir of infection. Cats can become infected following the ingestion of tissue cysts (in rats/ mice). Oocysts can remain viable in the environment for months. Generally, cats develop immunity after the initial infection and usually only shed oocysts once in their lifetime.

Table 11.1.: Ovine foetuses examined by Toxoplasma PCR in 2023 (n=215).

PCR Result	No of Cases	Percentage
No Pathogen detected	164	76.3
Positive	46	21.4
Inconclusive	5	2.3

Table 11.2.: Toxoplasma PCR and Toxoplasma serology (Agglutination Test) test results in 2023 (n=270).

Result	No of Cases	Percentage
Negative	212	78
Positive	58	22

Note:
A sample was deemed positive when either
or both tests were positive.
Inconclusive results were categorised as Negative.

Figure 11.1.: Diffuse placentitis in a ovine abortion caused by *T. gondii*. Photo: Aideen Kennedy.

Following ingestion of oocysts by the sheep, there is a phase of rapid division and dissemination throughout the body, which may result in necrosis in various organs e.g. brain, liver myocardium. Infection is most serious in pregnant animals exposed for the first time. In pregnant ewes, tachyzoites spread to the cotyledons, causing necrosis. Tachyzoites may also spread to the foetus, causing necrosis in multiple organs.

Characteristic changes to the placenta include dark red cotyledons speckled with white foci. Toxoplasmosis is not passed from sheep to sheep. Once immunity has developed the sheep is unlikely to abort again.

Prevention involves avoiding feed/ water contamination with cat faeces. Rodent control can be useful. A vaccine is available. *Toxoplasma gondii* is a zoonotic agent of greatest risk to immunocompromised people and pregnant woman.

Table 11.3.: Percentage of *Chlamydophila abortus* PCR results in ovine foetuses in 2023 (n=216).

PCR Result	No of Cases	Percentage
No Pathogen detected	148	**68.5**
Positive	48	**22.2**
Inconclusive	20	**9.3**

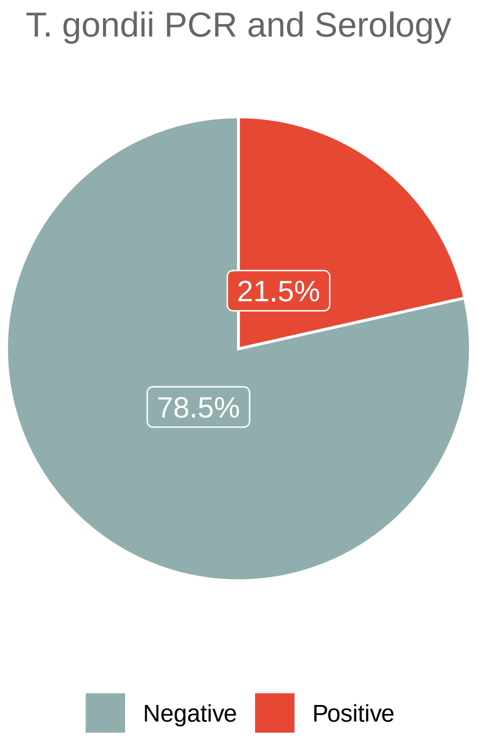

Figure 11.2.: Pie chart showing the *Toxoplasma gondii* PCR and serology (Agglutination Test) test results in ovine foetuses in 2023.

11.3. *Chlamydophila abortus* (EAE)

Chlamydia abortus is the causative agent of enzootic abortion of ewes (EAE). 22.2 *percent* of ovine foetuses tested for EAE by PCR were positive (Table 11.3 and Figure 11.3). The disease typically enters a flock through the purchase of an infected animal. When infected animals abort, large numbers of chlamydiae are shed in the placenta and uterine fluids resulting in environmental contamination. Infection is typically by ingestion. Non-pregnant female sheep, including newborn lambs, can pick up the infection from an aborting ewe and the organism will remain latent until the next pregnancy and then become active, causing the animal to abort. Ewes infected in late pregnancy do not typically abort as there is a lag period between infection and manifestation of reproductive failure. These ewes are likely to abort in the following pregnancy. Abortion generally occurs 2–3 weeks prior to expected lambing.

It is advisable to isolate ewes that abort for three weeks, destroy placentae and disinfect pens. Keep pregnant ewes away from infected pens and don't use aborted ewes to foster replacement ewe lambs. Ewes that have aborted because of EAE are considered immune to further abortions from the same cause, but these ewes may be persistently infected, and may excrete the organism, potentially allowing infection of naïve animals. Vaccines are available. *Chlamydia abortus* is a zoonosis and appropriate advice should be provided to people in contact.

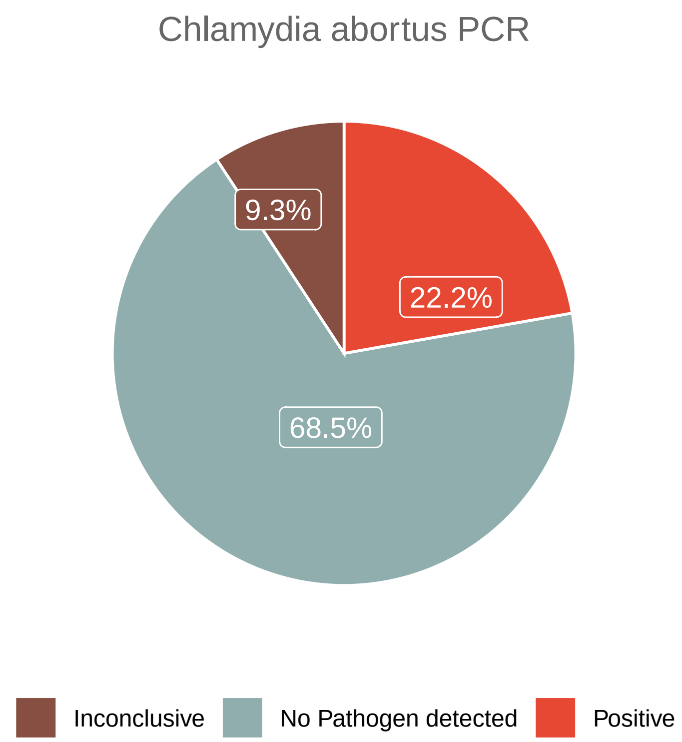

Figure 11.3.: Pie chart showing the *Chlamydophila abortus* PCR test results in ovine foetuses in 2023.)

11.4. Other Organisms

Routine foetal culture was performed on 426 post-abortion submissions during 2023 (Table 11.4). In the majority of cases, no significant bacterial growth was reported (68.8 *per cent*). Coliforms were detected in approximately 20 *percent* of cases, but the clinical significance of these organisms is uncertain. *Listeria spp.* were detected in almost 3.1 *per cent* of samples

Campylobacter abortion caused by *Campylobacter fetus fetus* or *Campylobacter jejuni* was identified in less than three *percent* of cases in 2023. It is also a potentially zoonotic agent. The initial source of infection is faeces of domestic livestock (e.g. about ten *per cent* of cattle faeces are positive for Campylobacter), dogs and wildlife, including birds.

Ingestion of food or water contaminated with the bacteria gives rise to a primary infection during pregnancy. Abortion usually occurs in the last third of pregnancy and large abortion storms may occur. The ewes do not become ill and typically do not abort from this cause in subsequent pregnancies.

Zoonotic implications

- Many of the ovine abortifacient pathogens are zoonotic, and thus can cause infection in humans.
- In particular pregnant women and immunocompromised people should avoid contact with ewes during the lambing season.

Table 11.4.: Combined frequency of detection of selected secondary abortion agents on routine foetal culture of ovine foetuses in 2023 (n=426).

Organism	No of Isolates	Percentage
No Significant Growth	293	**68.8**
Coliforms	83	**19.5**
Unclassified	17	**4.0**
Listeria spp	13	**3.1**
Campylobacter fetus	10	**2.3**
Streptococcus spp	10	**2.3**
Bacillus licheniformis	8	**1.9**
Staph. spp	7	**1.6**
Trueperella pyogenes	7	**1.6**
Aspergillus spp	5	**1.2**
Campylobacter jejuni	4	**0.9**
Campylobacter spp	1	**0.2**
Histophilus somnus	1	**0.2**
Mannheimia haemolytica	1	**0.2**
Salmonella dublin	1	**0.2**
Salmonella spp	1	**0.2**

12. Ovine Parasites

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12.1. Overview

The effective control and management of parasites on sheep farms is essential to their viability. Anthelmintic resistance i.e. the ability of parasites to survive treatments that would normally kill them, poses a real and constantly evolving challenge. In a nationwide survey of anthelmintic treatment failure on sheep farms in Ireland carried out by Keegan et al. (2017) it was reported that almost half of all anthelmintic treatments administered to lambs were ineffective.

The Regional Veterinary Laboratory (RVL) network has encountered a number of farms where an inability to effectively control parasitic gastroenteritis is threatening the sustainability of the sheep enterprise. The use of laboratory testing e.g. drench tests and faecal egg count reduction tests (FECRTs) is essential to establish the anthelmintic resistance status of the parasites on individual farms so that tailor made parasite programmes can be established for individual farms.

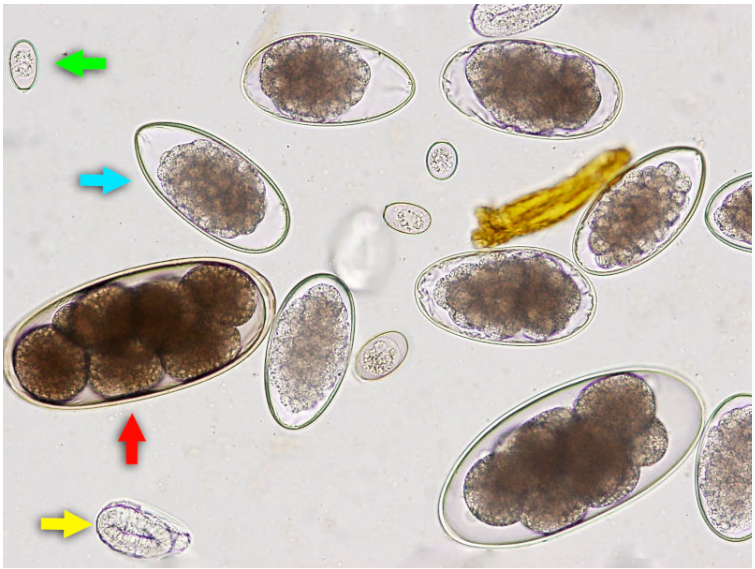

Figure 12.1.: Different parasitic eggs in a ovine faecal sample: Strongyle eggs (blue arrows), Nematodirus eggs (red arrow) and coccidial oocysts (green arrow) Photo: Cosme Sánchez-Miguel

12.2. *Trichostrongyles*

Trichostrongylidae nematodes, including genera such as *Ostertagia*, *Haemonchus*, and *Trichostrongylus*, have direct life cycles with infective larvae (*L3*) developing on pasture. Sheep ingest *L3* larvae during grazing, leading to adult

Table 12.1.: Number of ovine faecal samples tested for Trichostrongylidae eggs in 2023 and results by percentage (n=2717). The ranges assume the absence of H. contortus in the faecal sample.

Result	No. of samples	Percentage
Negative	985	**36**
Low (50-250 epg)	508	**19**
Medium (250-750 epg)	510	**19**
High (>750 epg)	714	**26**

worm establishment in the gastrointestinal tract. Factors influencing infection rates include climate, pasture management and host immunity. Clinical manifestations range from subclinical infections to severe disease, depending on worm burden and host factors. Figure 12.2 demonstrates the total number of samples tested per month for Trichostrongylidae eggs in 2023, with the percentage in each bar representing positive samples. This visualisation underscores the need for heightened vigilance and intervention during peak infection periods.

By closely monitoring these trends and adapting management practices accordingly, sheep farmers can effectively mitigate the impact of Trichostrongylidae infections on their flocks.

Faecal egg count (FEC) results for 2023 from 2717 ovine samples across all age groups are summarised in Table 12.1.

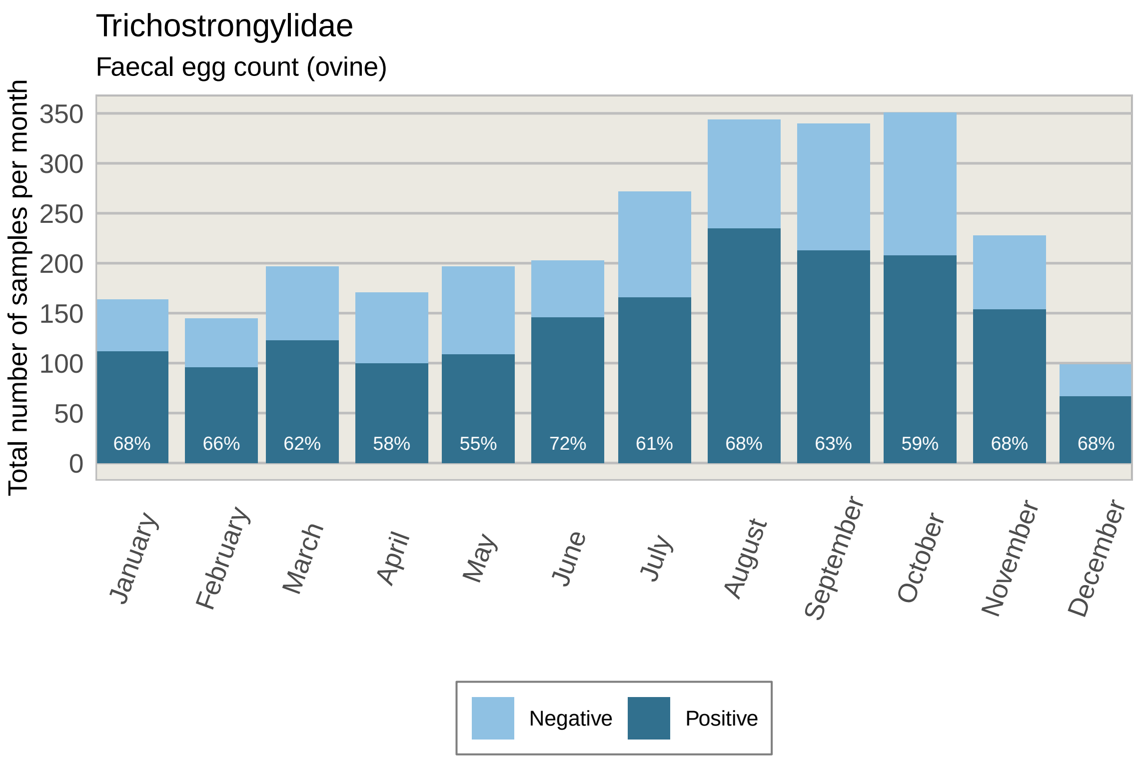

Figure 12.2.: Stacked count of ovine faecal samples (all ages) tested per month for Trichostrongylidae during 2023. The percentage in each bar represents positive samples (n=2717).

12.3. *Haemonchus contortus*

Haemonchus contortus (barber pole worm) is being diagnosed with increasing frequency in a number of RVLs. Frequently, affected sheep are found dead or present with lethargy and weakness prior to death. Diarrhoea may not be a pronounced clinical sign, while anaemia is a consistent feature. Each worm can remove about 0.05ml of blood per day so sheep with 5000 *H. contortus* worm burden may lose about 250ml daily. *Haemonchus contortus* have a very high fecundity frequently resulting in extremely high faecal egg counts in affected animals, it also means that these worms have the potential to develop resistance quite quickly.

Table 12.2.: Number of ovine faecal samples tested for *Nematodirus* eggs in 2023 and results by percentage (n=2717).

Result	No. of samples	Percentage
Negative	2417	**89.0**
Low (50-150 epg)	119	**4.4**
Moderate (>150-300 epg)	92	**3.4**
High (>300 epg)	89	**3.3**

Figure 12.3.: Barber's pole worm (*Haemonchus contortus* in the abomasum of a sheep. Photo: Maresa Sheehan

12.4. *Nematodirus*

It is recommended to use a white benzimidazole wormer for controlling *Nematodirus* worms, as there is minimal reported resistance to this wormer. This strategy preserves the efficacy of other wormer classes for later in the year when resistance to white wormers may be more prevalent (further information available here[1]). The timing of *Nematodirus* treatment should align with the annual *Nematodirus* forecast issued by DAFM.

Clinically, *Nematodirus* and *coccidial* infections present with very similar clinical signs. To ensure appropriate treatment, it is crucial to accurately diagnose the cause of clinical signs in lambs through faecal egg count testing.

According to Table 12.2, a total of 2717 ovine faecal samples were analysed to detect the presence of Nematodirus eggs in 2023. The results indicated that 89 *per cent* of the samples were negative for Nematodirus eggs, 4.4 *per cent* had low egg counts (50-150 eggs per gram, epg), 3.4 *per cent* had moderate egg counts (>150–300 epg), and 3.3 *per cent* had high egg counts (>300 epg).

Figure 12.4 visually represents the count of ovine faecal samples tested for Nematodirus eggs by month. The greatest frequency of submissions occurred in September and October, with 6 *per cent* positivity in each of these months. The graph also reveals a peak in the proportion of positive samples during the spring months, particularly in March (9 *per cent*), April (19 *per cent*), and May (22 *per cent*). The lowest percentage of positive samples was observed in February (1 *per cent*).

Nematodirus infections are more prevalent during the late spring/early summer periods, aligning with the typical life cycle and epidemiology of Nematodirus, which is known to cause issues in lambs during this time due

[1] https://www.teagasc.ie/media/website/publications/2020/Control-of-Stomach-Worms-Flyer.pdf

Table 12.3.: Number of ovine faecal samples submitted in 2023 (all ages) for detection of coccidial oocysts and results by percentage, (n=2749).

Result	No. of samples	Percentage
Not Detected	1555	**57**
Light Infection	807	**29**
Moderate Infection	201	**7**
Heavy Infection	110	**4**
Severe Infection	76	**3**

to the emergence of infective larvae.

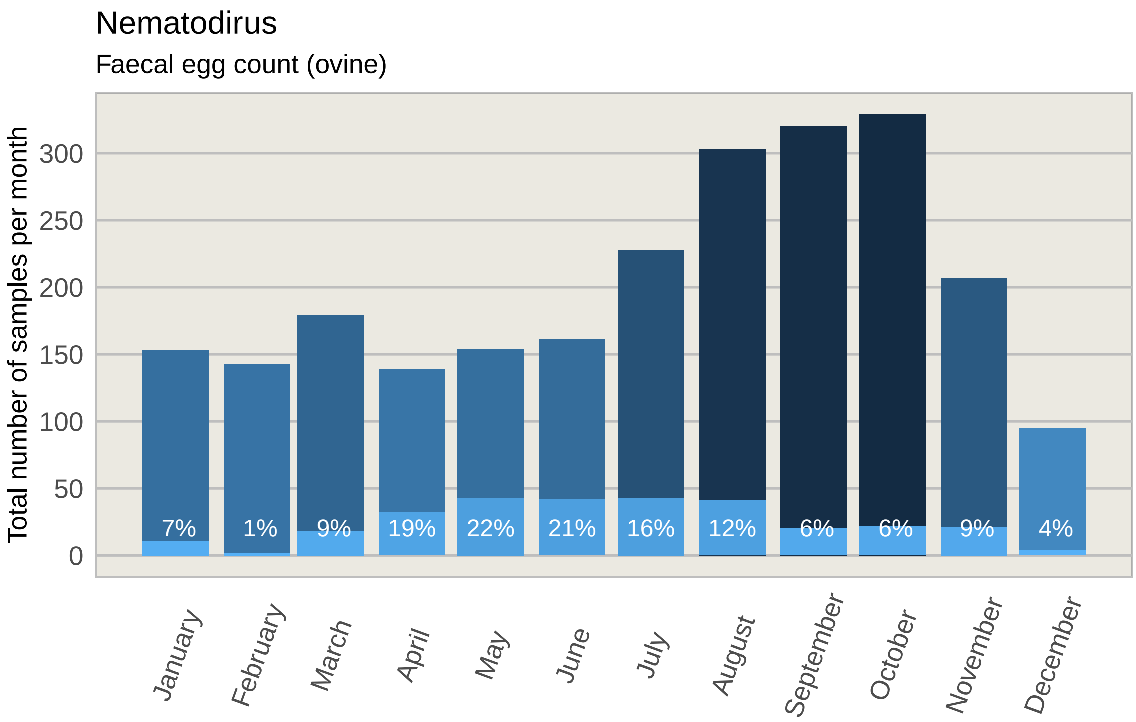

Figure 12.4.: Count of ovine faecal samples exmined for Nematodirus eggs in 2023. The percentage in each bar represents the number of positive samples per month n=(2717).

12.5. Coccidiosis

Coccidiosis is caused by protozoa of the genus *Eimeria*. Although numerous *Eimeria* species exist in the environment, only two are pathogenic to sheep. These parasites can persist in pastures and around water sources from previous grazing seasons. Despite the ubiquity of *Eimeria* on sheep farms, the need for treatment depends on the farm's history and specific environmental conditions.

Coccidiosis predominantly affects young lambs between 2 to 9 weeks of age, though older lambs can be impacted under conditions of immunosuppression or substantial parasitic load. Lambs ingest *Eimeria* oocysts, which migrate to the gut and invade the gut wall, causing tissue damage upon excystation. Clinical manifestations include diarrhoea, often containing mucus or blood, tenesmus, dehydration and impaired nutrient absorption. Severe infestations can lead to significant morbidity and mortality.

Given the prepatent period of 2—3 weeks before oocyst shedding and the potential for non-pathogenic species to be present, fecal oocyst counts must be used in conjunction with farm history and age-specific clinical signs for accurate diagnosis of coccidiosis. It is important to faecal sample a number of lambs when investigating coccidiosis.

Figure 12.5 illustrates the monthly distribution of faecal sample submissions tested for coccidial oocysts, highlighting the percentage of positive results. The data shows a distinct seasonal pattern with highest positivity rates observed in May (22 *per cent*), June (21 *per cent*), July (16 *per cent*), and August (12 *per cent*).

Table 12.3 classifies the severity of infection based on the number of oocysts detected. In the majority of samples (57 *per cent*) *Eimeria* oocysts were not detected. Light infections were detected in 29 *per cent* of samples, while moderate, heavy and severe infections were detected in seven *per cent*, four *per cent*, and three *per cent* of samples, respectively.

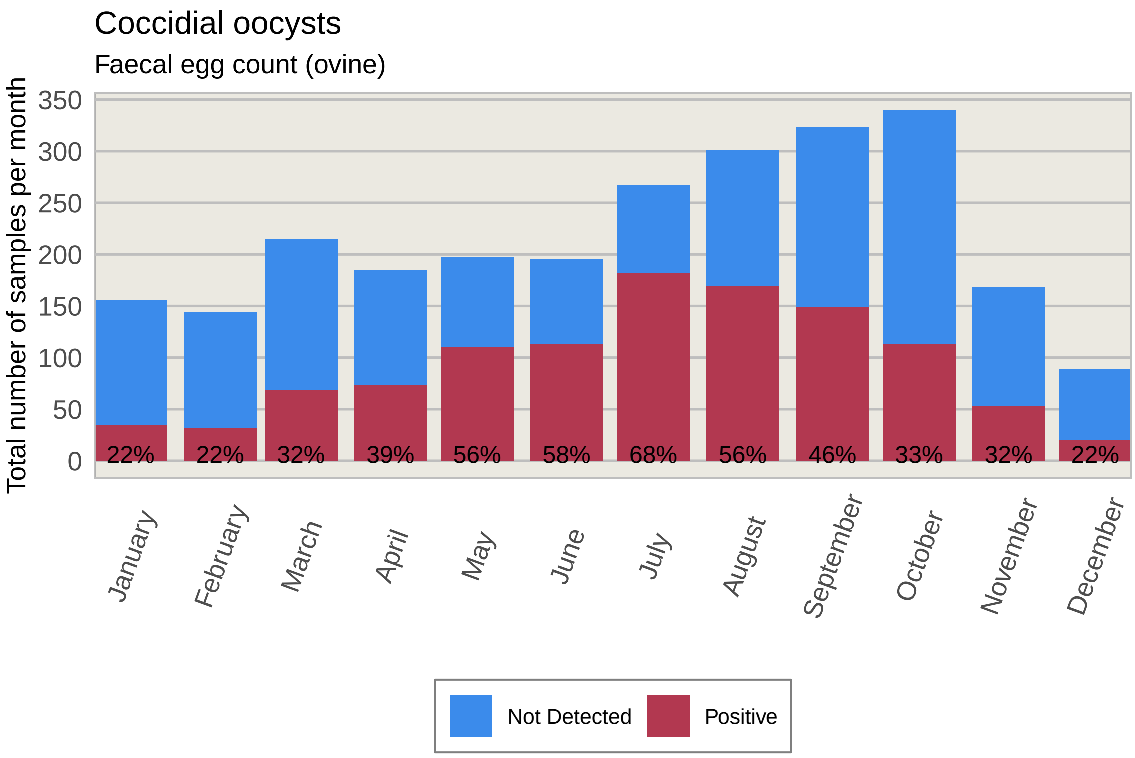

Figure 12.5.: Stacked number of ovine faecal samples (all ages) tested for coccidial oocysts in 2023. The percentage in each bar represents the number of positives (n=2749).

Parasite Control in Sheep: Four Key Actions

1. Use benzimidazoles to control Nematodirus
2. Use faecal egg counts to determine when to treat and what products are effective on farm
3. Do not treat adult ewes for roundworms unless there is a demonstrated need
4. Quarantine treatment of bought-in sheep with a wormer containing a new active

12.6. Liver fluke and rumen fluke

Liver and rumen fluke infections can profoundly affect sheep health and welfare, with the incidence varying year on year based on farm-specific conditions and annual climatic variations.

Liver fluke

Fasciola hepatica, the causative agent of liver fluke, requires mud snails for development, thriving in areas with high rainfall and warm temperatures.

Table 12.4.: Number of bovine faecal samples submitted in 2023 (all ages) for detection of liver fluke eggs and breakdown of positive and negative results (n=2492).

Result	No. of samples	Percentage
Liver fluke eggs not detected	2309	**93**
Liver fluke eggs detected	183	**7**

The life cycle of *Fasciola hepatica* begins when adult flukes release eggs (Figure 12.7) onto pastures, which hatch into larvae under favorable conditions. These larvae infect mud snails and mature within them, eventually being ingested by grazing sheep. After ingestion, the larvae migrate from the intestine to the liver, causing significant damage and maturing into adults in the bile ducts. This life cycle completes in approximately 12 weeks, with each adult fluke capable of producing up to 20000 eggs per day.

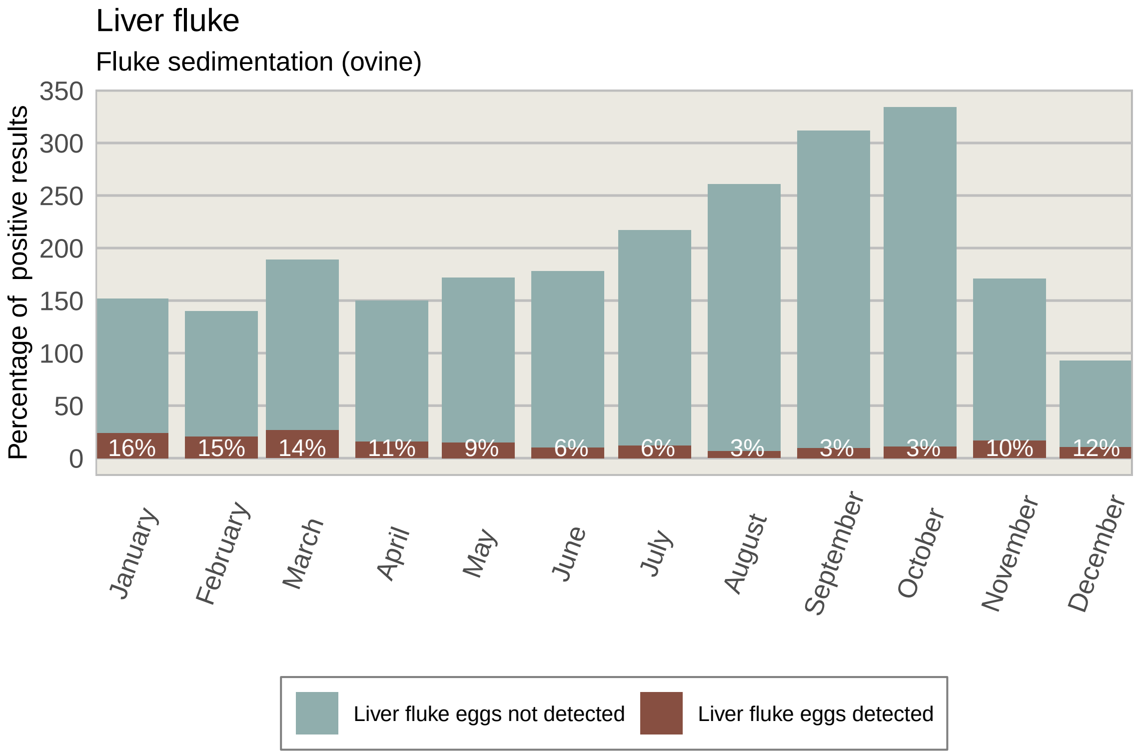

Figure 12.6.: Stacked number of ovine faecal samples (all ages) tested for liver fluke in 2023. The percentage in each bar represents the number of positive samples per month (n=2492).

Acute fasciolosis occurs 2–6 weeks after sheep ingest large numbers of *metacercariae* over a short period. The immature flukes cause substantial liver damage as they migrate, with clinical signs including sudden death, weakness, abdominal pain, jaundice, and anaemia.

Subacute fasciolosis results from the ingestion of fewer metacercariae over a longer period but still causes significant liver damage. Symptoms include rapid weight loss, lethargy, anemia, and occasionally death. Effective treatment requires administration of flukicides capable of killing both immature and adult fluke.

Chronic fasciolosis develops in sheep with long-standing, untreated infections, characterized by progressive weight loss, submandibular and ventral oedema (bottle jaw), diarrhoea, and anemia. Timely diagnosis and appropriate treatment strategies are essential for managing fasciolosis and mitigating its severe impacts on flock health and productivity.

Table 12.4 and Figure 12.6 provide a breakdown of the number of faecal samples tested for liver fluke eggs during 2023.

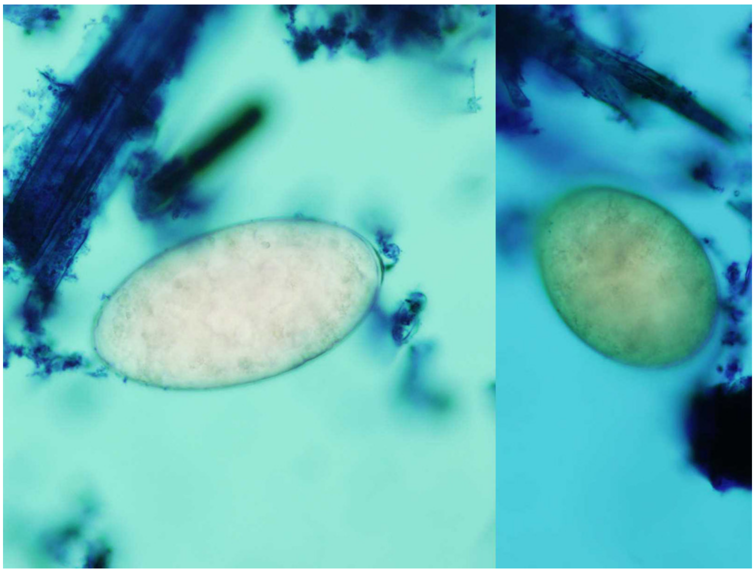

Figure 12.7.: Rumen fluke egg (left) and Liver fluke egg (right). Photo: Cosme Sánchez-Miguel

Table 12.5.: Number of ovine faecal samples submitted in 2023 (all ages) for detection of rumen fluke eggs and breakdown of positive and negative results (n=2492).

Result	No. of samples	Percentage
Rumen fluke eggs not detected	1914	**77**
Rumen fluke eggs detected	578	**23**

Rumen fluke

Rumen flukes (*Paramphistomum spp.*) are parasitic trematodes (Figure 12.7) affecting ruminants globally, with a life cycle also involving an intermediate snail host, the same intermediate host as liver fluke. Adult flukes inhabit the rumen, while immature stages (larvae) are localised to the small intestine. The ingestion of a large number of metacercariae over a short period can result in the presence of large numbers of immature rumen flukes in the intestines which can cause considerable intestinal damage, leading to clinical disease known as larval paramphistomosis. Clinical disease caused by larval paramphistomosis typically affects younger animals grazing heavily infected pasture.

Clinical signs of rumen fluke larval paramphistomosis infection include dullness, severe dehydration, rapid weight loss and profuse watery diarrhoea, sometimes with blood. Hypoalbuminemia and submandibular oedema are also indicative. Severe, untreated cases may result in death due to dehydration. Diagnosis of this disease requires the detection of larvae in faecal samples or at post mortem examination. This should not be confused with the detection of rumen fluke eggs in faecal samples which indicates the presence of adult rumen fluke in the rumen. Adult flukes in the rumen typically cause minimal harm. In the absence of clinical signs of such as diarrhoea, it is important to note that the detection of rumen fluke eggs in faecal samples is not reason enough to treat. Table 12.5 and Figure 12.8 demonstrate the number of faecal submissions tested for rumen fluke eggs during 2023.

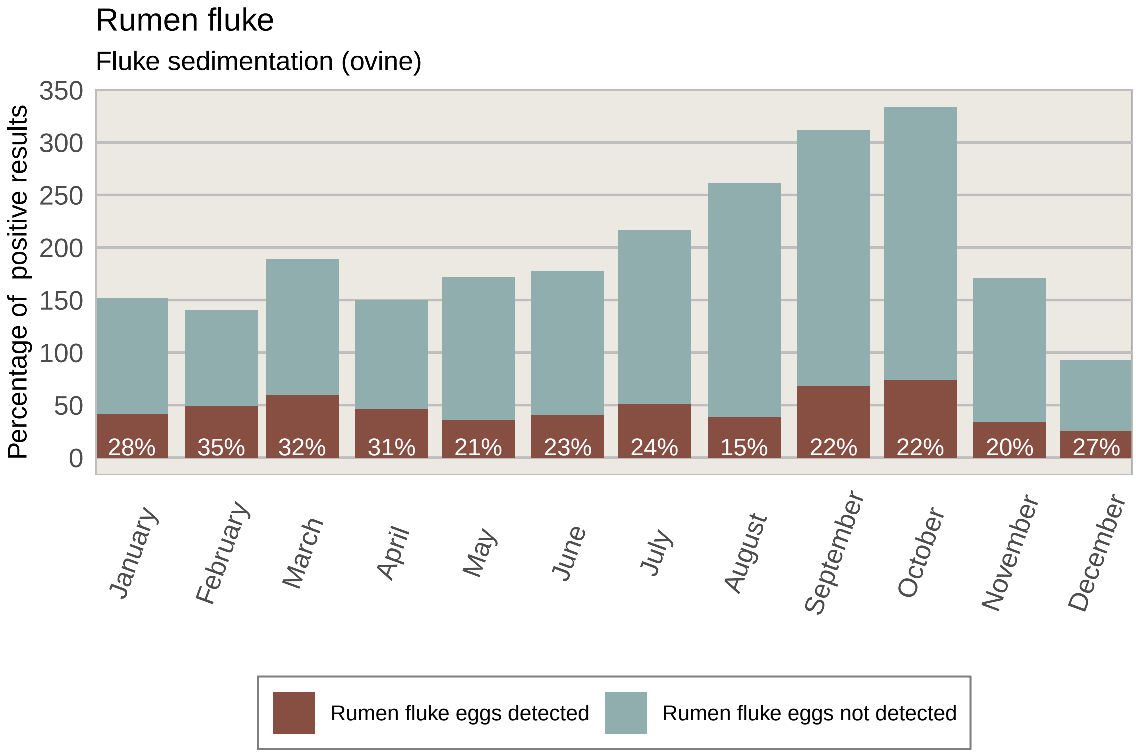

Figure 12.8.: Stacked count of ovine faecal samples (all ages) tested for rumen fluke. The percentage in each bar represents positive samples (n=2492).

12.7. Sheep scab

Psoroptes ovis is the causative agent of sheep scab, a highly contagious and notifiable disease. The mite spreads through direct contact between infested and un-infested animals, as well as via indirect transmission through contaminated environments, including shared grazing areas, housing and equipment.

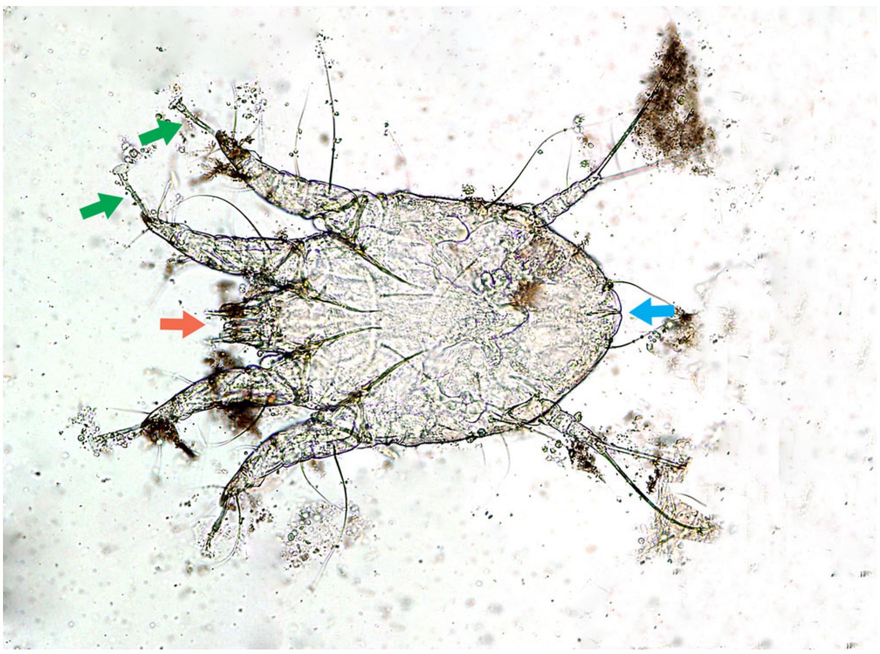

Figure 12.9.: Psoroptes spp., female mite (blue arrow), 3-joined pedicel with funnel-shaped suckers (green arrow) and pointed mouthparts (orange arrow). Photo: Cosme Sánchez-Miguel

Table 12.6.: Comparison of Plunge Dips and Injectable Macrocyclic Lactones

	Plunge Dips (Pyrethroid/Organophosphate)	Injectable Macrocyclic Lactones
Persistence	Generally > 16 days	Varies, only moxidectin has a persistence of > 16 days
Speed of action	Mites normally killed within 24 hours	May take several days to kill all mites present plus sheep may continue to itch for a number of days post-treatment (until all mite faeces has been washed off the fleece)
Potential to contribute to anthelmintic resistance development	Do not contribute to anthelmintic resistance to parasitic worms	Overuse of prophylactic treatments (MLs) for sheep scab can lead to increased resistance of gut worms (APHA 2020)

Note:
Source: Animal Health Ireland: Parasite Control in Herd Health Planning

Clinically, sheep scab is associated with severe pruritus, wool loss and the development of crusty skin lesions. Infected sheep may demonstrate signs of restlessness, rubbing against objects and biting or scratching their fleece, often leading to secondary skin infections. In severe cases, infestations can cause significant weight loss, decreased fertility, and, if untreated, mortality.

Effective control of sheep scab necessitates early detection and prompt treatment. Additionally, rigorous biosecurity measures are essential to prevent transmission within and between flocks.

Part III.

Porcine, Avian and Wildlife

13. Porcine Diseases

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13.1. Overview

In 2023, DAFM laboratories carried out necropsy examinations on 262 pig carcasses while 2315 non-carcass diagnostic samples were submitted from pigs for a range of diagnostic tests to assist veterinarians with disease investigation and for surveillance on Irish pig farms. These figures are akin to 2022 submission rates.

As in previous years, the pigs submitted for necropsy were predominantly from the weaner and piglet stages of growth and came almost exclusively from large-scale, intensive pig farming operations.

13.2. *Post Mortem* Diagnoses.

The most frequent disease diagnoses from pig necropsy submissions during 2023 are detailed in Table 13.1 and Figure 13.1. These data only reflects diagnoses reached in pigs submitted to DAFM laboratories, rather than incidence of disease in the pig population generally, as many factors will influence the decision to submit an animal for necropsy.

Enteritis

In 2023, gastrointestinal infections were the most frequently diagnosed disease category in pig carcasses submitted to DAFM labs, accounting for 29.4 *per cent* of cases, with neonates being most commonly affected. Neonatal

Table 13.1.: Conditions most frequently diagnosed on *post mortem* examinations of pigs in 2023 (n= 262).

Diagnosis	Total Number	Percentage
GIT Infections	77	**29.4**
Respiratory Infections	59	**22.5**
Other	39	**14.9**
No Diagnosis	25	**9.5**
Arthritis	21	**8.0**
Abortion	11	**4.2**
Bacteraemia/septicaemia/toxaemia	10	**3.8**
Meningitis	7	**2.7**
Salmonellosis	7	**2.7**
Porcine Circovirus Disease	6	**2.3**

Note:
Categories that have less than two cases have been included in the 'Other' category

diarrhoea in pigs can be caused by multiple pathogens, and outbreaks on farms often involve more than one aetiological agent.

Pneumonia/Pleuropneumonia

Respiratory infections were among the second most frequent diagnoses reached in DAFM labs pig *post mortem* investigations in 2023 accounting for 22.5 *per cent* of all diagnoses reached. All porcine respiratory disease investigations at DAFM labs undergo bacterial, viral, and histopathological examinations to determine aetiology.

Respiratory disease in pigs most commonly involves multiple pathogens, therefore, comprehensive testing of suitable cases is critically important for diagnostic accuracy. The term Porcine Respiratory Disease Complex (PRDC) is a syndrome that results from a combination of infectious and non-infectious factors. Intensive rearing/housing is a risk factor for outbreaks of pneumonia arising from introduction of disease to the group. This may result in lesions identified at slaughter ("pleurisy" is the most common cause of pig carcasses being detained or condemned at slaughter in Ireland), increased mortality rates and poor growth.

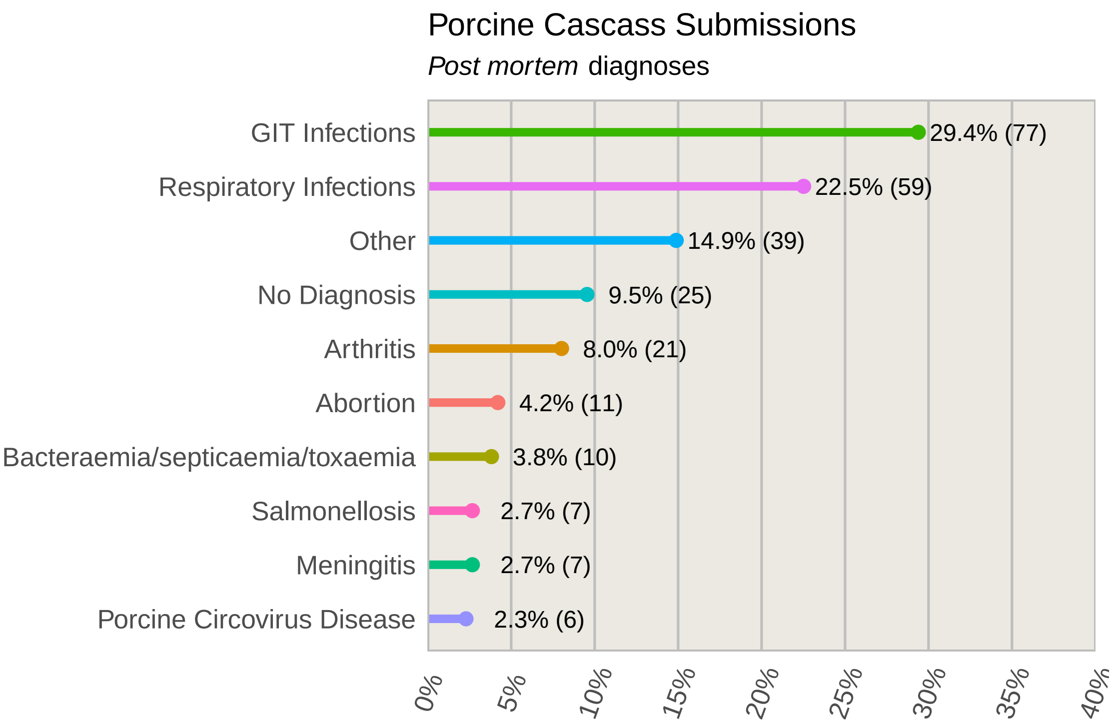

Figure 13.1.: Conditions most frequently diagnosed on *post mortem* examinations of pigs in 2023 (n=262). Note: Categories that have less than two cases have been included in the 'Other' category. The absolute number of cases is between brackets.

Non-infectious predisposing factors also contribute to PRCD, including poor environmental conditions, high stocking densities, stress, seasonal variations, genetic background, and production flow methods (such as all-in-all-out versus continuous flow systems).

The most commonly identified bacteria in pneumonia cases were *Actinobacillus pleuropneumoniae*, *Pasteurella multocida* and *Mycoplasma hyopneumoniae*. Additionally, viral agents such as influenza virus, porcine reproductive and respiratory syndrome virus (PRRSV), and porcine circovirus 2 (PCV2) were frequently detected, highlighting the multifactorial nature of the disease.

A porcine bacterial respiratory pathogen multiplex PCR test is conducted at the Cork BTL Lab. In 2023, out of 161 samples tested for *Actinobacillus pleuropneumoniae*, *Haemophilus parasuis*, and *Mycoplasma hyopneumoniae*, detection rates were 43.12 *per cent* for *Haemophilus parasuis*, 20.62 *per cent* for *Actinobacillus pleuropneumoniae*, and 8.12 *per cent* for *Mycoplasma hyopneumoniae*. Combining routine culture and PCR testing on *post mortem* pneumonia submissions offers the best chance of identifying bacterial respiratory pathogens. Some fastidious pathogens do not grow well in artificial media, and systemic antibiotic use can hinder bacterial growth in culture. Nevertheless, bacterial cultures remain essential for antimicrobial sensitivity testing.

13.3. *Streptococcus suis*

Streptococcus suis is a significant pathogen in pigs, commonly causing meningitis, septicaemia, endocarditis and arthritis, particularly in post-weaned pigs. It is also zoonotic, posing a risk to humans. There are up to 35 known serotypes. Piglets are colonised early in life, with *S. suis* considered a normal inhabitant of the upper respiratory tract, and it can readily be recovered from tonsils . Diagnosis is typically based on history, clinical signs and gross necropsy findings, with confirmation through bacterial culture.

In 2023, the most common serotypes identified across eleven farms were serotype 2 or 1/2 and serotype 9, each found on three farms. Serotype 1 or 14 was detected on two farms, while serotype 1 or 1/2 and serotype 7 were each identified on one farm.

Exotic Disease Surveillance Data

In 2023, 1553 samples were collected as part of the Cull Sow abattoir surveillance scheme. These samples were screened for Aujeszky's disease, African Swine Fever and Classical Swine Fever.

13.4. *Salmonella spp.*

Commercial pig producers are required to have a documented *Salmonella* control program in place for their farms. Slaughtered pigs are routinely screened for *Salmonella* antibodies throughout the year, with the results reported back to both the farm of origin and slaughter plants.

However, the current serological testing program at the factory level does not differentiate between *Salmonella* strains (serotypes). Identifying the specific serotype is essential for developing an effective on-farm control program. Herdowners are encouraged to participate in the funded Salmonella TASAH program, established by Animal Health Ireland (AHI), which offers on-farm bacteriological tests to identify the specific strains of Salmonella, if present. These results are then used to create farm-specific control plans, developed by the designated PVP in collaboration with the herdowner.

14. Poultry Diseases and Surveillance

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14.1. Avian Influenza Surveillance

Avian influenza type A is a contagious disease caused by viruses which are naturally found in, and which are adapted to, populations of wild birds. Avian influenza viruses can also affect poultry and mammalian species (depending on the virus subtype) including wild mammals, rodents, pigs, cats, dogs, horses and humans.

Based on the severity of the disease avian influenza is divided into low pathogenic (LPAI) and high pathogenic (HPAI) strains. LPAI may present with mild or no clinical signs in poultry. On the other hand, HPAI strains can cause severe clinical signs such as respiratory signs, reduced food intake, diarrhoea, and nervous signs; and in some cases, HPAI strains can cause sudden death with no other symptoms. In layers, drop in egg production and/or poor egg quality has been reported.

Avian influenza viruses are classified into subtypes based on two surface proteins, haemagglutinin (HA) and neuraminidase (NA). There are approximately 16 HA subtypes and 9 NA subtypes which are used to identify avian influenza viruses e.g. H5N8, H5N6 etc. All HPAI are notifiable to the European Commission and the World Organisation for Animal Health (WOAH) within 24 hours of confirmation of the disease. These notifiable subtypes can be associated with acute clinical disease in chickens, turkeys, and other birds. Other subtypes such as LPAI H6- are not notifiable under the legislation, but they still can cause losses in production.

Active surveillance:

DAFM carries out two types of active surveillance for avian influenza.

a) Avian influenza serology testing in poultry through the national Poultry Health Programme (PHP). The Poultry Health Programme is a DAFM surveillance programme to support trade in poultry, and to comply with EU regulations, including *Regulation (EU) 2016/429*, *Regulation (EU) 2035* of 2019 and Commission Delegated *Regulation (EU) 2020/688*. The PHP includes testing for *Mycoplasma* and *Salmonella*, and , to increase avian influenza surveillance, samples are also tested for AI by AGID/ELISA. In 2023, 8805 poultry samples were tested for AI by this method through the PHP (Table 14.1).

b) Avian influenza H5 and H7 serology testing of poultry under the EU Poultry Surveillance Scheme. Ireland's avian influenza surveillance programme is based on representative sampling, which considers criteria in *Annex II of Commission Delegated Regulation (EU) 2020/689* at a level reflective of *Annex I of Commission Decision 2010/367/EU*. In 2023, 7082 samples were tested for H5 and H7 HAI. The categories sampled for the EU Poultry Surveillance Scheme include:

- Broilers-Free Range
- Broiler Breeders

Table 14.1.: Avian influenza surveillance testing during 2023 in Ireland.

Programme	No Animals tested	Non- notifiable AI subtypes	Notifiable H5/H7 subtypes
Poultry Health Programme (AGID/ELISA test)a	8805	0	0
Poultry -H5 and H7-EU Surveillance (HI)b	7082	0	0
Wild birds (PCR)	167	0	42 x H5N1 HPAI, 1x H5Nx
Poultry (PCR)c	456	0	0
Captive birds (PCR)	91	0	1 x H5N1 HPAI (Flamingo)

[a] AGID: Agar Gel Immunodiffusion test;
[b] HI: Haemagglutination Inhibition test for H5 and H7;
[c] Poultry-PCR: includes individual animals and pooled swabs from different animals

- Layers Free Range
- Layers Non-Free Range
- Fattening Turkeys
- Turkey Breeders
- Fattening Ducks
- Fattening Geese

Passive surveillance:

1. Passive surveillance of wild birds.

Wild bird surveillance for avian influenza in Ireland is risk based. It is implemented as a passive surveillance scheme, as dead, moribund or sick birds are reported to DAFM by members of the public or the National Parks and Wildlife Service (NPWS) by ringing the Avian Influenza Hotline (076 1064403) or the after-hours number (1850 200456). Sick or dead birds can also be reported to DAFM directly using the Wild Bird-Avian Check App[1], which can be accessed via smart phones, tablets, PCs and laptops. The birds are collected by trained personnel and submitted to the Regional Veterinary Laboratories (RVL) for sampling. Samples are then submitted to the Central Veterinary Research Laboratory (CVRL) where avian influenza testing is carried out.

A list of species of wild birds to be targeted for surveillance for avian influenza is provided by the Commission Implementing *Decision 2010/367/EU* in accordance with the scientific opinion provided by EFSA. This list is amended according to the demographics of each country. See list here: List of Target Species for Avian Influenza Surveillance[2].

In 2023, 167 wild birds were tested by passive surveillance; from those the majority of AI detections were in Common Terns (19) and the rest in Black-headed Gulls, Whooper Swans, Peregrine Falcons, Red Kites, Eurasian Buzzard, Herring Gull, Mute Swan, Roseate Terns and Sandwich Terns. 42 detections were confirmed as H5N1 Highly Pathogenic Avian Influenza (HPAI) and one was H5Nx.

2. Passive surveillance of poultry and other captive birds

Avian influenza is a notifiable disease in Ireland, meaning that anyone who suspects that an animal/bird may have the disease is legally obliged to notify DAFM.

[1] https://aviancheck.apps.rhos.agriculture.gov.ie/report
[2] https://www.gov.ie/en/publication/50ce4-avian-influenza-bird-flu/

Table 14.2.: Official Sampling for Poultry Health Programme and EU AI surveillance during 2023 in Ireland

Type of submissions	Test	Number of tests	Positive
National-Poultry Health Programme	M. gallisepticum SPAT	28787	0
	Avian Influenza AGID/ELISA	8805	0
	M. meleagridis SPAT	1653	0
	Salmonella arizonae 'H' SAT	1200	0
EU-H5 H7 HI -Surveillance	Avian Influenza H5	7082	0
	Avian Influenza H7	7082	0

Following notification through the Regional Veterinary Office (RVO), an official investigation will be carried out by DAFM, directed by the competent authority (National Disease Control Center) with official samples submitted to the CVRL for testing. In addition, flock owners and PVPs are encouraged to engage with their Regional Veterinary Laboratory to aid with diagnosis of other avian disease conditions.

In 2023, H5N1 HPAI was detected in a flamingo from a zoological collection. After following up DAFM investigation the rest of the flamingos were negative for avian influenza (Table 14.1).

14.2. Avian *Mycoplasma spp.* Surveillance

Active surveillance

The Poultry Health Programme (PHP) operated by DAFM includes surveillance for poultry mycoplasmosis. Mycoplasmas in poultry, whilst of no public health concern, can present significant problems both commercially and potentially for bird welfare. Therefore, poultry are screened for *Mycoplasma Gallisepticum* and-or *Mycoplasma Meleagridis*.

Mycoplasma gallisepticum (MG): This mycoplasma is associated with a chronic respiratory disease. Typically, it is slow in onset and can result in significant commercial losses in production. This mycoplasma can infect chickens, turkeys and game birds. Ducks and geese can also become infected particularly when associated with infected chickens.

Mycoplasma meleagridis (MM): With this mycoplasma vertical transmission in the egg can be a significant factor. It is a disease of breeding turkeys with clinical disease possible in the progeny chicks. Respiratory symptoms are the main cause of economic loss.

The DAFM Poultry Health Programme seeks to provide a surveillance platform for MG and MM in commercial flocks. As part of this programme breeding flocks of both turkeys and chickens are routinely tested for serological evidence of MG or MM (turkeys only). The plan for each poultry subgroup varies but typically flocks are subject to serological testing at pre-movement (from rearing), exports, at point of lay, and during production (Typically every 12 weeks).

The frequency of sampling is set out in the *Council Directive 2009/158/EC* of 30 November 2009 on animal health conditions governing intra-Community trade in, and imports from third countries of, poultry and hatching eggs' , and the *EU commission Decision 2011/214/EU*. The sample size is based on a representative sampling strategy: 60 birds per house in houses of 1000 birds or more, with design prevalence of 5 *per cent*.

In 2023, 28787 and 1653 serum samples were screened for *M. gallisepticum* and *M. meleagridis*, respectively, at the CVRL as part of DAFM PHP programme (Table 14.2).

Table 14.3.: Number of official on-farm poultry samples *Salmonella spp.* detection results in 2023.

Flock / bird type	Number of samples tested	Number of samples with Salmonella spp. detected	Number of samples with Salmonella spp. Not Detected
Broiler	170	8 (a)	162
Broiler Breeder	1071		1071
Layer	448	3 (b)	445
Layer breeder	2		2
Turkey	69	5 (c)	64
Turkey Breeder	8		8
Total	1768	16	1752

[a] Salmonella Typhimurium x 6 isolates (from 3 flocks) and S. Derby x 2 isolates (from 1 flock)
[b] Three isolates of Salmonella Typhimurium from just two layer flocks
[c] S. Senftenberg x 4 isolates from one flock and S. Typhimurium x 1 isolate

Passive surveillance

In addition to *M. meleagridis* and *M. gallisepticum*, *Mycoplasma synoviae* is also tested as a part of passive surveillance. The three serotypes are notifiable diseases in Ireland, meaning that anyone who suspects that an animal may have the disease is legally obliged to notify DAFM.

Beyond disease reporting, DAFM operates a network of Regional Veterinary Laboratories (RVLs), strategically located around the country. Farmers and private veterinary practitioners (PVPs) submit large numbers of samples from sick animals to the laboratories every week. Farmers are encouraged to report suspicions of *mycoplasma* infection to their local Regional Veterinary office, and to make use of their local Regional Veterinary Laboratory to aid with diagnosis of disease conditions.

14.3. Avian Salmonella Surveillance

As part of the national Poultry Health Programme, serological testing for screening of *Salmonella* arizonae is carried out in turkey flocks in addition to Avian influenza and *M. meleagridis* (Table 14.2). Last year, 1200 serum samples were screened for *S.* arizonae.

In parallel, every year, DAFM carries out the EU Salmonella Surveillance by collecting samples on-farm and confirming detected serotypes by culture. Programme is as follows:

- In at least one flock of broilers on 10 per cent of commercial broiler premises with at least 5000 birds.
- Three times per production cycle for all flocks on all broiler breeder premises.
- In at least one flock per year per layer holding comprising at least 1000 birds.
- Once a year in at least one flock on 10 per cent of holdings with at least 500 fattening turkeys.
- Once a year in all flocks with at least 250 adult breeding turkeys between 30 and 45 weeks of age.
- All holdings with elite, great grandparent and grandparent breeding turkeys.

In 2023, 1752 samples collected from farms by DAFM were analysed; of these, *Salmonella spp.* were detected; in 4 broiler farms (S. Typhimurium from 3 flocks and S. Derby from 1 flock), in two layer flocks (S. Typhimurium) and in two turkey finishing holdings (S. Typhimurium and S. Senftenberg) (Table 14.3).

Table 14.4.: Paramyxovirus- 1 (PMV-1) testing during 2023 in Ireland.

Number of birds	Exports (parrots, falcons, pigeons)	Wild birds	Poultry Diagnostics	Results
87	65	7	15	Negative

Table 14.5.: PCR testing of submitted samples (PVP and RVL submissions) in 2023. (b)

Pathogen	Burds tested (n)	Positive birds (n)
Avian pneumovirus	19	0
Infectious Bronchitis (c)	106	19
Chlamydia psittaci (a)	27	0
Infectious laryngotracheitis (a)	10	0
Mycoplasma synoviaem (a)	66	4
Mycoplasma gallisepticum(a)	43	5
Marek's Disease Virus (c)	127	34

[a] Notifiable diseases
[b] This table does not include the pathogens detected as part of surveillance programmes or farm investigations for Class A diseases.
[c] These tests do not differentiate between vaccine and wild type strain

14.4. Newcastle Disease and pigeon PMV1

Newcastle Disease (ND) is a notifiable disease that affects poultry and it is caused by virulent strains of Avian Avulavirus 1 -AAvV-1- (also called Avian Paramyxovirus type 1 -APMV1- or PMV1). A similar variant, pigeon AvV-1 (PPMV1) infects pigeons and other wild birds. AAvV-1 infections may be presented as a wide range of clinical signs depending on the strain virulence from lethargy and mild respiratory signs to egg drop production, neurological signs, and sudden death. Every year, samples from suspected cases and carcasses from poultry are submitted to the CVRL and RVLs for ND testing. In addition, certain wild bird species are screened by PMV1 as a means of passive surveillance.

In 2023, 87 birds were tested for PMV1 PCR. These included Exports (parrots, falcons, pigeons), wild birds and poultry diagnostics. There were not detections of PMV1 in 2023 (Table 14.4).

14.5. Other Disease Diagnostics

Beyond the active and passive surveillance for important notifiable diseases, DAFM carries out testing for other notifiable and non-notifiable diseases that have significant economic impact. Suspect and healthy animals -for monitoring purposes in this case- from backyards and commercial flocks are tested. PVPs submit swabs directly to the CVRL (Table 14.5) and carcasses of animals are submitted to the RVLs where they are sampled.

Last year, the pathogens most detected in poultry backyards were Marek's Disease Virus (34) and infectious bronchitis virus (19), however those tests do not differentiate vaccine from wild type strains. Other pathogens detected were *M. synoviae* (4) and *M. gallisepticum* (5) in backyards.

14.6. Case Reports in Poultry (Dublin RVL)

The predominant diseases identified in avian submissions detected at DAFM RVLs during 2023 were *E. coli* infection, *Enterococcus spp.* infection, Marek's disease, *Brachyspira spp* infection, coccidiosis, intestinal nematodes infections, ectoparasitisms, and some pathological affections with an animal welfare background includiong cannibalism and pododermatitis.

Colisepticaemia

Colisepticaemia is caused by *Escherichia coli* and is a cause of significant economic loss worldwide. This disease complex (also referred as salpingitis/peritonitis/salpingoperitonitis syndrome, and egg peritonitis syndrome) was the most common cause of death in poultry submissions and was diagnosed in a large variety of enterprises such as layer hens, broiler breeders, broilers chickens, and in chicks affected with yolk sacculitis. Lesions were usually expressed with mild to severe fibrinous celomitis involving often internal organs, and histologically associated with heterophils infiltration, intravascular thrombi and intralesional bacteria aggregates. Sero-fibrinous cellulitis and ingluvitis were also observed in severe infection.

Several factors such as concurrent bacterial or parasitic diseases, as well as non-infectious factors (i.e. adverse environmental conditions) are often linked with *E. coli* infection, suggesting that salpingitis/peritonitis are often a result of opportunist infection. Live vaccines (e.g. Newcastle disease or IB), and nutritional deficiencies may increase susceptibility. Outbreaks in some flocks could be the consequence of cannibalism or vent pecking. Disease is generally the result of ascending infection via the cloaca, and *E. coli* is typically isolated in pure growth from the reproductive tract.

Pathogenic strains may also invade from the respiratory tract following infection with other respiratory pathogens. Moreover, sequestered colonies in sites such as the intestine, nasal passages, air sacs or reproductive tract may be a latent source of infection. Birds are continuously exposed through contaminated faeces, water, dust and environment, and yolk sacculitis is usually related to egg contamination in the hatchery or infection during the hatching. On farm control measures include a vigorous sanitation program, good litter management, dust and ammonia levels control, and minimising sources of stress, parasitism, and viral infections.

In some cases, *E. coli* isolates also tested positive to O78:K80 antiserum. O78:K80 serotype, together with O2:K21 and O1, mostly, contributes to the formation of the avian pathogenic *E. coli* (APEC) outbreaks.

Enterococcus spp. infection

In 2023, several broiler chick submissions presented with lameness and increased mortality, despite being in good to moderate body condition. On *post mortem* examination, these chicks exhibited fibrinous or fibrous pericarditis and necrosis of the femoral head. Cultures from the liver and bone marrow consistently yielded *Enterococcus spp.*, suggesting a bacterial involvement in the pathology.

Diseases associated with enterococci in poultry, although worldwide in distribution, are relatively uncommon and the growth of the causative bacteria in the laboratories is difficult. However, it has recently been shown that early mortalities in flocks, which are likely to be attributed to "poor chick quality", are in some cases due to this infection. Enterococci can be recovered from the environment, including hatcheries, and can be associated with septicaemia. *E. faecium* has been recovered from endocarditis in chickens and *E. cecorum* has been obtained from bacterial chondronecrosis and osteomyelitis in broilers. Clinically, lameness and swellings affecting primarily tarsometatarsal joints and feet are observed, and differential diagnosis include joint infection due to *S. aureus*, *Mycoplasma synoviae*, avian reovirus, and mineral imbalance in the diet, especially in growing animals and layer hens.

Marek's disease

Throughout the year, several poultry submissions displayed gross lesions suggestive of Marek's disease, including enlarged spleens, thickened sciatic nerves and multifocal pale, firm masses in the muscles and internal organs.

These cases were later confirmed through histological examination and PCR testing. In the majority of confirmed cases, the clinical history was non-specific, with signs such as depression, weight loss, anorexia, and diarrhea. Additionally, almost all cases had concurrent bacterial or parasitic infections, further highlighting the immunosuppressive role of the Marek's disease virus.

Figure 14.1.: Marek's disease: Severe diffuse hepatomegaly and splenomegaly with severe multifocal to coalescing white-grey round firm well-demarcated areas throughout the hepatic and splenic parenchyma, which also appeared diffusely severely firm. Scattered petechiaetion in the spleen were also seen. Photo: Sebastian Mignacca

Marek's disease is caused by an alpha herpesvirus and usually affects birds older than four weeks of age. In the infected flocks, it can express in different presentation. In the acute form, its incidence is frequently between 10–30 *per cent* or higher. Mortality can increase rapidly over few weeks and then cease or can continue at a steady or falling rate over several months and predisposes to secondary infections. Affected birds are often paralysed, whilst grossly, the bursa may be enlarged or atrophied.

Histologically the lesions consist of T-cell neoplasms and there may be infiltration in a number of organs such as skin, muscle, proventriculus, eye, brain and peripheral nerve. Due to its highly contagious nature and ability to survive for long periods, both within the host and in the environment, its eradication is difficult. Affected animals shed the virus constantly and some birds may be latently infected. Control is based mainly on preventive vaccination and improved management methods. However, depopulation must be considered when other measures are ineffective.

Brachyspira spp infection

The genus *Brachyspira* includes nine officially recognised species, several of which are pathogenic to mammals and birds. Avian intestinal spirochaetosis (AIS) is a gastrointestinal disease in poultry caused by the colonisation of the caeca and/or colon-rectum by *B. pilosicoli*, *B. intermedia*, and *B. alvinipulli*. AIS primarily affects layer hens and broiler breeders over the age of 15 weeks. Clinical signs (mainly induced by *B. pilosicoli*) can range from asymptomatic to severe disease, leading to increased mortality rates.

Mild to moderate disease could result in 6—10 *per cent* reduction in egg production, delayed onset of lay, reduced growth rates and decreasing egg quality (smaller, less numerous, poor-quality shells, and less coloured yolk), faecal stained eggs, and changes of the animal dropping (diarrhoea, increased fat content, foamy consistence due to increased gas production, and presence of mucus and blood). Systemic infection results in increased flock mortality and it is infrequently observed. Wild birds are typically asymptomatic.

Since mid-2022, DAFM is running a survey on selected avian samples submitted to the Dublin RVL. Study includes only whole avian carcass submissions. After *post mortem* examination (PME), faecal pools (up to 5 adult animals for each submission) are tested for *Brachyspira spp*, *Brachyspira intermedia*, *B. intermedia* & *B. pilosicoli*, and *B. hyodysenteriae* PCRs.

To the end of December 2023, out of 155 avian submissions (438 birds in total), 47 faecal pools [17 commercial layers (CL); 10 broiler breeders (BB); 10 backyards (BY); 6 exotics (E); 4 others] were tested. Thirteen samples were positive for *B. intermedia* (4 CL; 2 BY), *B. intermedia* & *pilosicoli* (2 CL), and other non-identified *Brachyspira spp** (1 CL; 1 BY; 3 E), respectively (E were adult peacock, flamingo, and ornamental hens).

The clinical histories of affected birds included weight loss, increased mortality, decreased production, increasing in pale eggshells, dehydration, and changes of the dropping. On *post mortem* examination, they had intestinal content ranging from normal to dark or alternatively pale and mucoid, and mild to severe segmental gassy intestine, mainly of ceca and colon.

Histological changes ranged from mild to multifocal lymphoplasmacytic typhlitis (layers), or multifocal severe necrotising typhlitis associated with mixed bacterial aggregates (peacock). In some cases, numerous slender filamentous bacteria were clearly seen within the lamina propria of the caecal mucosa in sections stained with Warthin-starry. However, this technique was often unrewarding. It is worth noting that ten positive submissions had intercurrent diseases (bacteriemia, parasitism, gout), and it is uncertain if *Brachyspira spp* represented either a primary or secondary agent. *B. intermedia* was the common species identified. Finally, BB samples tested all negative, and *B. hyodysenteriae* was not detected.

Figure 14.2.: Gout: 4 year-old guinea fowl (*Numida meleagris*). Tibiofemoral joint dry and containing mild white chalky deposits within the cavity. Severe dehydration and chalky aggregates within the skeletal muscles, epicardium, Glisson capsule, mesentery, gizzard, oviduct, and parietal coelom were also seen. Photo: Sebastian Mignacca

Intestinal nematodes (*Heterakis spp* infection)

Several avian submissions during 2023 exhibited segmental, moderate to severe enlargement of the small and large intestines. Upon opening, a few to numerous small, round to elongated white-grey worms, approximately 0.5 mm in length, were observed within the intestinal lumen. Infection with *Heterakis spp.* typically causes only mild pathology that generally does not significantly impact bird performance.

However, a high parasite burden can lead to illness. Moreover, *Heterakis spp.* acts as a vector for *Histomonas meleagridis*, the causative agent of histomonosis in poultry, posing an additional risk to infected birds.

Ectoparasitism

External parasitic infections were sometimes observed in fowl, wild and zoo birds. However, noteworthy was a submission of table layer hens reporting worsening of body conditions and feather loss. When the carcass submission was received, a massive amount of small motile red and brown parasites were evident, throughout and outside the box, and covering the birds. Carcasses had severe diffuse pallor with also hepatic histological changes consistent with anaemia/hypoxia, and the parasites were confirmed as *Dermanyssus gallinae*.

It is important to note that *D. gallinae* can survive for up to 34 weeks without feeding. Additionally, this parasite is capable of biting humans, leading to small red lesions and intense itching.

Cannibalism and vent pecking, and pododermatitis

From an animal welfare aspect, feather and/or vent pecking, cannibalism, and pododermatitis were observed in some avian submissions during 2023.

Lesions ranged in moderate feather and/or vent pecking or fatal cannibalism with faecal and blood staining of the feathers around the vent, wounds, scars and necrotic debris within the cloaca, and intestinal segments protruding out of the orifice. Carcasses showed also generalised severe pallor of comb, muscles and viscera, large fresh blood clots in the coelomic cavity, and large intestine and part of the small intestine missed. Cohorts often had large amount of feather fragments within the alimentary tract.

Cannibalism has been reported in most the enterprises. Stress and overstocking is usually associated with this issue, but outbreaks are often more severe in large flocks of free-range or aviary birds. It may be reduced by selecting less cannibalistic strains of poultry, avoiding early onset of lay, providing high perches from an early age and nests that minimize visibility of the cloaca during laying, ensuring an adequate diet, reducing stress, providing attractive foraging material, and removing affected or ill thrifty birds.

On the other hand, uni- or bilateral pododermatitis appears to be triggered by litter conditions. It could be influenced by dietary factors (methionine and biotin deficiency, altered protein digestibility, high unsaturated fats), and enteric health. Wet litter, high or low litter pH, and high ammonia can also contribute to its pathogenesis, especially in housed animals or during winter. Pododermatitis is usually painful and can lead to bacterial infection, and a weekly inspection is recommended to detect early lesions. Applying fresh litter, switching bedding from straw to wood shavings, installing slats under the drinkers, providing smooth surfaces to walk on, and managing the litter and ventilation, could be beneficial.

An interesting case of pododermatitis was observed in a flamingo (*Phoenoterus chilensis*) showing ambulatory difficulty which had multifocal moderate to severe large foci (1x1.5 cm) of hyperkeratoses, fissures, nodular lesions, and papillomatous growths on the plantar surface of the base of feet throughout the portion of the digits. Cohorts had similar lesions. Foot lesions are highly prevalent and widely distributed in the captive flamingos in Europe and other countries.

The odds of birds having hyperkeratosis, papillomatous growths, and fissures are higher in animals kept on concrete surface, indoors, and in cold temperatures. Weight and age are also important in the onset and progression of pododermatitis, and zinc in the diet could be involved as predisposing factor for skin damage.

Erysipelas

Sixty-two-week-old layers from a free range flock, reporting increased mortality, poor body condition, and with anatomo-histopathological findings of the coelomic organs indicative of sepsi, cultured *Erysipelothrix rhusiopathiae* from internal organs.

Erysipelothrix rhusiopathiae, the causative agent of erysipelas, infects a wide range of poultry species and has been isolated from mammals and fish as well. In laying hens, erysipelas appears to be an emerging disease, particularly in farms transitioning from cage systems to free-range, organic, and barn housing systems.

Common sources of infection include contaminated soil, litter, water, dead animals, rodents, wild birds and pigs. Biting insects, such as poultry red mites, can act as both vectors and reservoirs for the bacteria. Erysipelas tends to affect older layers, typically between 43 and 73 weeks of age. The first clinical sign is often acute mortality, with affected hens displaying symptoms such as lethargy, diarrhea, swollen heads and uncoordinated movement before death.

In turkeys, a chronic form of the disease can develop, particularly in flocks that have been vaccinated against erysipelas. This chronic presentation is characterised by joint infections ("joint ill") and endocarditis. Despite the infection, carcasses are usually well-conditioned and muscled, although ecchymosis (bruising) may be visible in subcutaneous fat and thigh muscles. Internal organs such as the liver, spleen, and kidneys are often enlarged.

Effective management involves prompt removal of dead birds and eliminating potential sources of infection. In countries where erysipelas vaccination is available, emergency vaccination is not typically practical for flocks already in production. However, vaccination of the next 3–5 replacement flocks after an outbreak is recommended to prevent recurrence. It is also important to note that erysipelas is a zoonotic disease, and *E. rhusiopathiae* can infect humans through skin wounds, making proper biosecurity and handling procedures essential.

Salmonellosis due to *S.* Pomona

A submission from the west coast of Ireland involved three 2-week-old Capercaillie (*Tetrao urogallus*) chicks. The owner, who had a small hatchery in his kitchen, originally had six chicks intended for breeding purposes. Three of the chicks had already died in the preceding days, with yersiniosis suspected by the private veterinary practicioner. The preservation of the submitted chicks was very poor, making a complete post-mortem examination impossible. However, *Salmonella* pomona was cultured from the faecal samples. Noteworthy were the unusual circumstances surrounding both the origin and intended purpose of the submission.

Gallibacterium anatis infection

In 2023, *Gallibacterium anatis* was cultured from the liver and coelomic fibrinous exudate of backyard hens on multiple occasions. Although *G. anatis* is typically a commensal organism residing in the respiratory and reproductive tracts, it can act as an opportunistic pathogen under favorable conditions, leading to reproductive disorders and systemic infections.

Megabacteria infection

A 3.5-year-old canary was diagnosed with multifocal mild to severe heterophilic ingluvitis and proventriculitis, associated with high numbers of *Macrorhabdus ornithogaster* (formerly known as megabacteria). These large, microscopic organisms are a common cause of gastrointestinal disease in birds.

Macrorhabdus ornithogaster infection typically leads to chronic weight loss syndrome, characterised by soft, bulky, dark stools containing poorly digested food, despite an increased appetite. The disease often progresses over a period of more than one month, but sudden death can occur following acute vomiting episodes. Interestingly, *Macrorhabdus ornithogaster* has been found in the feces of clinically healthy birds, while in contrast, severely emaciated birds often show no presence of *Macrorhabdus ornithogaster* in their faeces, despite heavy colonisation in the stomach. This variability highlights the complex nature of the infection and its unpredictable clinical presentation.

Fatty liver haemorrhage syndrome

Occasionally, table egg layers and backyard hens were submitted with striking findings of excessive adipose deposits throughout the coelomic cavity, often accompanied by severe liver pathology. These liver abnormalities included extensive diffuse blood clots on the parietal surfaces, large areas of parenchymal and capsular rupture, and significant organ enlargement with a distinctive yellow-ochre discoloration.

Figure 14.3.: FLHS: Adult back yard hen. Right liver lobe diffusely moderately pale and friable, with moderate multifocal yellow-cream-brown small round areas throughout the parenchyma. Large severe rupture and haemorrhages within the ventral surfaces of the Glisson capsule and the hepatic parenchyma of the contralateral hepatic lobe. Note also the diffuse abundant layer of fat in the abdominal cavity. Photo: Sebastian Mignacca.

Histological analysis confirmed changes consistent with fatty liver hemorrhagic syndrome (FLHS), a metabolic disorder typically seen in table-egg layers. FLHS is believed to result from a complex interplay of nutritional, hormonal, genetic, and environmental factors. The syndrome frequently leads to catastrophic liver rupture and hemorrhage, making it a critical condition in affected flocks.

Neoplasia

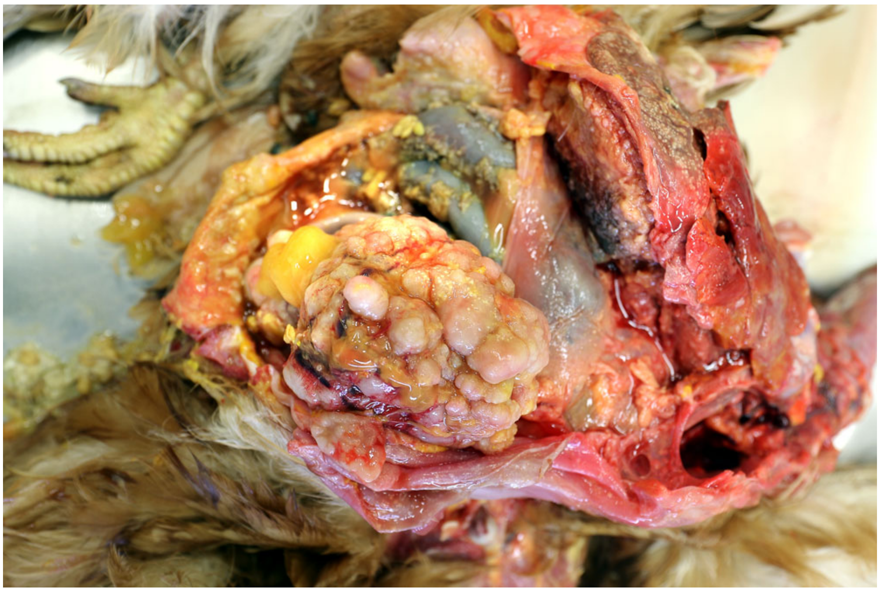

Figure 14.4.: Adenocarcinoma. Single large firm pink-grey cauliflower-like mass within the coelomatic cavity and attached to the cloaca and the distal oviduct; on cross section it showed a thick wall and a cavity with scattered elongated blood collections. Fibrous thick large membranes multifocally adhered to the celomatic organs covered by multifocal pink-grey-yellow firm small globular lesions, and mild collection of turbid fluid were also present.Photo: Sebastian Mignacca.

A backyard flock of six Rhode Island Red hens were euthanised due to suspected avian influenza (AI), following reports of respiratory distress, sneezing, and poor condition. AI testing returned negative results, but surprisingly, three hens were found to have adenocarcinomas, while another had a leiomyoma. The lesions ranged from firm, cream-grey, medium-sized masses to large, cauliflower-like masses (up to 8x7x7 cm) located within the abdominal cavity, attached to peripheral organs and the distal oviduct. All tumors appeared to originate from the oviduct. Adenocarcinomas of the reproductive tract are common in older laying hens with high ovulation rates, while leiomyomas are benign smooth muscle tumors often found incidentally in older hens and broiler breeders. The exact cause of these tumors remained unclear, but it was unusual that four of the six hens in this small backyard flock had neoplasms.

Miscellaneous cardiovascular lesions:

Cardiac pathologies and abnormalities of the large blood vessels at the base of the heart were sporadically observed in 2023, primarily affecting birds submitted from zoological collections. These cases included cartilaginous metaplasia of the aorta and ruptures of major vessels, often attributed to mycotic infections.

Figure 14.5.: Vessel rupture. Focal extensive irregular severe thickening of the main arterial blood vessels at the base of the heart (systemic aortic arch and right subclavianartery), with focal complete rupture of the relative walls (not visible in the pic) and severe multifocal to coalescing fresh blood clots within the air sacs and the lungs. Multifocal large fresh blood clots within the oral cavity, choanae, and tracheal lumen were also seen. Note also the mild diffuse pallor of the carcass. Photo: Sebastian Mignacca

Other diagnoses

Other sporadic diagnoses observed throughout 2023 primarily involved less common bacterial infections, as well as conditions such as fatty liver hemorrhagic syndrome, tumors, aspergillosis, mycoplasmosis (*Mycoplasma gallisepticum* and *M. synoviae*), adenovirus infections, lymphoid leukosis, Gumboro disease, trichomoniasis, amyloidosis, and various breast myopathies, among others.

Selection of cases for *post mortem* examination

Effective case selection for diagnosis, particularly from large poultry operations, is crucial. Birds submitted should represent typical cases of the disease observed on the farm, rather than random selections. The above cases highlight the importance of strong sampling skills by private veterinary practicioners, along with continuous communication and feedback from them, as well as good cooperation with farmers to ensure accurate and reliable diagnoses.

In the few cases where avian submissions remained undiagnosed or inconclusive, the primary issue was the poor condition of the samples upon arrival. This included carcasses in advanced decomposition, insufficient ice packed with the carcass during shipping, inadequate packaging, or delays caused by couriers.

Unfortunately, despite *post mortem* examinations, some submissions still resulted in inconclusive findings regarding the cause of mortality.

15. Wildlife Surveillance

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DAFM's Veterinary Laboratories examined several wildlife species both as part of DAFM's wildlife disease surveillance exercises and to also to assist the National Parks and Wildlife Service (NPWS) in investigating suspected wildlife in 2023.

15.1. Hares

DAFM veterinary laboratories examined seven hares (*Lepus timidus hibernicus*) in 2023. NPWS submitted four hares for *post mortem* examination from Co Galway suspected of having been hunted by dogs. There was evidence of severe trauma and the injuries seen included severe subcutaneous haemorrhage bilaterally over the ribs, with haemorrhage and tearing of the intercostal muscles and comminuted rib fractures resulting in punctured lungs and marked pulmonary haemorrhage. The *Garda Siochana* successfully prosecuted the individuals involved in this case and custodial sentences and fines were handed down. In a separate case, a leveret had skin lacerations consistent with dog bites. Coccidiosis was identified as the cause of death in two hares submitted having been found dead after a coursing meeting.

15.2. RAPTOR Programme

The RAPTOR (*Recording and Addressing Persecution and Threats to Our Raptors*) Programme, is a collaboration between the National Parks and Wildlife Service (NPWS), the State Laboratory and the Regional Veterinary Laboratories and has been running since 2011. It is a mechanism for managing suspected wildlife crimes and disease surveillance in raptors and birds of special interest.

There are several components to this programme including x-rays, *post mortem* examination and toxicology testing. The RAPTOR protocol is currently undergoing revision to better segregate and resource wildlife crimes submissions, particularly those likely to result in prosecution, from those of surveillance value and this is at an advanced stage.

In 2023, NPWS submitted 29 birds to DAFM veterinary laboratories under the RAPTOR programme, including Buzzards (*Buteo buteo*), Barn Owls (*Tyto alba*), Kestrels (*Falco tinnunculus*), Peregrine Falcons (*Falco peregrinus*), Sparrowhawks (*Accipiter nisus*), white-tailed eagles (*Haliaeetus albicilla*), an osprey (*Pandion haliaetus*) and an eagle chick. All birds were first tested for avian influenza (AI) and if test positive to AI no further testing of samples was conducted. If there was an AI negative test result and where preservation allowed, samples were collected at *post mortem* and were submitted to the State Laboratory for toxicology testing.

Tests carried out on these samples in the State Laboratory include alphachloralose, betachloralose, brodifacoum, bromadiolone, carbofuran, chlorophacinone, coumatetralyl, diclofenac, dicumarol, difenacoum, difethialone, diphacinone, flocoumafen, flunixin, meloxicam, methiocarb, methiocarb sulfoxide, nitroxinil, strychnine and warfarin. The sample for testing is extracted from the matrix and subjected to liquid chromatography tandem mass spectrometry (LC-MS), which is a common analytical technique used for confirmatory analysis for the presence of analytes in biological matrices. Liver samples from a buzzard found dead in Co. Kilkenny and submitted to the state lab for toxicology detected Brodifacoum (an anticoagulant rodenticide) but, as there was

Figure 15.1.: Peregrine falcon (*Falco peregrinus*) to be examined within the national scheme to monitor mortality in Irish brids of prey (RAPTOR) due to poisoning.

no gross evidence of internal haemorrhage in the carcase usually associated with rodenticide poisoning and advanced carcase autolysis, the significance of the detected levels could not be determined with certainty.

A Barn Owl was found dead in Co Westmeath and had liver residues of bromifacoum and flocoumafen. No internal haemorrhages were noted in the autolysed carcase. These chemicals have a similar anticoagulant effect, therefore, combined, even at lower concentrations, they could potentially result in secondary poisoning with sub lethal effect due to prolonged clotting times affecting survivability. A peregrine falcon found dead in Co Tipperary had been shot and there was significant internal haemorrhage. Another peregrine falcon was submitted from Co Tipperary with a metal object impaled in the pectoral muscles and chest resulting in significant internal haemorrhage and tissue trauma. Bacterial hepatitis was diagnosed in a white fronted goose found dead in Co Wexford.

15.3. *Echinococcus multilocularis* Survey

Echinococcus multilocularis is a zoonotic tapeworm that infects the red fox (*Vulpes vulpes*)as a definitive host, other definitive hosts include cats and dogs. There are a number of forms of human echinococcosis, but alveolar echinococcosis is more frequently caused by *Echinococcus multilocularis* and is a serious parasitic zoonosis. People affected show symptoms of fatigue, weight loss, abdominal pain, general malaise and signs of hepatitis or hepatomegaly. In untreated patients, the disease can develop to a severe form resulting in liver failure. The adult tapeworm passes eggs into the intestine, which are excreted in the faeces and ingested by intermediate hosts (mice, voles and shrews typically) which can then infect the definitive hosts. Zoonosis occurs when man is the intermediate host.

The island of Ireland is considered free from *E. multilocularis* and therefore it is a requirement under the EU Pet Travel Scheme (PETS) that all dogs entering Ireland are treated with an anthelmintic effective against *Echinococcus spp.* prior to entering the country. Ireland must provide scientific evidence to the EU of our *E. multilocularis* free status, therefore DAFM undertakes an annual survey of wild fox population from across the country to assess the prevalence of this parasite. In 2023, 384 foxes were sampled and tested using PCR and all were negative for *Echinococcus multilocularis*.

Foxes submitted as part of the Echinococcus survey in 2023 were also sampled as part of an EU funded research project to enhance the surveillance for animal and human Influenza viruses in Ireland. Samples of brain, lung and intestine were collected from more than 416 foxes. In total, 1239 samples were tested for avian influenza (AI) using molecular testing protocols as per the European Reference Laboratory (EURL) for Avian Influenza and the WOAH diagnostic manual. All samples have tested negative to date. In an additional part of this study, samples (swabs) from seals from the Irish Rescue Centre were also tested for AI in Backweston DAFM laboratories. In collaboration with UCD School of Veterinary Medicine, 70 seal samples were tested for Avian Influenza in 2023 and all were negative. This work is part of the OH-ALLIES project (One Health- All Ireland for Europe Surveillance), Grant number 101132910, funded by European Health and Digital Executive Agency (HADEA) under the EU4Health Programme (EU4H).

Part IV.

Miscellaneous

16. Mycobacterial Disease: TB

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16.1. Introduction

Bovine tuberculosis (bTB), caused by *Mycobacterium bovis*, and Johne's disease (JD), caused by *Mycobacterium avium* subspecies *paratuberculosis* continue to pose significant challenges to animal health and livestock farming in Ireland. Furthermore, *M. bovis* is recognised as the primary cause of zoonotic tuberculosis infections in people. The Department of Agriculture, Food, and the Marine's (DAFM) role in monitoring and control of mycobacterial disease aims to protect both human and animal health and acts as an important support to Irish agri-food activity and trade.

16.2. Bovine tuberculosis

Bovine tuberculosis is a chronic granulomatous disease of cattle, usually characterised by lesions in pulmonary and lymph node tissue. While any member of the *Mycobacterium tuberculosis* complex (MTBC) may cause bTB, in Ireland, the infection is almost exclusively associated with *M. bovis*. Furthermore, *M. bovis* is also associated with TB infections in wildlife species such as badgers and deer, other domestic and exotic species and, occasionally, humans. Nowadays, overt clinical disease is relatively rare in cattle, in large part due to the success of the national bTB eradication programme (ERAD). Nevertheless, in 2023, ERAD reported an overall herd incidence of just under 5 *per cent* and thus, bTB still presents a significant challenge to the Irish dairy and beef farming sectors though loss of production and restrictions on trade in affected herds.

The National Reference Laboratory for bovine tuberculosis (bTB NRL) is operated by the Bacteriology and Parasitology division at the DAFM laboratory complex at Backweston. The main function of the bTB NRL is to support the activities of the national bTB eradication programme (ERAD) in its efforts to reduce and eliminate bTB from the national herd by providing diagnostic support and advice to veterinary colleagues.

The majority of samples processed by the bTB NRL represent tissue submissions from suspect bTB lesions detected at routine *post mortem* abattoir inspection. The bTB NRL received 7098 bovine samples from abattoirs during 2023. Of these, 5001 represented lesions detected in cattle previously deemed free from bTB at their previous herd test (these are known as 'slaughter check' lesions). The remainder comprised samples from singleton (n = 487) and inconclusive (n = 367) tuberculin skin test animals as well as samples from bTB positive animals submitted for special investigation (n=591) or strain type (n = 274) testing.

All samples submitted from abattoirs are examined for the presence of a gross lesion. Samples with no visible lesion (NVL) on gross examination are submitted for mycobacterial culture. Prior to 2023, all samples with a gross lesion were submitted for histopathological examination: those with a definitive positive (i.e., TB granuloma) or negative (i.e., actinobacillosis, neoplasia or parasitic lymphadenitis) diagnosis required no further testing whereas those with an inconclusive diagnosis (e.g., non-specific granuloma) were submitted for culture.

From June 2023 onwards, all samples with an inconclusive histopathological diagnosis were submitted for

Figure 16.1.: Tuberculous lesion in bovine lymph node in preparation for histopathological examination. Photo: DAFM bTB NRL.

Direct TB PCR testing instead of culture. The Direct TB PCR test is based on the method developed by the EU-RL and uses two targets specific to the Mycobacterium tuberculosis complex (MTBC), namely *IS6110* and *mpb70*, as well as a target specific to *Rhodococcus equi* (ChoE). The test was extensively validated at the bTB NRL and shows comparable sensitivity and specificity to culture for lesioned tissue. The incorporation of Direct TB PCR testing into the diagnostic workflow resulted in significantly decreased turnaround times meaning that >90 *per cent* of herd owners receive their results within five weeks of slaughter. On foot of the successful implementation of the test, the histopathology test was discontinued from May 2024 onwards and all samples with lesions are submitted for Direct TB PCR testing.

Table 16.1.: Summary of diagnostic results for samples submitted for bTB testing to the National Reference Laboratory for bovine tuberculosis in Ireland during 2023.

Species*	Samples submitted (n)	Mycobacterium bovis positive (%)	Nontuberculous Mycobacteria positive (%)
Bovine (slaughter check)	5001	2559 (51.2%)	47 (0.9%)
Bovine (diagnostic)	144	52 (36.1%)	13 (9.0%)
Badger	1103	356 (32.3%)	193 (17.5%)
Cervine	110	16 (14.5%)	30 (27.3%)
Exotic (alpaca)	38	32 (84.2%)	1 (2.6%)
Exotic (other)	24	0 (0%)	3 (12.5%)
Caprine	21	15 (71.4%)	0 (0%)
Porcine	8	1 (12.5%)	0 (0%)
Avian	3	0 (0%)	0 (0%)
Feline	1	0 (0%)	0 (0%)
Ovine	1	0 (0%)	0 (0%)
Vulpine	1	0 (0%)	0 (0%)

* Bovine (slaughter check) samples represent lesions detected at routine post-mortem exam at slaughter of animals previously deemed free of bTB. Samples from the other species as well as the bovine (diagnostic) samples represent samples submitted from regional veterinary laboratories, private veterinary practices or laboratories. Note that some diagnostic sample submissions comprised of two or more tissue samples which were tested separately, in such cases the overall result was reported and included in this summary.

The bTB NRL also received 1454 submissions for diagnostic investigation during 2023. The majority of samples were submitted by the RVLs (n = 1229; 8 *per cent*) with the remainder comprising a small number of suspect ovine and porcine lesions detected at *post-mortem* abattoir inspection and diagnostic samples submitted by PVPs. Of these, 1103 (74.9 *per cent*) were samples submitted from badgers, 144 were bovine diagnostic samples (i.e., incidental findings at *post mortem* of bTB negative animals or *post mortem* of TB positive animals submitted to RVLs rather than to an abattoir), 110 were from deer and 38 from alpacas.

Table 16.1 presents a summary of the diagnostic test results for samples submitted for bTB confirmation during 2023. Just over half of all slaughter check samples were positive for *M. bovis* with lower prevalence in diagnostic sample submissions except for alpacas. Nontuberculous mycobacteria (NTM) were isolated from just under 1 *per cent* of bovine slaughter check samples but were more prevalent in other submission types, particularly in badgers (17.5 *per cent*) and deer (27.3 *per cent*). Nine badgers were positive for the *M. bovis* BCG vaccine strain. This strain was not found in any other species and these findings are likely due to the vaccination programme though this will be confirmed using whole genome sequencing. It should be noted that these results do not reflect prevalence of bTB in the wider animal population, rather, they represent prevalence within a subset of suspected bTB cases.

16.3. Whole genome sequencing (WGS)

Whole genome sequencing (WGS) is increasingly being used by the Department's laboratories as a tool to aid in characterising the phylogeny and genetic make-up of various bacterial species. It's main utility within the bTB NRL is in building a phylogenetic database of bTB isolates which will help to inform the overall epidemiological picture of *M. bovis* infection in Ireland and aid in outbreak investigations at farm, local and regional level. While WGS allows for the highest resolution of discrimination between different strains of *M. bovis*, its usefulness as an epidemiological tool is very much dependant on the quality and comprehensiveness of the underlying database. To this end, the bTB NRL continues to build its *M. bovis* WGS database and, in 2023, 1720 isolates were sequenced (the largest number to date). The bTB NRL *M. bovis* WGS database currently comprises approximately 5400 sequenced isolates, of which c. 85 *per cent* are of bovine origin, c. 12 *per cent* were isolated from badgers and the remainder comprising isolates from species such as deer, alpaca and other domestic and exotic animals.

17. Mycobacterial Disease: Johne's Disease

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17.1. Introduction

Johne's disease is a progressive, chronic granulomatous disease affecting the intestinal tract of ruminants caused by *Mycobacterium avium* subspecies *paratuberculosis* (MAP). Clinical signs include diarrhoea, weight loss, lethargy, submandibular oedema, and death. Latency is a common feature of the disease, and although exposure to infection commonly occurs early in life, clinical signs are most frequently manifested between two tofive years of age.

The Irish Johne's Control Programme (IJCP) is managed by Animal Health Ireland (AHI) and provides knowledge and tools to farmers to help prevent infection entering their farm, or, where it is already established, to mitigate spread and to reduce and ultimately eliminate infection from the herd. For more information, please see Animal Health Ireland webpage[1].

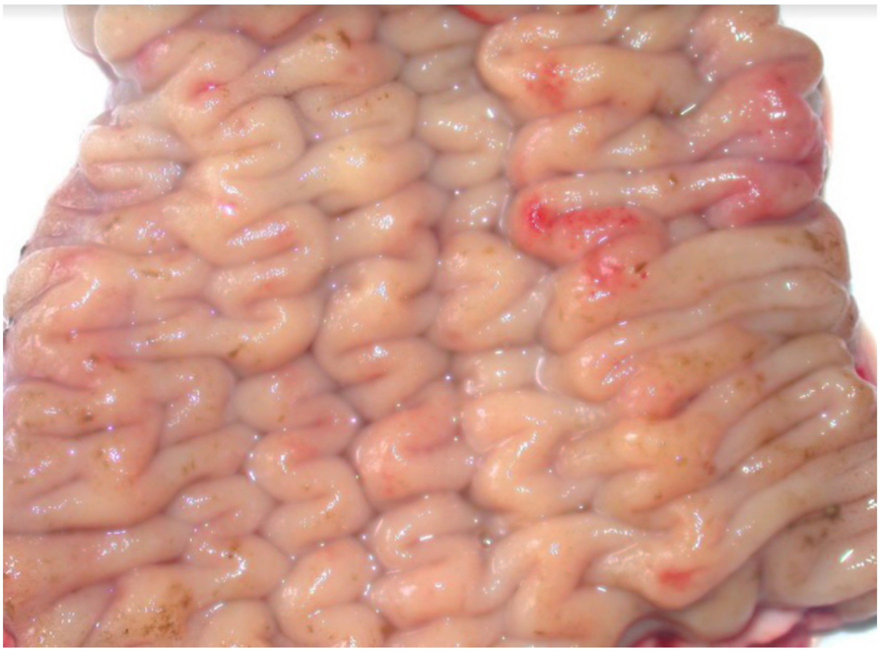

Figure 17.1.: Thickening and corrugation on the mucosal surface of the ileum in a cow which had Johne's disease manifested by ill-thrift and diarrhoea. Photo: Colm Brady.

[1] https://animalhealthireland.ie/programmes/johnes-disease/irish-johnes-control-programme-ijcp-information/

Table 17.1.

Table 17.2.: Summary of diagnostic results for samples submitted for MAP testing to the National Reference Laboratory for Johne's disease in Ireland during 2023.

	Serology			Culture	
Species	**Samples (n)**	**MAP ELISA positive**	**MAP ELISA suspect**	**Samples (n)**	**MAP culture positive**
Bovine	2075	206 (9.9%)	9 (0%)	189	58 (30.7%)
Caprine	115	6 (5.2%)	0 (0%)	10	3 (30%)
Ovine	103	9 (8.7%)	0 (0%)	38	4 (10.5%)
Exotic	3	0 (0%)	0 (0%)	6	0 (0%)

17.2. Diagnosis

Diagnosis of JD is challenging as definitive diagnosis often relies on histopathological examination. However, a number of diagnostic tests, when used along with appropriate interpretation of clinical signs and herd health history, are available to aid in diagnosis at animal and herd level.

Serological testing for antibodies to MAP infection is conducted using an enzyme linked immunosorbent assay (ELISA) and is used to screen animals and herds for exposure to MAP. The specificity of MAP ELISA is affected by tuberculin testing and exposure to other mycobacteria while sensitivity may be lower in subclinically infected animals. Despite these limitations MAP ELISA offers a low cost, short turnaround time test which can identify animals suitable for further testing.

Bacterial culture of faecal or tissue samples is considered the gold standard *ante mortem* test to determine the presence of MAP. However, intermittent or absent shedding mean that sensitivity is low in the early stages of infection and furthermore, turnaround testing time may be up to six weeks. Faecal or tissue samples may also be tested for the present of MAP using targets specific to the MAP genome. Although this test has a much shorter processing time than culture, it is affected by the same limitations of culture with relatively lower sensitivity and specificity.

Most of the diagnostic work for JD is carried out by commercial laboratories approved by the IJCP and is supported by the NRL for Johne's disease, operated by the DAFM Bacteriology and Parasitology division. The NRL for JD also provides diagnostic support to the RVLs and to PVPs and in 2023, processed 2296 samples for MAP ELISA testing and 243 samples for culture, the majority of which were for bovine animals. A summary of these results is present in Table 17.1.

18. Zoonotic Diseases

Note

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Zoonotic diseases, or zoonoses, are defined by the World Health Organisation (WHO) as any disease or infection that is naturally transmissible from vertebrate animals to humans. Transmission occurs as a consequence of direct contact, indirect environmental contact, or through food. According to the World Organization for Animal Health (OIE), 60 *per cent* of existing human diseases are zoonotic and 75 *per cent* of emerging infectious human diseases are of animal origin.

The WHO describes *One Health* as "an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better public health outcomes". One Health provides an opportunity to protect public health by developing policies to control pathogens in the animal population, thereby reducing transmission of zoonotic pathogens to humans. Some examples of zoonotic diseases include salmonellosis, campylobacteriosis, listeriosis, tuberculosis, brucellosis, yersiniosis, toxoplasmosis, coxiellosis, leptospirosis and cryptosporidiosis. During 2023, DAFM Regional Veterinary Laboratories (RVLs) isolated and identified or otherwise detected a number of zoonotic agents, some of which are discussed below.

18.1. Campylobacteriosis

During 2023, DAFM RVLs isolated *Campylobacter jejuni* from 70 bovine faecal samples and 6 ovine faecal samples.

Campylobacteriosis caused by *Campylobacter jejuni* is usually asymptomatic in animals but it can cause gastrointestinal disease in humans. In animals, *Campylobacter spp.* can be found in both healthy and diarrhoeic animals. It can cause acute enteritis in many domestic animals. In cattle and sheep, some species of *Campylobacter* are reported to cause abortion (*C. jejuni*, *C. fetus subsp. fetus*).

Campylobacteriosis is recognised as the most commonly reported cause of gastrointestinal disease in humans in the European Union (EU) since 2005. In 2023, there were 3737 confirmed cases of human campylobacteriosis reported in Ireland (HSPC 2024)[1]. In food-borne outbreaks of campylobacteriosis the most common sources of infection are contaminated broiler meat and milk. Symptoms of disease in humans include diarrhoea, pyrexia, abdominal pain, nausea and vomiting. Guillaume-Barré syndrome is also reported as a rare sequel to *Campylobacter spp.* infection.

18.2. Coxiellosis (Q fever)

During 2023, DAFM tested 961 bovine, ovine and caprine sera for antibodies to *Coxiella burnetii*, the causative agent of Q fever, of which 85 tested positive (8.8 *per cent*). *C. burnetii* DNA was detected by PCR test in 56 of

[1] https://www.hpsc.ie/notifiablediseases/annualidstatistics/Annual_ID_Summary_Report_for_HPSC_Web_v9.0-2019-2023-11072024.pdf

1268 samples tested (4.4 *per cent*), typically swab samples taken from foetuses or foetal membranes.

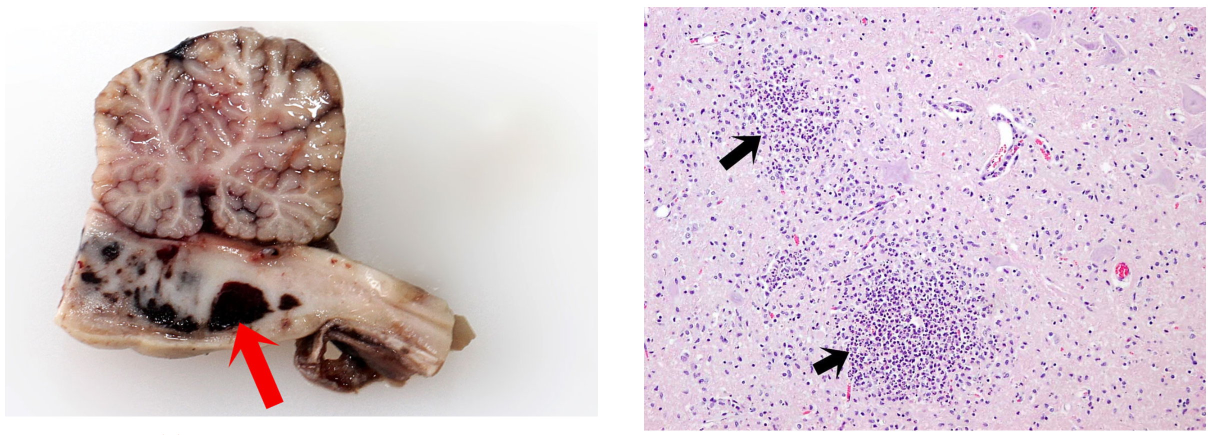
C. burnetti is the aetiological agent of Q fever, a zoonotic bacterial infection associated primarily with parturient ruminants. *C. burnetii* has a wide host range, infecting many hosts from arthropods to humans. Zoonotic infections originate from bacteria circulating in animal reservoirs, mainly domestic ruminants. Certain occupational groups, predominantly those in contact with animals or animal products such as farmers, veterinarians and abattoir workers, are at a higher risk of exposure. Transmission of *C. burnetii* occurs primarily by the aerosol route via inhalation of aerosolised bacteria shed by infected animals, primarily after giving birth or aborting. The greatest risk of infection occurs at parturition by inhalation, ingestion or direct contact with birth fluids or placenta. *C. burnettii* is also shed in milk, urine and faeces. In animals, the predominant reservoir hosts are cattle, sheep and goats. Other species reported to shed *C. burnetii* include domestic mammals, marine mammals, reptiles, ticks and birds. Infection in animals is usually subclinical, but animals will still shed the bacteria and become long-term carriers. Shedding can persist for months, and infection may persist for years and is probably lifelong. Clinical manifestations in animals mainly relate to reproductive disorders such as infertility, stillbirth, abortion, endometritis or mastitis.

Disease manifestation in humans varies in severity from asymptomatic infection to fatal disease, with a range of acute or chronic symptoms such as fever, pneumonia, hepatitis, endocarditis or fatigue. In humans, the majority of outbreaks have been associated with wind dispersal of contaminated, desiccated, reproductive materials. Risk factors for zoonotic transmission of *C. burnetii* have been identified and include an association with small ruminants, proximity between animals and humans particularly around parturition, and dry, windy weather (causing transmission in airborne dust). Four cases of Q fever in humans in Ireland were reported in 2023 (HSPC 2024)[2].

18.3. Listeriosis

During 2023, *Listeria spp.* were isolated from 44 bovine, two ovine and one camelid sample, mainly from cultures of foetal stomach contents. *L. monocytogenes* was the species most frequently isolated.

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 the mammalian intestinal tract, which contaminates the environment.



(a) Cerebellum and midbrain

(b) Microabscesses

Figure 18.1.: Hemorrhagic inflammation (a) caused by *L. monocytogenes* in the proximity of the origin of the cranial nerves (midbrain). (b) Necrosuppurative encephalitis with microabscessation in the midbrain of a sheep. Photos: Cosme Sánchez-Miguel.

In adult ruminants, encephalitis and meningoencephalitis are the most common forms of listeriosis.

Other clinical manifestations in animals include abortion, perinatal mortality and septicaemia. Aborted foetuses and necropsy of septicaemic animals present the greatest infection risks to human handlers; there are re-

[2] https://www.hpsc.ie/notifiablediseases/annualidstatistics/Annual_ID_Summary_Report_for_HPSC_Web_v9.0-2019-2023-11072024.pdf

ported cases of fatal meningitis, septicaemia and papular exanthema on arms after handling infected aborted material or immersion in *L. monocytogenes* contaminated puddles/mud runs. Pregnant women should be protected from infection due to the danger to the foetus, and the possibility of abortion, stillbirth and neonatal infection.

While human listeriosis is rare, mortality can reach 50 *per cent*, and infections among the elderly, the immunocompromised and pregnant women have higher mortality rates. In 2023, there were 18 confirmed human cases of listeriosis in Ireland (HSPC 2024)[3].

18.4. Salmonellosis

During 2023, DAFM RVLs isolated *Salmonella spp.* from 41 foetuses submitted to the RVL network; the most common serotype was *Salmonella enterica* Dublin. Overall, *Salmonella spp.* were isolated from 118 of 5804 submissions cultured (2 *per cent*).

Salmonellosis is caused by several species of *Salmonella*, but the majority of animal and human disease are associated with serovars of *S. enterica*. The clinical presentation in animals varies from an asymptomatic chronic carrier state to acute/chronic enteritis to the more severe presentation of systemic septicaemia. Young animals usually develop the septicaemic form, adult animals commonly develop acute enteritis, and chronic enteritis is more often seen in growing pigs and occasionally in cattle. *Salmonella* also causes abortion in pregnant animals. Asymptomatic carriers are a zoonotic risk in all host species. The most common pathogenic serotypes of *S. enterica* are *S.* Dublin and *S.* Typhimurium. Infection of food-producing animals with *Salmonella spp.* presents a serious public health risk because food products of animal origin are considered a significant source of human infection.

In 2023 in Ireland there were 406 confirmed human cases of salmonellosis (HSPC 2024)[4]. Transmission of salmonellosis to humans occurs via direct contact with infected animals, indirect contact (e.g., with animal housing/equipment), or the consumption of contaminated water and foodstuffs. Symptoms tend to be more severe in the very young, the elderly and those who are immunocompromised. Symptoms of salmonellosis in humans include diarrhoea, vomiting, pyrexia and inappetence, and in more severe cases it can cause septicaemia.

18.5. Yersiniosis

Yersinia pseudotuberculosis was isolated from seven animal specimens in 2023. *Y. pseudotuberculosis* causes enteric infections which are often subclinical in wild and domestic animals, and humans. Three species of *Yersinia* are pathogenic for animals and humans; *Y. pestis* (the aetiological agent of the bubonic plague), *Y. enterocolitica* and *Y. pseudotuberculosis*. Most human infections are caused by *Y. enterocolitica*; *Y. pseudotuberculosis* infection is relatively uncommon in humans.

Yersiniosis in humans is usually related to consumption of raw/undercooked pork as pigs are the main carriers of *Y. enterocolitica*, but disease can also occur after direct contact with infected animals. Human cases of yersiniosis present as gastrointestinal disease and mesenteric lymphadenitis, with complications such as reactive arthritis, erythema nodosum, bacteraemia and sepsis.

Provisionally, there were 30 confirmed cases of yersiniosis in Ireland in human patients in 2023 (HSPC 2024)[5].

[3] https://www.hpsc.ie/notifiablediseases/annualidstatistics/Annual_ID_Summary_Report_for_HPSC_Web_v9.0-2019-2023-11072024.pdf

[4] https://www.hpsc.ie/notifiablediseases/annualidstatistics/Annual_ID_Summary_Report_for_HPSC_Web_v9.0-2019-2023-11072024.pdf

[5] https://www.hpsc.ie/notifiablediseases/annualidstatistics/Annual_ID_Summary_Report_for_HPSC_Web_v9.0-2019-2023-11072024.pdf

Part V.

Animal Health Ireland

19. Bovine viral diarrhoea (BVD) Eradication Programme

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19.1. Overview

In July 2022 the Irish BVD programme was approved by the EU Commission and in May 2023, the maintenance of approval was granted. This approval is an important achievement for the programme and a prerequisite for applying for recognition for freedom.

19.2. Results

Nearly 2.4 million calves were born in 2023. As in previous years, a high level of compliance with the requirement to tissue tag test these calves was observed, with results available for over 99.6 *per cent* of these calves. Only 0.026 *per cent* of calves tested in the year had positive or inconclusive results (BVD-positive), which when put in the context of all the animals in Ireland, the animal level prevalence is 0.01 *per cent*. The prevalence of herds with a suspect or confirmed BVD case continued to decrease to only 0.38 *per cent* of 83000 breeding herds (Figure 19.1).

Analysis of herd prevalence at County level showed that Co Carlow was completely free in 2022 and 2023 and that Counties Clare, Kilkenny, Sligo, Wexford and Wicklow only had 1-2 suspect herds during 2023 (Figure 19.1). When all herds are taking into account (circa 109k), the herd-level prevalence is 0.23 *per cent*. At the end of the year only a handful of suspect animals remained alive in seven herds, with many counties not containing any. Updated programme results are available on a weekly basis here[1].

For herds where a positive/inconclusive result is disclosed, an immediate restriction of animal movements for both moves in and out to reduce the risk of infected animals leaving the herd and spreading the virus. A series of requirements must be completed before the restriction may be lifted and these include an initial three-week period of herd restriction, beginning on the date of removal of the suspect animal, which serves as a 'circuit-breaker' to allow circulation of any additional transient infections established by the suspect or confirmed animal(s) to diminish or cease. After this period, the restrictions are lifted following completion of each of the following three measures by a trained private veterinary practitioner (PVP) nominated by the herd owner: an epidemiological investigation, carrying out a full herd test, and vaccinating all female breeding animals. By the end of 2023, over 48 thousand animals had been blood tested and close to 61 thousand had been vaccinated.

The measures have had an impact in reducing the period from test to removal of positive calves when compared to previous years. Analysis of the time in days showed that in 2019 this took a median of seven days whilst in 2023 it was reduced to a median of three days.

[1]http://animalhealthireland.ie/?page_id=229.

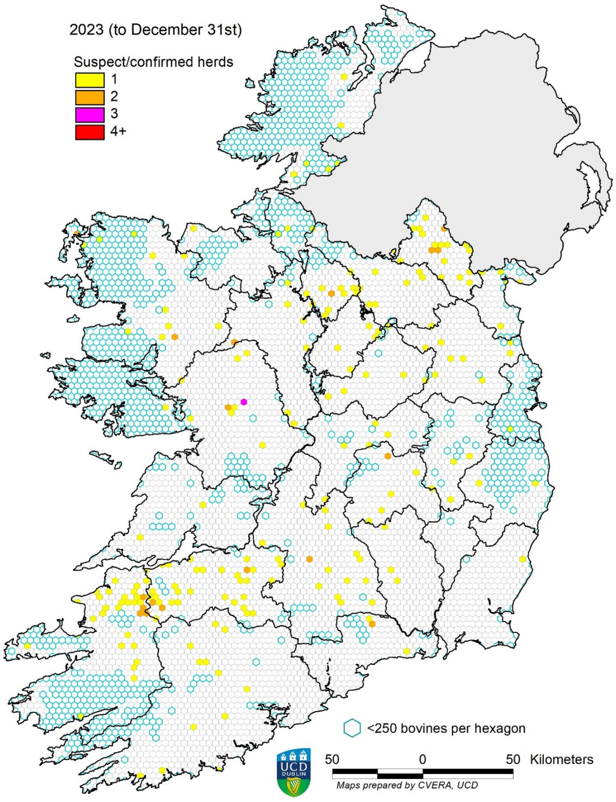

Figure 19.1.: Map showing distribution of herds with a suspect or confirmed BVD suspect animals born in 2023 up to the 31^{st} December. Each hexagon represents an area of approximately $10km^2$.

19.3. Hotspots during 2023

A new map has been developed to identify geographical hotspots in ROI so that high-risk locations can be identified (Figure 19.2). This map shows areas with an increased density of herds with BVD-positive births in 2023. It shows a clear hotspot in the North Kerry-Limerick area and other non-blue areas of concern, including the area in Co Monaghan. This may be explained, at least in part, by the high level of infection in neighbouring counties in Northern Ireland, particularly County Armagh and highlights the importance of implementing measures to prevent introduction of infection and to detect and resolve it where present.

19.4. Negative herd status (NHS)

By the end of 2023, over 96 *per cent* of breeding herds had acquired NHS, with a further 2.7 thousand only being ineligible due to the presence of a small number of untested animals. The status of almost all animals (99.6 *per cent*) in the 83000 breeding herds in Ireland is now known, including a decreasing number of animals born before the start of the compulsory programme in 2013 that have neither been tested nor produced a calf.

At the end of 2023, after a number of phone calls by the BVD Helpdesk, the number of these animals reduced to 104. The majority of these animals were in beef herds. The number of animals born since January 2013 that do not have a valid test result and are therefore not compliant with the requirements of the legislation was also reduced to 11 thousand at the end of 2023. The majority of these have never been tested, while a small number have had an initial empty result and not been retested. Most of these animals were 2023-born (88 *per cent*), with smaller numbers from preceding years.

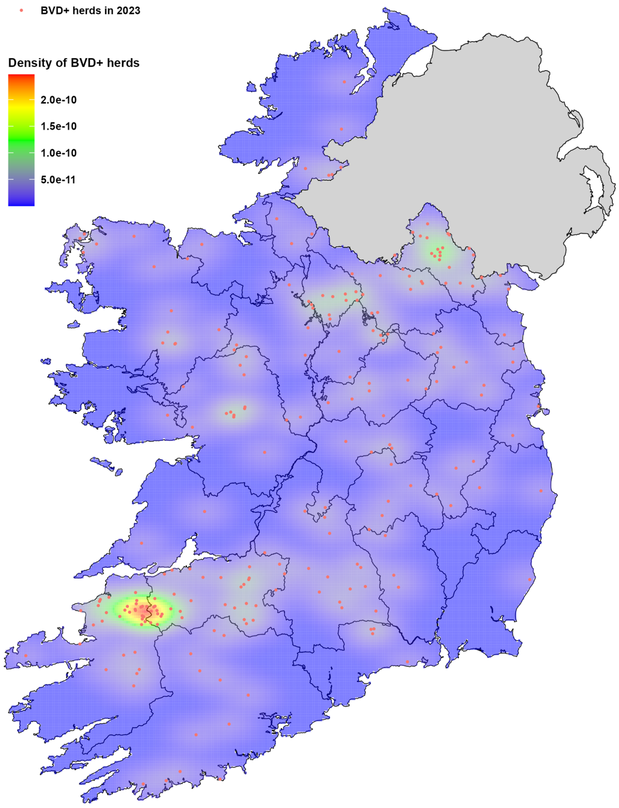

Figure 19.2.: Map showing the density of herds with BVD-positive births in 2023. A higher proportion of herds in non-blue areas had BVD-positive results in 2023, and herds in these areas are at increased risk of having BVD-positive calves in 2024.

Herds qualify for negative herd status (NHS) by meeting the following requirements:

1. Existence of a negative BVD status for every animal currently in the herd (on the basis of either 'direct' or 'indirect' results);
2. Absence of any suspect or confirmed animal(s) from the herd in the 18 months preceding the acquisition of NHS.

20. Infectious Bovine Rhinotrachetis (IBR) Eradication Programme

María Guelbenzu Gonzalo
BVD & IBR Programme Manager
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20.1. Overview

During 2023, a proposal for a national IBR eradication programme was presented to the IBR Implementation Group (IBRIG). This group includes representatives from the processing sectors, DAFM, farm organisations, breed societies and Teagasc. The proposal, developed by the IBR Technical Working Group (IBRTWG) was designed taking into consideration the recently introduced European Animal Health Law, with the goal of acquiring recognition for the programme in due course and thereafter recognition of freedom.

Available data suggested that around 80 *per cent* of breeding herds in Ireland have some level of infection. Therefore, the proposed programme envisaged an initial reduction phase to decrease the herd level prevalence in the country whilst recognising herds that meet a set of requirements as free.

During this phase it is proposed to apply an initial test to determine the herd status, which would consist of a bulk tank milk test in dairy herds. DAFM is currently undertaking national bulk tank milk surveillance which can provide cost-effective guidance to dairy herds on next steps, with use of targeted blood sampling in suckler herds providing similar information. This phase would be followed by an eradication phase, with ongoing review and refinement of the programme. Vaccination, biosecurity and testing are key elements of the proposed programme.

The Implementation Group raised a number of questions based on the presentations, and these have been addressed by the IBRTWG in advance of convening a further meeting of the IBRIG. The overall objective of this group will be to decide on the merits or otherwise of implementing a national IBR Programme.

20.2. Vaccination

Analysis of the latest vaccine sale data shows that a high level of expenditure on IBR vaccination is still ongoing. Currently in Ireland there is a continued high level of expenditure on IBR vaccination. During 2022, over 3.3 million IBR vaccine doses were sold (Figure 20.1). This is an increase from the previous 12 months and reflects a continuing trend seen over the past seven years.

20.3. National Beef Welfare Scheme 2023

In 2023 the DAFM launched the National Beef Welfare Scheme (NBWS) as a support measure designed to enhance animal health and husbandry on suckler farms. The scheme supported farmers in meal feeding suckler calves in advance of and after weaning, and in testing for the presence of IBR in their herds.

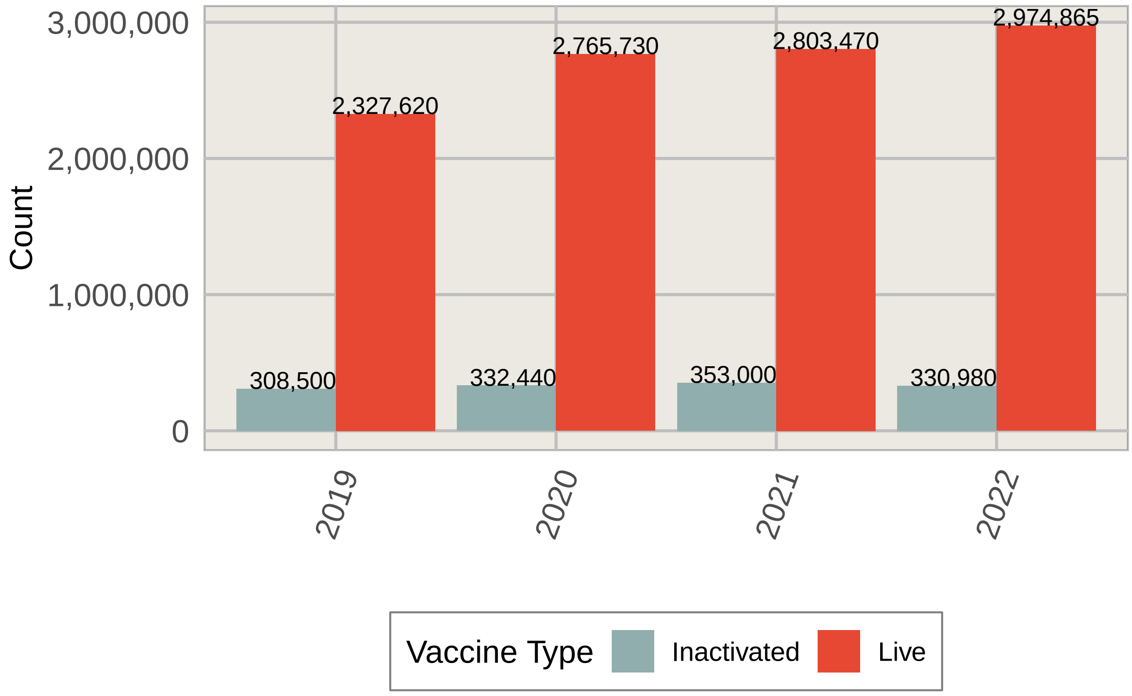

Figure 20.1.: Number of doses of IBR vaccine sold by year and vaccine type (inactivated, live) and total.

The IBR testing done under the NBWS 2023, consisted of performing a 'snapshot' test per herd to determine the herd-level IBR status. The snapshot required the sampling of 20 randomly selected animals over nine-months-old, to ensure there were no maternal antibodies remaining, and that were used or intended for breeding. It was important to include animals of all ages and groups in this testing to obtain a result that truly reflects the status of the herd. Where a herd had twenty or more bovines, a minimum of twenty were to be tested and where a herd had less than twenty bovines, all were to be tested, including those under nine months of age.

More than 10000 herds undertook this testing and the analysis of the results is ongoing. The findings will be incorporated into the modelling of options for a National IBR programme and presented to the IBR Technical Working Group and Implementation Group.

21. Irish Johne's Control Programme (IJCP)

Liam Doyle
Johne's disease (JD) Programme Manager
Animal Health Ireland (AHI)

21.1. Programme delivery

Approved Veterianry Practices (AVPs)

There are currently 531 AVPs trained and active in the programme carrying out VRAMPs and 477 AVPs trained to complete TASAH investigations.

The essential components of the IJCP are as follows:

1. Nomination of an Approved Veterinary Practitioner (AVP), these being private veterinary practitioners who had undertaken JD training delivered by AHI.
2. Regular completion of a Veterinary Risk Assessment and Management Plan (VRAMP) by a nominated AVP.
3. An annual Whole Herd Test (WHT) of eligible animals (those aged two years and above) in years one to four of the programme using either a milk or serum sample from each animal.
4. Ancillary testing of faecal samples (by PCR) of all animals following ELISA test-positive or inconclusive results (requirement to complete ancillary testing following inconclusive results has been removed from 01/05/2024) in herds where infection has not already been confirmed (i.e. absence of previous faecal-positive result).

VRAMP

Figure 21.1 below shows VRAMP completions for the years 2019 to 2023 inclusive. According to a herd's test results which are initially assessed in the first year of IJCP membership (Year 1) it is allocated to a particular pathway at the start of its second year: test negative pathway (TNP) or test positive pathway (TPP).

Along with the pathway a herd is also allocated number of years in that pathway, starting at two. During the four years of Phase 2 of the IJCP all herds, no matter what their pathway or number of years were required to complete an annual WHT. In terms of VRAMPs in 2023, all herds except for those in Year 4 and 5 TNP required annual VRAMP completion, shown in Figure 21.1 as the 408 herds which did not complete a VRAMP in 2023. In 2023 1129 VRAMPs were completed, which along with the 408 TNP year 4 and 5 herds not requiring a VRAMP meant that 1557 of the total registered herds (n=2230) fulfilled programme requirements. 693 herds registered in the programme did not complete a VRAMP in 2023.

Figure 21.2 below shows the pattern of VRAMP completions in years 2019 to 2023. Line graphs for each year recording monthly totals of VRAMPs completed show similar patterns of completion, with most done towards the end of each programme year. 2022 and 2023 differed from previous years, in that as already described

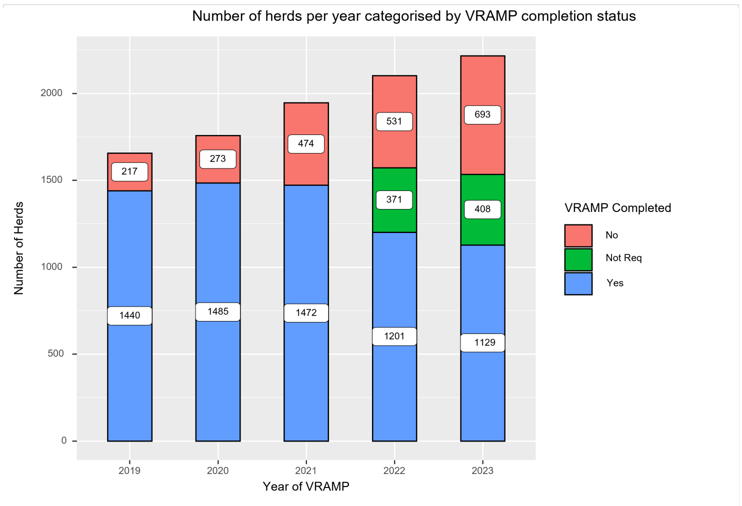

Figure 21.1.: Number of herds per year categorised by VRAMP completion status.

a cohort of herds in year 4 and 5 TNP were not required to complete a VRAMP. This is the reason why the line graph for year 4 and 5 TNP does not start at zero in January 2022 and 2023.

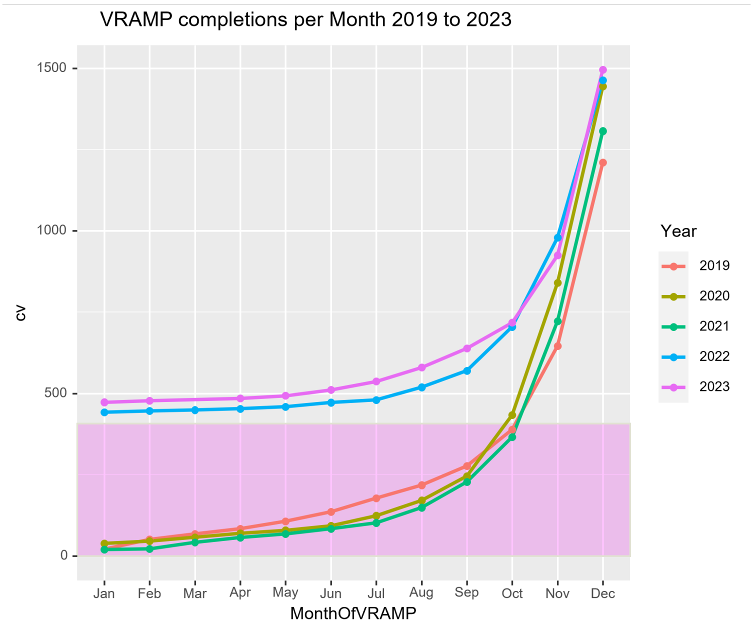

Figure 21.2.: VRAMP completions per month 2019 to 2023.

Whole Herd Test (WHT)

At the end of the programme year for 2023 (31st of January 2024) 985 whole herd tests (WHT) had been completed in both beef and dairy herds (44 *per cent*). 222 herds in Year 5 of the TNP were not required to complete a WHT in 2023 (10 *per cent*) and 209 herds started a WHT but did not complete it (9.4 *per cent*) (Figure 21.3). 814 herds did not start a WHT in 2022 (36.5 *per cent*). The number of herds not starting a WHT in 2023 was greater than 2022 (814 vs 606; Figure 21.2).

WHTs are carried out using either milk or blood ELISA tests. The proportion of testing using milk ELISA has increased due to the increase in herd owners utilizing milk recording. The total number of ELISA tests (milk and blood) carried out in 2023 was 194,440 (2022 – 220,047). Details of the numbers of blood and milk samples, and associated results are provided in Table 21.1.

Figure 21.2 shows the combined total of blood and milk ELISA tests per month carried out in 2022 and 2023.

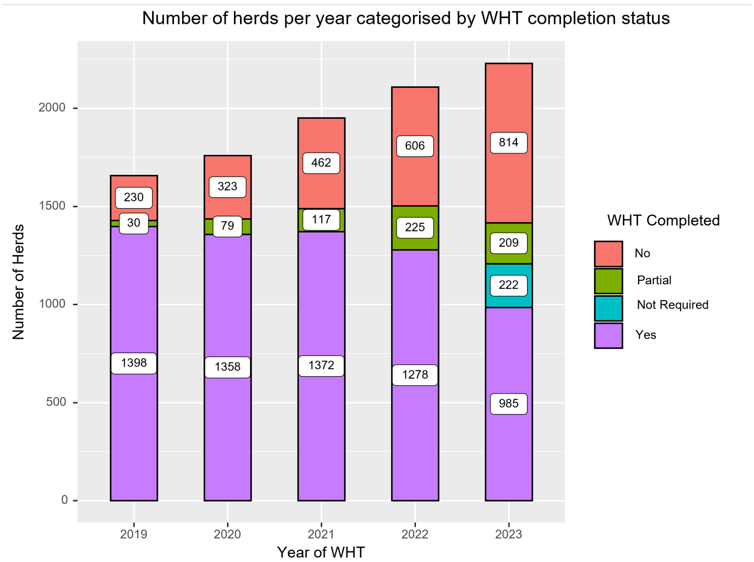

Figure 21.3.: Number of herds per year categorised by VRAMP completion status.

Table 21.1.: IJCB ELISA testing conducted during 2023

Test	Sample	No. of tests	Negative	Positive	Inconclusive
ELISA	Blood	78257 (40%)	74610	**2854 (3.6%)**	793 (1.0%)
ELISA	Milk	116183 (60%)	110752	**3122 (2.7%)**	2309 (2.0%)
Total ELISA	Milk + Blood	194440	185362	**5976**	3102

The pattern of testing is similar in 2023 to both 2022 with most of the testing being carried out between June and October. However, the peak level of testing in 2023 is lower than 2022, partially explained by the fact that in 2023 a cohort of 222 herds entered Year 5 TNP which meant they did not have to complete a WHT in the 2023 programme year.

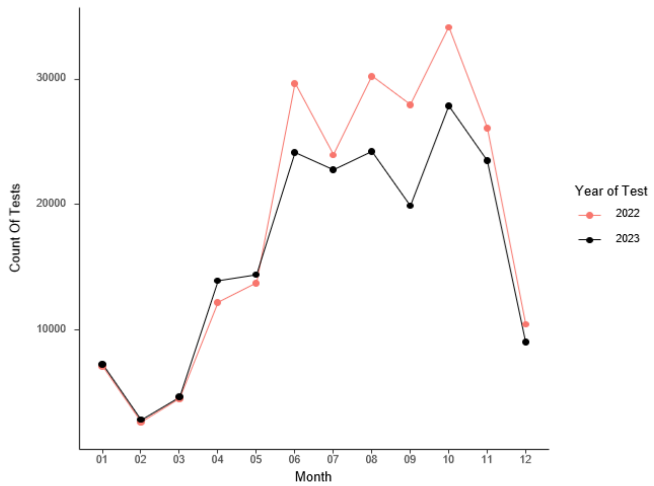

Figure 21.4.: Line chart showing combined total of blood and milk ELISA tests per month in 2022 and 2023.

Ancillary testing of faecal samples (by PCR)

In 2023 ancillary testing of all animals was carried out following ELISA test-positive or inconclusive results in herds where infection has not already been confirmed (i.e., absence of previous faecal-positive result).

Table 21.2.: 2023 PCR Test Results

Year	Test	Sample	No. of tests	Negative	Positive	Inconclusive
2023	PCR	Faeces	3,958	3629	301 (7.6%)	28

A total of 3958 ancillary PCR tests were carried out, of which 301 (7.6 *per cent*) were positive (Table 21.2). This positivity rate is increased relative to 2022 when it was 6.1 *per cent*. Figure 21.5 shows the monthly count of ancillary PCR tests carried out for each of the years 2021 to 2023. The pattern across the years is consistent, with the bulk of ancillary testing between October and March.

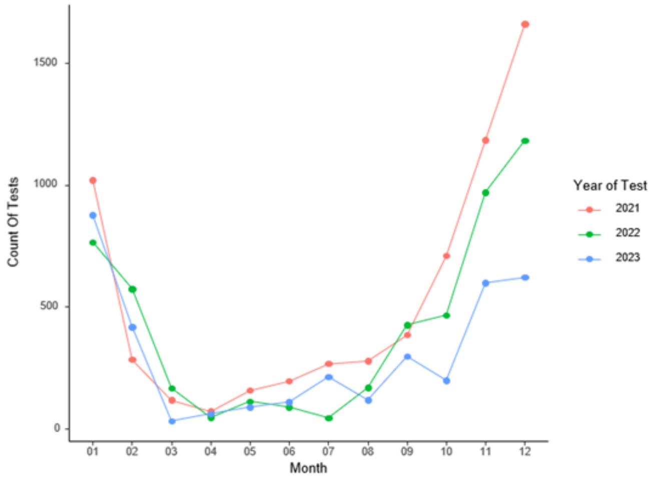

Figure 21.5.: Monthly count of ancillary PCR tests per year 2019 to 2023.

21.2. Targeted Advisory Service on Animal Health (TASAH)

Table 21.3.: JD TASAH Investigations Completed Per Year (2019-2023)

Year	Number of Investigations
2019	68
2020	88
2021	84
2022	97
2023	92

MAP Bulk Tank Milk (BTM) testing summary

For Johnes disease, since 2019, national surveillance of dairy herds has been conducted by the Department of Agriculture, Food and Marine (DAFM) to detect MAP antibodies using BTM samples. Two rounds of testing are performed each year, during spring and autumn. Results are shown up to 2023 (9 rounds of testing) and have been analysed (Figure 21.6).

The findings reveal a limited occurrence of antibody detection (2—7 *per cent* of herds per testing round), which is considerably lower than the estimated overall infection prevalence in the population at a herd level (30 *per cent*). This disparity arises due to the fact that the proportion of cows with antibodies in positive herds falls below the threshold necessary to consistently yield a positive result in bulk tank testing. As a result, a negative

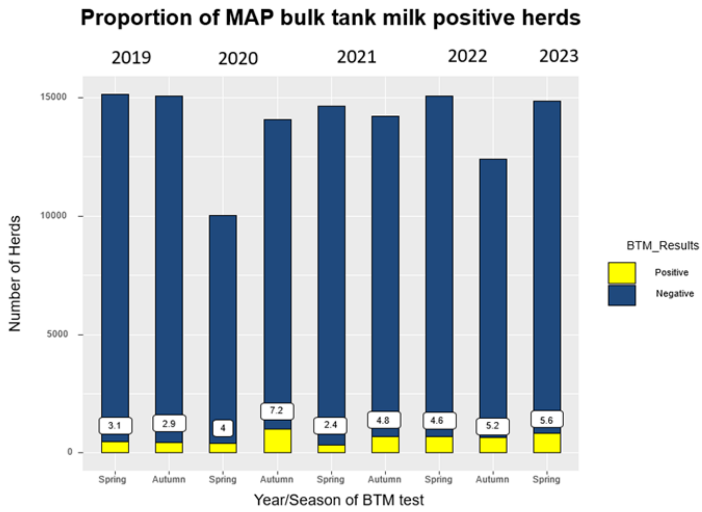

Figure 21.6.: MAP BMT testing each Spring and Autumn 2019 to 2022 inclusive.

outcome offers little assurance that a herd is infection-free. However, a positive result is useful for case detection, suggesting that the level of infection present is at the upper end of the national profile.

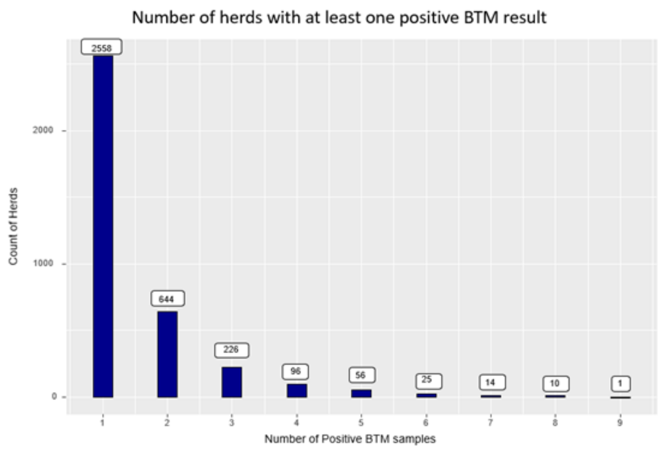

Figure 21.7.: Number of herds with at least one positive result

Of the 17252 herds tested across any of the 9 sampling points, 3630 tested positive at least once (Figure 21.7). These herds are informed by a letter from DAFM of their positive results and encouraged to join the IJCP. Testing of samples will continue with one round each spring and autumn.

Additional components to the IJCP:

1. Veterinary investigation, funded through the Targeted Advisory Service on Animal Health (TASAH) under the Rural Development Programme, following positive ancillary test results.

2. Members undertake not to move any animal that is inconclusive, positive or suspect based on testing for JD, except directly to a knackery, licensed slaughter premises, feedlot or herd from which animals are exclusively sent to slaughter.

Part VI.

Agri-Food and Biosciences Institute

AGRI-FOOD
& BIOSCIENCES
INSTITUTE

22. Bovine Diseases, AFBI

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22.1. Neonatal Calves (0–1 month old)

Neonatal enteritis remains the most frequently diagnosed cause of death in calves up to one month of age accounting for 37 *per cent* of cases (Table 22.1 and Figure 22.3). Common infectious causes of diarrhoea recorded included *E. coli*, *Salmonella* Dublin, rotavirus, coronavirus, coccidia and *Cryptosporidium*. Inadequate colostrum intake, stress and poor hygiene are important predisposing factors which contribute to the severity of scour outbreaks. Pathogenic *E. coli* infections usually cause watery diarrhoea in very young calves from about 15 hours to three days of age.

Thirty-one cases of diarrhoea due to *E. coli* were recorded with 17 of these presenting with the *E. coli* K99 antigen. Rotavirus is a common cause of diarrhoea in both dairy and beef suckler herds and it usually affects calves from about four days to two weeks. Rotavirus was detected in 49 cases (23 *per cent* of the enteric infections). Coronavirus may produce an enteritis similar to that caused by rotavirus. Twenty-three cases of enteritis due to coronavirus were recorded in 2023. Transit of calves through markets increases the likelihood of exposure to *Salmonella*. Four cases of BVDV infection were recorded in neonatal calves less than one month old in 2023. Fifty-two cases of enteritis due to the protozoan parasite *Cryptosporidium* were diagnosed in 2023, higher than the 36 cases recorded in 2022 and the 39 cases which were recorded in 2021.

Respiratory tract infections were the next most frequently diagnosed cause of mortality in neonatal calves accounting for almost 20 *per cent* of cases. *Mycoplasma bovis* was the most frequently diagnosed bacterium causing respiratory disease being recovered in 43 of the 116 cases (37 *per cent*) of respiratory infections, followed by *Mannheimia haemolytica* which was detected in nine of the 116 cases (8 *per cent*) of neonatal respiratory infections, *Trueperella pyogenes* was detected in eight cases and *Pasteurella multocida* was detected in two cases.

Table 22.1.: Conditions most frequently diagnosed in calves less than one month old submitted to AFBI for *post mortem* in 2023 (n= 589).

Category	No. of cases	Percentage
Enteric infections	215	**36.5**
Respiratory infections	116	**19.7**
Nutritional / metabolic conditions	80	**13.6**
Septicaemia / toxaemia	65	**11.0**
Other diagnoses	31	**5.3**
Navel ill / Joint ill	30	**5.1**
GIT torsion /obstruction	18	**3.1**
Heart / circulatory system	8	**1.4**
Peritonitis	8	**1.4**
Neurological diseases	7	**1.2**
Hepatic conditions	6	**1.0**
Diagnosis not reached	5	**0.8**

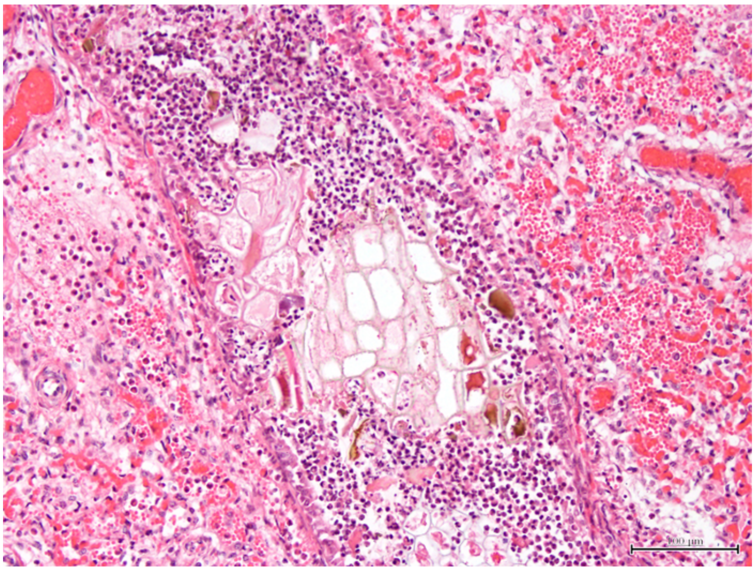


Figure 22.1.: Aspiration pneumonia in a ten-day-old calf. There is plant material and inflammatory exudate in a bronchiole. Adjacent alveoli are congested and infiltrated by inflammatory cells. Photo: Seán Fee.

As was the case in previous years, RSV was the most frequently diagnosed viral respiratory pathogen diagnosed (12 cases) and eight cases of PI3 infection were recorded. Aspiration pneumonia accounted for six cases (5 *per cent* of respiratory infections). Cases of aspiration pneumonia (Figure 22.1) occur most frequently after careless drenching or passage of a stomach tube, but cases may also occur if weak or acidotic calves inhale regurgitated stomach contents.Four cases of fungal pneumonia were recorded.

Nutritional and metabolic conditions were the next most frequently diagnosed group of conditions. Hypogammaglobulinaemia due to inadequate absorption of colostral antibody was recorded in 61 cases and was the most frequently recorded nutritional/metabolic condition (accounting for 76 *per cent* of the diagnoses in this category) followed by 16 cases of ruminal feeders (20 *per cent* of the 80 cases in this category) and one case of ruminal acidosis. Ruminal feeders develop in calves where there is a failure of closure of the oesophageal groove, and rather than bypass the rumen as it should milk enters and sours in the rumen. Good husbandry practices are important to prevent the development of ruminal feeders.

(a) Atresia jejuni)

(b) Atresia jejuni

Figure 22.2.: Swelling of the abdomen (a) due to atresia jejuni in a four-day-old calf. (b) Atresia jejuni in a three-day-old calf. Small intestine proximal to the atresia is dilated by fluid and gas. Intestine distal to the obstruction is void of content. Photos: Seán Fee.

These include using standardised feeding regime, feeding calves at the same time each day, feeding the correct volume of milk at a consistent temperature, preparing milk replacer according to the manufacturer's instructions and mixing thoroughly at the advised temperature. Calves should be in an unstressed state when fed and should not be moved, handled or dehorned immediately prior to feeding. Feeding bucket fed calves through teats should help with closure of the oesophageal groove. Clean water should be available to calves at all times.

Death due to septicaemic or toxaemic conditions represented 11 *per cent* (65 cases) of deaths in neonatal to one-month-old calves. Colisepticaemia was the major cause of death in this group accounting for 31 cases (48 *per cent* of the septicaemic / toxaemic conditions) and emphasising the need for good hygiene in calving pens and neonatal calf areas, adequate disinfection of the umbilicus of new-born calves and of course adequate feeding of good quality colostrum to new-born calves in the first six hours of life. Twelve cases of salmonellosis due to *Salmonella* Dublin were diagnosed in neonatal calves in 2023 and one case of *Salmonella* Agama was recorded. Young calves less than three-months-old are in one of the highest risk groups for acquiring Salmonella infections.

To reduce the risk of infection good calving pen management and hygiene is of critical importance. Regular disinfection of the calving pen is important, bedding should be clean, the number of cows present in the calving pen should be minimised and importantly the calving pen should not be used as a sick bay. Calves should receive adequate colostrum, colostrum should not be pooled, and calves should be reared in clean hygienic environment at an appropriate stocking density and away from adult animals and older calf groups. Four cases of systemic pasteurellosis were recorded in neonatal calves in 2023.

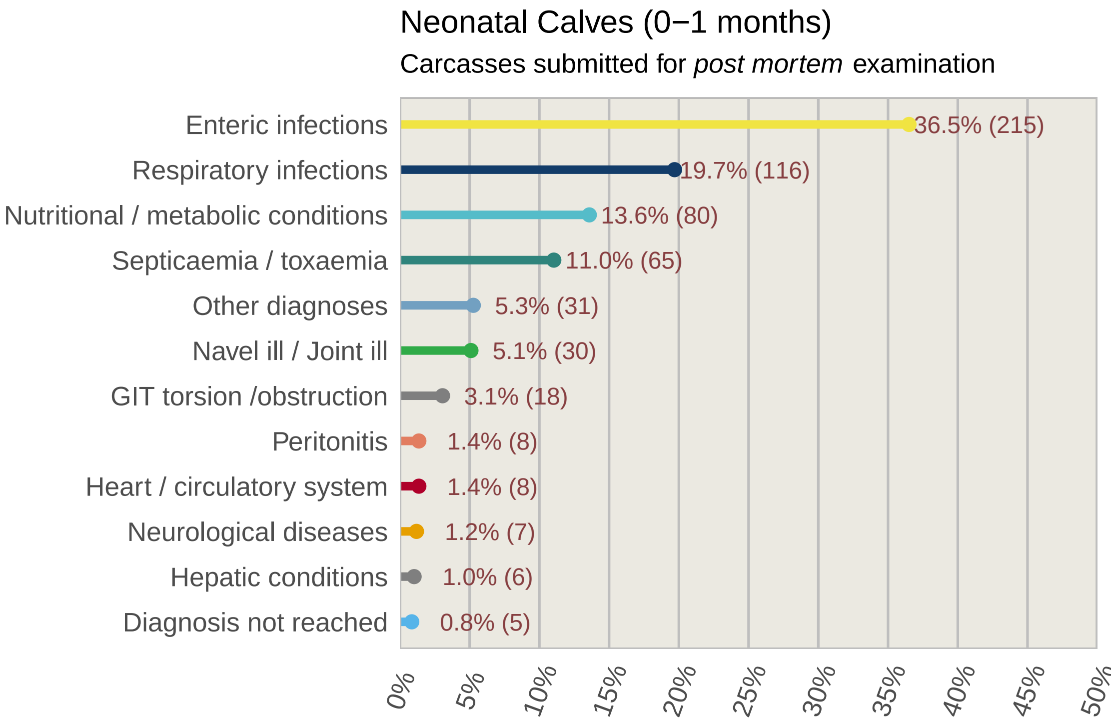


Figure 22.3.: Conditions most frequently diagnosed in calves less than one month old submitted to AFBI for *post mortem* in 2023 (n=589). The absolute number of cases is between brackets.

Navel-ill accounted for 5 *per cent* of diagnoses at *post mortem* examination of neonatal calves (30 cases) emphasising the need for good calving pen hygiene and the importance of dipping/spraying of the navel.

Gastrointestinal obstructions and / or torsions represented 3 *per cent* of the cases recorded in neonatal calves. Five cases of intestinal atresia (Figure 22.2a and Figure 22.2b) were recorded, and atresia was the most frequently recorded condition in this category. All cases were recorded in calves from three to seven days old and most cases had a history of abdominal distension. The atresia was blocking the jejunum in three cases, the large intestine in one case, and there was one case of atresia ani.

22.2. Calves 1–5 months old

As was the case in previous years, respiratory tract infections and pneumonia were by far the most commonly recorded cause of death in calves from one to five months of age and were recorded in 57 *per cent* of the 421 cases in this age group (Table 22.2 and Figure 22.5).

Bacterial respiratory infections were most frequently diagnosed. *Mycoplasma bovis* was detected in 84 cases of pneumonia. While *Mycoplasma bovis* can and does cause pneumonia by itself, it is also important because of

Table 22.2.: Conditions most frequently diagnosed in calves one to five months old submitted to AFBI for *post mortem* in 2023 (n= 421).

Category	No. of cases	Percentage
Respiratory infections	240	**57.0**
Nutritional / metabolic conditions	37	**8.8**
Enteric infections	29	**6.9**
Other diagnoses	29	**6.9**
GIT torsions /obstruction	17	**4.0**
Clostridial disease	15	**3.6**
Peritonitis	12	**2.9**
Urinary tract conditions	10	**2.4**
Septicaemia / toxaemia	8	**1.9**
Diagnosis not reached	8	**1.9**
GIT ulcer / perforation	7	**1.7**
Cardiovascular conditions	5	**1.2**
Neurological diseases	4	**0.9**

its effects on immune function within the lung and it can predispose to respiratory infections caused by other bacteria. The main transmission route to young calves is via milk, from individual cows or from bulk milk, and once infection is established in a calf further spread may occur to cohort calves by respiratory secretions and aerosols.

Figure 22.4.: Blackleg lesion in muscle of a six-month-old heifer calf. Photo: Seán Fee.

Arthritis due to *Mycoplasma bovis* was recorded in a number of these pneumonic calves. Typically, one or multiple joints were swollen with suppurative contents and confirmation was based on detection of *Mycoplasma bovis* nucleic acid by PCR. *Pasteurella multocida* was detected in 29 cases and there were 20 cases of pneumonia due to *Mannheimia haemolytica*. There were 14 cases of pneumonia due to *Histophilus somni* and 12 cases of pneumonia due to *Trueperella pyogenes*. Parasitic pneumonia due to lungworm was recorded more frequently in 2023 than in 2022 or 2021 rising from nine cases in 2021 to 17 cases in 2022 and to 20 cases in 2023. BRSV was the most commonly recorded viral respiratory infection (11 cases) followed by three cases of PI3 and three cases of BVDV infection. One case of fungal pneumonia was recorded.

Thirty-seven cases of nutritional or metabolic conditions were recorded with the most frequent being ruminal acidosis (22 cases) and there were ten cases of bloat.
Infections of the gastrointestinal tract represented the third most important group of diagnoses at 7 *per cent* of diagnoses in this age group.

Cryptosporidial infection (five cases) and coccidiosis (two cases) were the most frequently recorded enteric infections. Coccidiosis may occur in contaminated conditions such as damp, dirty straw bedding indoors or around feeding and drinking troughs contaminated with faeces outdoors. Diarrhoea is sometimes accompanied by straining and blood may frequently be observed in the faeces. Veterinary advice on treatment should be sought and attention should be paid to the hygiene of calf pens and the cleanliness and positioning of feeding troughs.

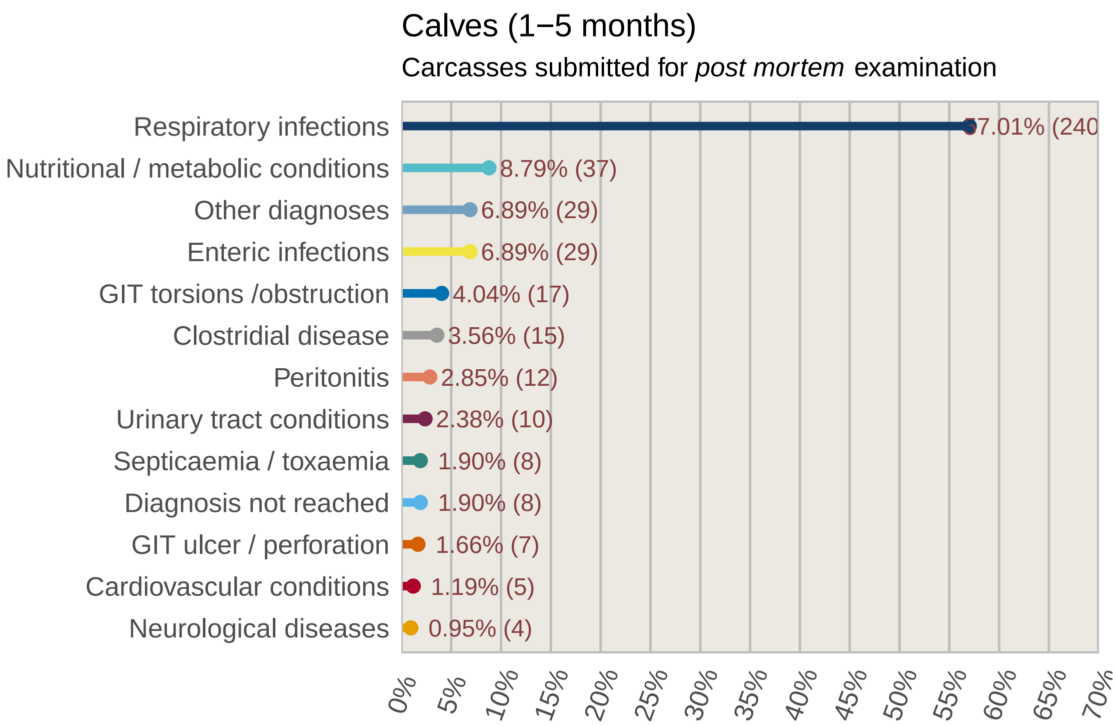


Figure 22.5.: Conditions most frequently diagnosed in calves one to five months old submitted to AFBI for *post mortem* in 2023 (n=421). The absolute number of cases is between brackets.

Significant non-infectious conditions of the gastrointestinal tract included ulcers, perforations, torsions and obstruction. There were 14 cases of gastrointestinal torsion. Gastrointestinal torsion may occur subsequent to increased or decreased gastrointestinal motility which in turn is affected by nutritional changes and upsets, gas accumulation and bloat, carbohydrate overload and acidosis.

Three cases of perforation of the abomasum were recorded and a further four cases of abomasal ulceration were recorded. The causes of abomasal ulceration and perforation are non-specific and include calf stress as well as husbandry and nutritional factors.

Fifteen cases of clostridial myositis (blackleg) were recorded in 1-5 month-old calves (Figure 22.4).

22.3. Weanlings 6–12 months old

Pneumonia was the main cause of death in older calves (from six to 12 months old) followed by deaths caused by clostridial infections and gastrointestinal infections (Table 22.3). Bacterial infections were again the most frequent recorded cause of respiratory infections. *Mycoplasma bovis* was detected in 33 cases representing 33 *per cent* of respiratory diagnoses, Pasteurella multocida was detected in 12 cases (12 *per cent* of respiratory diagnoses), and *Histophilus somni* in five cases. Three cases of pneumonia due to *Mannheimia haemolytica* were recorded and *Trueperella pyogenes* was also isolated in three cases. Parasitic pneumonia due to lungworm infection was recorded in 21 cases which represented a small increase on the number of hoose cases in 2022 when 19 cases were detected. Respiratory infections caused by viruses were detected in 13 cases (13 *per cent* of respiratory infections) with BRSV (six cases), PI3 (four cases), BVDV (two cases) and IBRV (one case).

Nineteen cases of clostridial disease were recorded (11 *per cent* of diagnoses in this age group) and with most of these being cases of blackleg (18 cases or 95 *per cent* of the clostridial infections recorded). The remaining

Table 22.3.: Conditions most frequently diagnosed in weanlings calves six to twelve months old submitted to AFBI for post mortem in 2023 (n= 173).

Category	No. of cases	Percentage
Respiratory tract infections	101	**58.4**
Clostridial disease	19	**11.0**
Enteric infections	15	**8.7**
Other diagnoses	14	**8.1**
Diagnosis not reached	10	**5.8**
Nutritional / Metabolic conditions	8	**4.6**
Cardiovascular diseases	6	**3.5**

clostridial infection detected in this age group was a case of botulism, recorded in a six-month-old calf found dead at pasture.

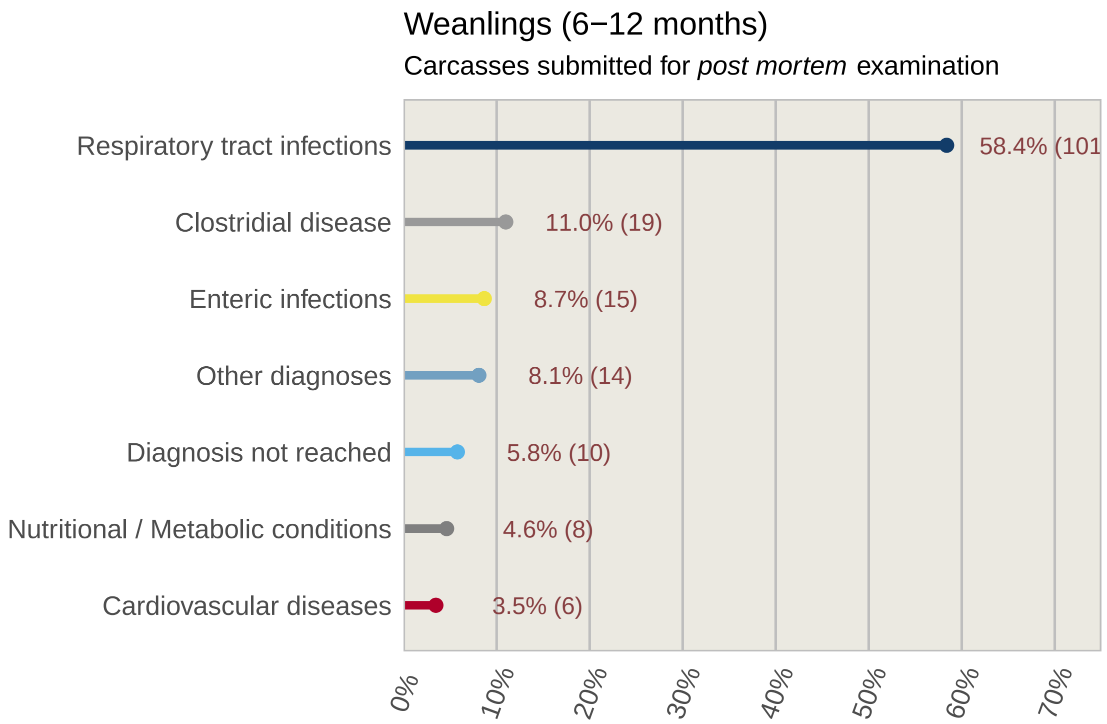


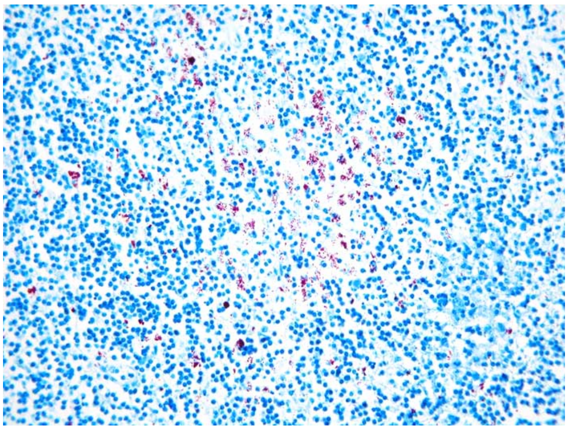
Figure 22.6.: Conditions most frequently diagnosed in weanlings calves six to twelve months old submitted to AFBI for *post mortem* in 2023 (n=173).The absolute number of cases is between brackets.

Gastrointestinal infections represented 9 *per cent* of cases (15 cases) recorded in weanlings. Almost half of these were cases of parasitic gastroenteritis (seven cases). As in 2022 there was one case of BVDV/Mucosal disease. There was an unusual diagnosis of Johne's disease in a seven-month-old calf which presented with a history of illthrift (see Case Report 1).

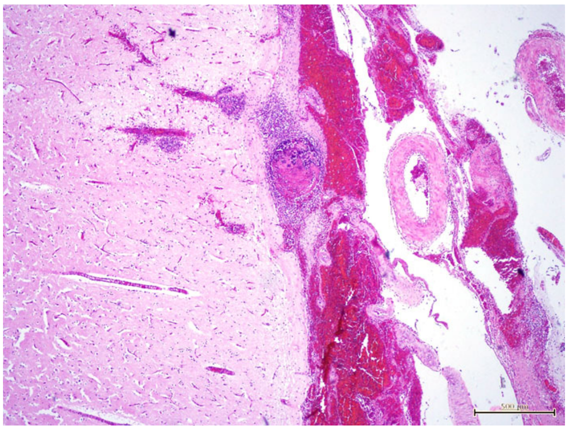
22.4. Adult Cattle (older than 12 months)

As has been the case in previous years respiratory infections were the most frequently diagnosed cause of death in adult cattle (>12 months old) (Table 22.4 and Figure 22.10). *Mycoplasma bovis* (20 cases) was the most frequently diagnosed pathogen. *Mannheimia haemolytica*, an increasingly important cause of pneumonia particularly in adult cows was the next most frequently reported respiratory pathogen (14 cases of this infection were recorded representing 15 *per cent* of respiratory infections in adult bovines) and twelve cases of pneumonia due to *Pasteurella multocida* were recorded. Seven cases of pneumonia due to *Trueperella pyogenes* were diagnosed in 2023.

Seven cases of parasitic pneumonia (hoose) due to the nematode *Dictyocaulus viviparous* were recorded in



(a) Acid-fast bacilli,MAP



(b) Thrombotic meningoencephalitis

Figure 22.7.: Acid-fast bacilli (a) of Mycobacterium avium subsp paratuberculosis (red organisms) in the ileocaecal lymph node of a seven-month-old calf (Ziehl-Neelsen). Photo: Paul Colville. Infectious thrombotic meningoencephalitis (b) in an eight-month-old calf. Photo: Seán Fee.

2023, down a little on the ten cases of hoose which were recorded in 2022. Hoose may occur in older cattle grazing contaminated pasture where anthelmintic regimes or grazing practices are not conducive to acquiring protective immunity at a younger age. Pneumonia due to tuberculosis was recorded in two diagnostic submissions. In one case there was severe suppurative pneumonia and fibrosis affecting 80 *per cent* of the right lung and right pleura, and there was severe suppurative pneumonia affecting 50 *per cent* of the left lung. Suppurative foci frequently contained gritty content and purulent fluid. There were typical lesions of tuberculosis (Figure 22.8) on histological examination and Mycobacterium bovis was cultured.

Figure 22.8.: Pulmonary tuberculosis in a cow. Photo: Seán Fee.

Eight cases of viral respiratory infection were detected comprising seven cases of IBRV infection and one case of BVDV. Four cases of embolic pneumonia were recorded. Embolic pneumonia cases occur when bacteria or septic thrombi from a primary source of infection spread to the lungs via the blood stream. In two of the four cases infection spread from udder cleft dermatitis (Figure 22.9) where a large unhealing skin defect was present between the left and right forequarters of the udder, in one case the initial site of pathology was liver abscessation and in one case infection spread from an oesophageal lesion.

Nutritional and metabolic conditions accounted for 39 cases (10 *per cent* of the cases in adult cattle). The main conditions encountered included hypomagnesaemia (13 cases), hypocalcaemia (13 cases), ruminal acidosis

Table 22.4.: Conditions most frequently diagnosed in adult cattle (older than 12 months) submitted to AFBI for *post mortem* in 2023 (n= 388).

Category	No. of cases	Percentage
Respiratory infections	92	**23.7**
Nutritional / metabolic conditions	39	**10.1**
Cardiac / circulatory system	36	**9.3**
Diagnosis not reached	34	**8.8**
Other diagnoses	28	**7.2**
Enteric infections	26	**6.7**
Liver disease	23	**5.9**
Clostridial disease	22	**5.7**
Reproductive / mammary conditions	20	**5.2**
Nervous system conditions	15	**3.9**
GIT ulceration / perforation / foreign body	11	**2.8**
Peritonitis	11	**2.8**
Intestinal or gastric torsion / obstruction	11	**2.8**
Poisoning	11	**2.8**
Skeletal conditions	9	**2.3**

Figure 22.9.: Udder cleft dermatitis lesion (UCD) in an eight-year-old cow. Photo: Seán Fee

(eight cases), and three cases of ketosis.

Diseases of the heart and circulatory system (36 cases) accounted for 9 *per cent* of the conditions recorded in cattle older than 12 months. The most frequently reported cardiovascular diagnoses were thrombosis of the caudal vena cava (eight cases). Thrombosis of the caudal vena cava is an occasional complication of liver abscessation and liver abscessation is predisposed to by repeated bouts of ruminal acidosis. There were six cases of vegetative endocarditis, five cases of pericarditis, four cases of cardiac abscessation and three cases of myocarditis. Arterial rupture was recorded in five cases, four of these involved the uterine artery in gravid dairy cows and one case was the fatal sequela to an aortic aneurysm.

Clostridial disease was responsible for 6 *per cent* of deaths in adult cattle in Northern Ireland. Blackleg was the most commonly diagnosed clostridial disease in adult cattle (14 cases), followed by botulism (five cases) and black disease (three cases).

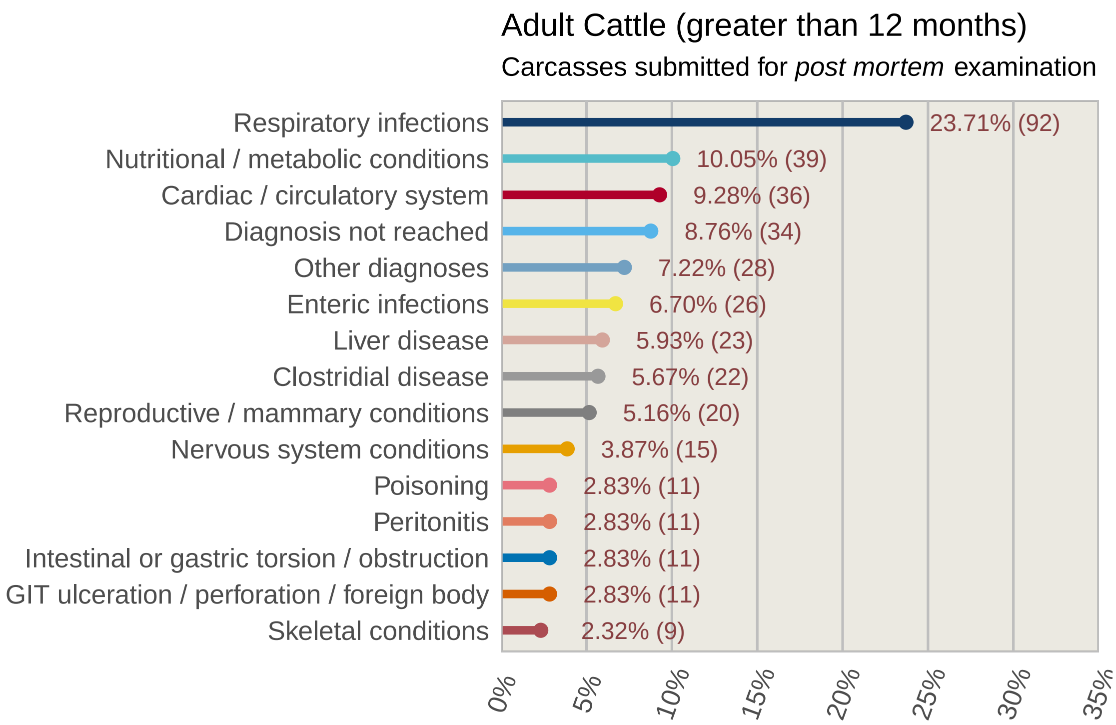


Figure 22.10.: Conditions most frequently diagnosed in adult cattle (older than 12 months) submitted to AFBI for *post mortem* in 2023 (n=388). The absolute number of cases is between brackets.

Johne's disease in a calf. Paul Colville and Seán Fee.

Johne's disease is a slow developing contagious bacterial infection of the intestines of ruminants. Calves are particularly susceptible to infection in the first month of life and most infections occur before six months of age. Calves generally become infected from faeces, colostrum or milk containing the causative bacteria. The calf's dam or other cows are the usual source of infection. Disease onset is particularly slow, many cases remain subclinical, and clinical cases develop slowly with typical clinical signs of ill thrift, weight loss and profuse diarrhoea usually observed in adult animals two to six years old.

A seven-month-old calf Friesian calf was submitted in November 2023. The calf was in very poor condition and there was faecal staining of the hind end. There was ulceration of the tongue, very watery large intestinal contents, and mild pneumonia. Bacteriology was unremarkable, testing for BVDV by PCR was negative, and faecal testing for gastrointestinal worm eggs and coccidia was negative. Lungworm larvae were detected in faeces. On histology there was chronic granulomatous enteritis at the ileocaecal junction with abundant intralesional acid-fast bacilli (Figure 22.7a). Similar acid-fast bacilli were present in the ileocaecal lymph node. DNA of Mycobacterium avium subsp paratuberculosis (MAP), the causative bacterium of Johne's disease was detected by PCR, thus confirming Johne's disease.

This case is unusual given the young age at which clinical and fatal disease presented. The herdowner was advised of the benefits of using an official Johne's disease control program such as the AFBI Cattle Health Scheme.

23. Bovine Respiratory Diseases, AFBI

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Bovine respiratory disease (BRD) is a multifactorial disease involving a combination of viral, bacterial or parasitic pathogens along with host and environmental factors. It is one of the most common diseases diagnosed in carcasses or samples submitted to AFBI (Table 23.1 and Figure 23.1).

All bovines carry viruses and bacteria in their upper respiratory tract but when an animal becomes stressed such as by overcrowding, transporting or weaning; is immunocompromised or is in an environment with a high level of infection they can become overwhelmed, and BRD can develop. Unfortunately, due to the many different agents involved it can often be difficult to determine the inciting agent in the pneumonia particularly in chronic cases.

BRD is mostly diagnosed in young, housed cattle with 106 cases of pneumonia identified in the 1-to-5-month age category compared to 36 cases in the 6 to 8 month age category. There are many vaccines marketed at calves which target a combination of the pathogens involved in BRD.

Mycoplasma bovis is the most common pathogen detected in carcasses submitted with identification in 39.3 *per cent* of cases in 2023 compared to 37.4 *per cent* in 2022. Although diagnosed by PCR, it is important to interpret its presence in relation to gross and histopathological findings of the lungs, as the pathogen may be present but not causing disease.

Most cases were diagnosed in the 1-to-5-month age category, with 35 confirmed pneumonia cases. The pathogen is significant at a farm level as along with causing pneumonia it can cause otitis media, mastitis and arthritis. Treatment of *Mycoplasma bovis* is difficult, carrier animals can occur and although vaccines have been developed, reducing its transmission is the best option to reduce prevalence.

Mannheimia haemolytica and *Pasteurella multocida* are members of the *Pasteurellaceae* family and are both commensals of the upper respiratory tract causing disease when the immune system is impaired. *Mannheimia haemolytica* was detected in 11 *per cent* of pneumonia cases in 2023 compared to 10.4 *per cent* of cases in 2022.

Table 23.1.: Relative frequency of the different aetiological agents identified in cases of pneumonia diagnosed during post mortem by AFBI in 2023 (n= 374).

Category	No. of cases	Percentage
Mycoplasma bovis	147	**39.3**
Dictyocaulus viviparus	46	**12.3**
Pasteurella multocida	44	**11.8**
Mannheimia haemolytica	41	**11.0**
Trueperella pyogenes	27	**7.2**
Bovine Respiratory synthical virus BRSV	23	**6.1**
Histophilus somnus	18	**4.8**
Parainfluenza virus 3	9	**2.4**
Infectious Bovine Rhinotracheitis (IBR)	9	**2.4**
Bovine Viral Diarrhoea (BVD)	6	**1.6**
Fungal	3	**0.8**
Mycobacterium bovis	1	**0.3**

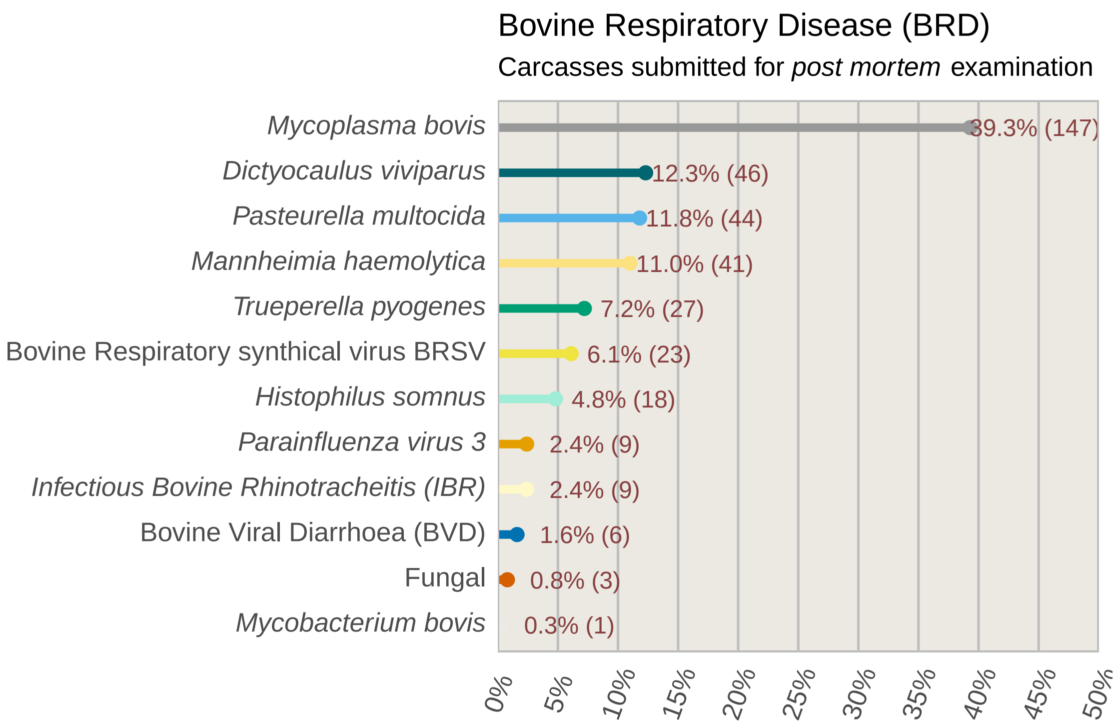

Figure 23.1.: Relative frequency of the different aetiological agents identified in cases of pneumonia diagnosed during *post mortem* by AFBI in 2023 (n=374). The absolute number of cases is between brackets.

M. haemolytica causes fibrinous pleuropneumonia and is often diagnosed as a primary disease in calves however it is now an emerging disease identified in adult animals particularly dairy cows. *P. multocida* was detected in 11.8 *per cent* of cases in 2023 compared to 15.3 *per cent* of cases in 2022. *P. multocida* doesn't cause as fulminant a pneumonia as *M. haemolytica* and can occur secondary to other disease processes within the lungs.

Trueperella pyogenes was identified in 7.2 *per cent* of pneumonia samples. This bacteria doesn't generally cause primary disease and invades secondary to another pathogen or disease process.

Bovine Respiratory Disease Virus (BRSV) is the most common virus detected in carcasses submitted diagnosed in 6.1 *per cent* of cases which is a decrease from 7.1 *per cent* in 2022. The virus is generally detected in young calves and causes an interstitial pneumonia which can predispose to secondary bacterial infections.

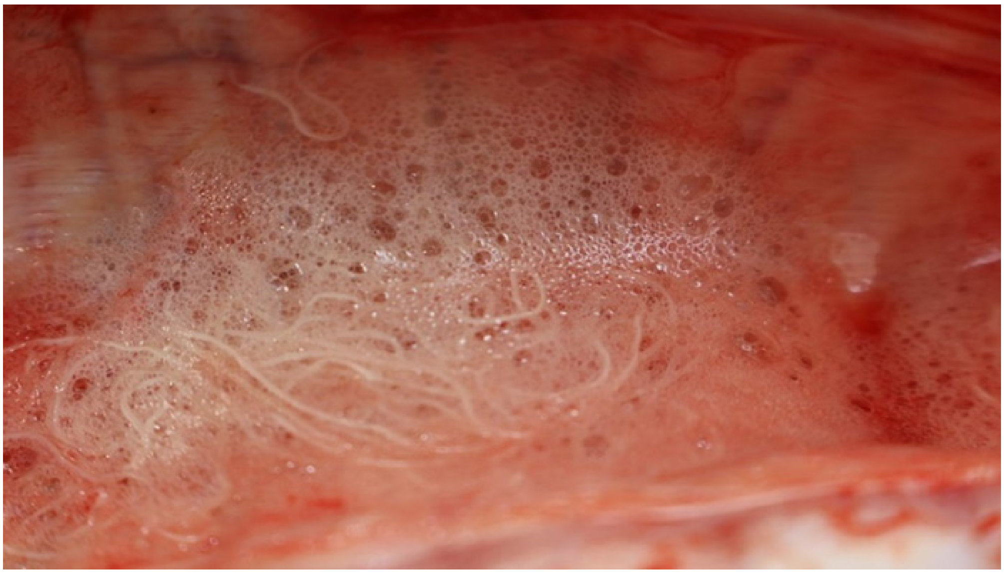

Figure 23.2.: Lungworm within the tracheal lumen admixed with foam. Photo: Lauren McFarland

23.1. Parasitic Pneumonia in Cattle

Parasitic bronchitis (Figure 23.2) is caused by the lungworm *Dictyocaulus viviparus*. The disease generally affects first season grazing calves but can affect older cattle if they have never exposed, had rigorous anthelmintic use in the first grazing season or haven't had been exposed to lungworm. Most animals will undergo infection and develop immunity however if there is a high challenge this could lead to severe respiratory disease and death.

Lungworm was detected in 12.2 *per cent* of pneumonia cases in 2023 and was the second most common pathogen detected. Both 2022 and 2023 have had a higher number of cases diagnosed than in each of the previous 5 years. Out of 46 cases of confirmed parasitic bronchitis diagnosed in 2023 70 *per cent* were diagnosed in the months August to October.

However, there were still ten cases diagnosed in November and December likely due to residual lungworm after housing and a longer grazing season. However there have also been links with animals fed cut grass while housed.

24. Bovine Mastitis, AFBI

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Mastitis involves inflammation of the mammary gland caused by trauma or most commonly microbes entering the tissue through the teat canal. Bovine mastitis is one of the most significant causes of economic loss in the dairy industry due to decreased production, increased somatic cell counts, cost of treatment, removal of treated milk and culling of chronically affected cows.

There are two types of infectious mastitis named after their source either contagious or environmental. Contagious pathogens spread cow to cow at milking and can be minimized by good parlor management while environmental pathogens have a primary reservoir in the environment including bedding.

AFBI carries out somatic cell count, culture and antibiotic sensitivity testing on milk samples to provide PVPs and farmers with the knowledge of the pathogens involved on farm and the appropriate treatment to help minimize antibiotic resistance. It is becoming increasingly important to choose the right antibiotic treatments with a requirement to avoid critically important antibiotic use and avoid blanket cow antibiotic treatment at drying off.

In 2023, 533 milk samples were received with no bacteria detected in 47 samples (Table 24.1 and Figure 24.1). The significance of the pathogen detected on culture will depend on the cell count, level of the organism detected and if it was isolated in pure culture. In 2023 86 samples with 3 or more different organisms isolated were classified as contaminated hindering interpretation. Samples can become contaminated by poor sampling technique, inadequate storage and a prolonged period before it reaches the lab.

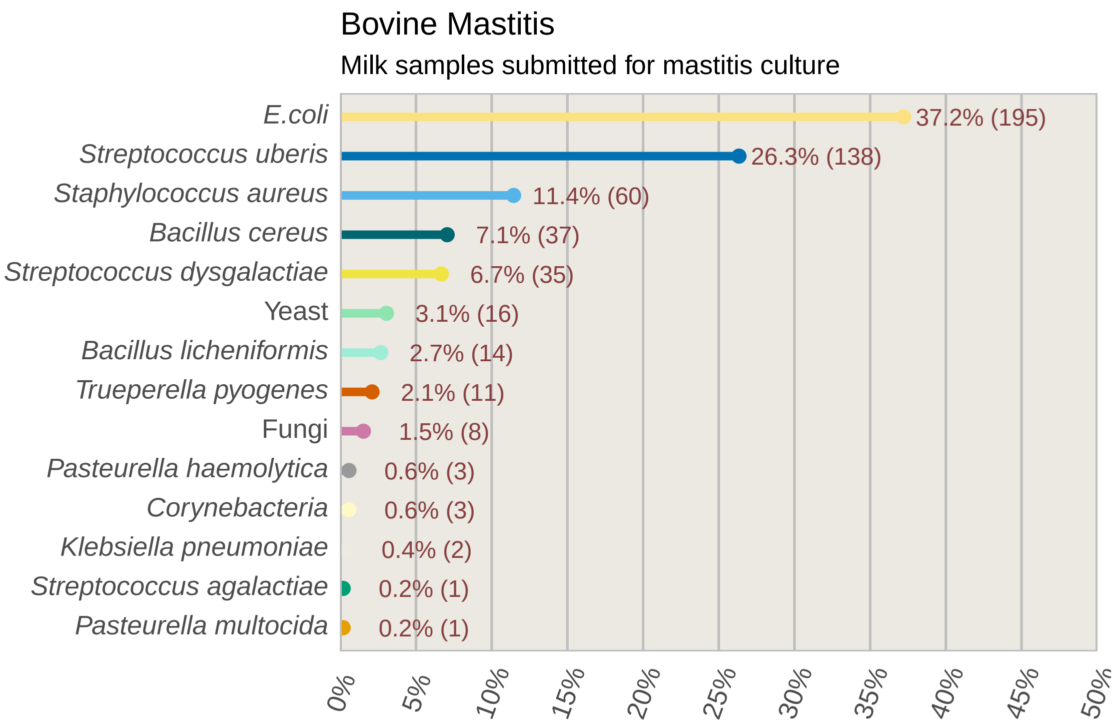

Figure 24.1.: Pathogens isolated in milk samples submitted to AFBI in 2023 (n=524). The absolute number of cases is between brackets.

Escherichia coli an environmental cause of mastitis was the most common bacteria isolated in 2023 account-

Table 24.1.: Pathogens isolated in milk samples submitted to AFBI in 2023 (n= 524).

Category	No. of cases	Percentage
E.coli	195	**37.2**
Streptococcus uberis	138	**26.3**
Staphylococcus aureus	60	**11.4**
Bacillus cereus	37	**7.1**
Streptococcus dysgalactiae	35	**6.7**
Yeast	16	**3.1**
Bacillus licheniformis	14	**2.7**
Trueperella pyogenes	11	**2.1**
Fungi	8	**1.5**
Corynebacteria	3	**0.6**
Pasteurella haemolytica	3	**0.6**
Klebsiella pneumoniae	2	**0.4**
Pasteurella multocida	1	**0.2**
Streptococcus agalactiae	1	**0.2**

ing for 37.2 *per cent* of the samples submitted. It was also the most common pathogen detected in 2022 comprising of 36 *per cent* of submissions. *E. coli* is the most common cause of toxic mastitis however care must be taken in interpreting its presence with more significance placed on a pure culture and in animals with corresponding clinical signs.

Streptococcus uberis is a pathogen capable of surviving in diverse environments and was the 2nd most frequently detected pathogen in 2023 at 26.3 *per cent* in comparison to 29.2 *per cent* in 2022. Although it is an environmental pathogen it can be difficult to treat if chronic infection develops and can spread cow to cow.

Staphylococcus aureus, a contagious pathogen which often spreads cow to cow via the milking machine or the milker's hands, was identified in 11.4 *per cent* of samples in 2023 compared to 15 *per cent* in 2022. This bacterium often causes subclinical mastitis and treatment can be difficult due to the ability of cows to become chronic carriers.

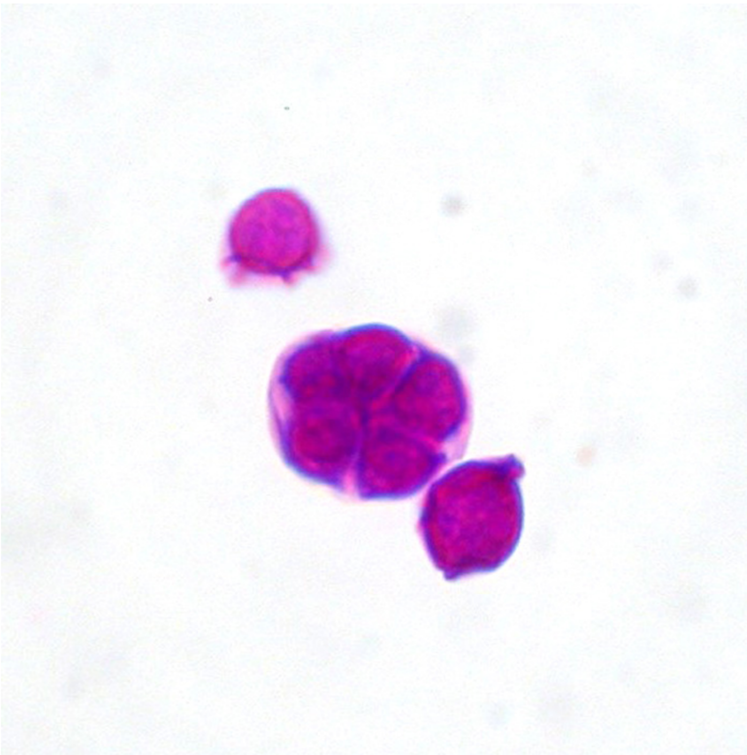

Figure 24.2.: Images of Prototheca sp. from a milk sample. Photo: Bob Hanna.

Streptococcus dysgalactiae is both a contagious and environmental pathogen detected in 6.7 *per cent* of samples in 2023 compared to 5.2 *per cent* in 2022.

Yeast and fungal mastitis caused by pathogens such as *Candida albicans* are causes of environmental mastitis. In 2023 they accounted for 4.6 *per cent* of pathogens isolated compared to 3.2 *per cent* in 2022. Their numbers have risen over the last number of years and are linked with treatment for other pathogens with contaminated syringes. Although cases are usually mild, they are usually refractory to treatment with limited availability of antimycotic agents.

Prototheca spp. a type of algae was identified in a milk sample submitted in 2023. This pathogen causes a rare form of environmental mastitis that can sporadically clear or lead to chronic infections. Due to the nature of the pathogen, it is usually refractory to conventional intramammary or systemic treatments.

25. Bovine Abortion, AFBI

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Of the 336 bovine abortions AFBI examined in 2023 (Figure 25.1), an infectious agent was identified in 50 *per cent* of submissions and this reflects that non-infectious causes such as anomalies in the foetus or maternal factors such as fever or malnutrition, may also induce pregnancy loss. Examination of the dam, the placenta and the foetus with maternal serology provides the greatest opportunity to obtain a diagnosis.

Bacterial agents comprised 81.5 *per cent* of infectious diagnoses, with *Bacillus licheniformis*, *Trueperella pyogenes*, *Neospora caninum* and *Salmonella* spp the most frequently diagnosed infectious agents occurring in 33 *per cent* of all bovine abortion submissions. The proportion of bovine abortions associated with *Salmonella* spp increased in 2023, with 10.7 *per cent* of bovine abortions associated with *Salmonella* sp compared to 5.2 *per cent* in 2022. The cattle adapted serotype of *Salmonella enterica* subspecies enterica, S Dublin, was the predominant *Salmonella sp* identified with 80 *per cent* of cases occurring between July and November.

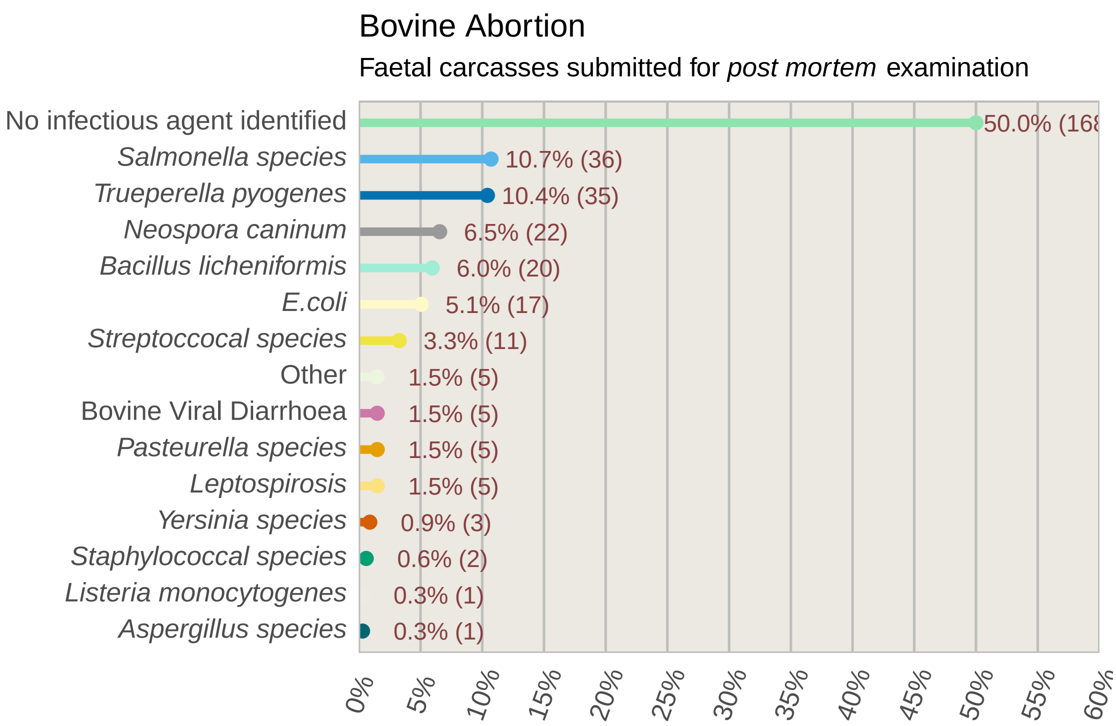

Figure 25.1.: Relative frequency of the identified infectious agents of bovine abortion from submitted foetal *post mortems* in 2023 (n=336).

Non bacterial infections were also detected in abortion cases, with both *Neospora caninum* and Bovine Viral Diarrhoea (BVD) virus being detected, and occasional abortions associated with fungal infections.

Congenital abnormalities were detected in occasional foetuses including cleft palate, hydrocephalus, cystic kidneys and skeletal deformities and a case of skin hyperfragility.

26. Zinc Sulphate Turbidity Testing, AFBI

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The Zinc Sulphate Turbidity Test is a means of identifying a failure of passive transfer of maternal immunoglobulins to calves and lambs in the immediate post-natal period. The nature of the ruminant placenta is such that there is little or no passive transfer of immunoglobulins in utero and so the offspring relies on absorption of immunoglobulins present in colostrum through the intestinal wall to provide passive immunity to infections in the first weeks of life, such as those causing enteric diseases and septicaemia.

Failure of passive transfer (FPT) results in calves that have an increased risk of mortality, increased susceptibility to respiratory disease and diarrhoea, and have a decreased average daily weight gain. In addition, there are increased on farm costs resulting from increased antimicrobial use to treat sick calves. The test indirectly measures the concentration of immunoglobulins in serum, particularly IgG, through a salt precipitation reaction in which the resulting turbidity is proportionate to the concentration of immunoglobulins, which is measured by colorimetry.

The ZST is best utilised to assess colostrum management on a herd basis. Several healthy calves/lambs should be sampled (approx. ten) as individual results can vary and not be representative of the herd situation. In addition, sick animals can have lowered levels of immunoglobulin due to antigen binding or protein loss, or falsely elevated levels due to dehydration. Neonates should be sampled between one and seven days of age, but not within the first 24 hours as it takes some time following colostrum ingestion to reach peak circulating immunoglobulin levels.

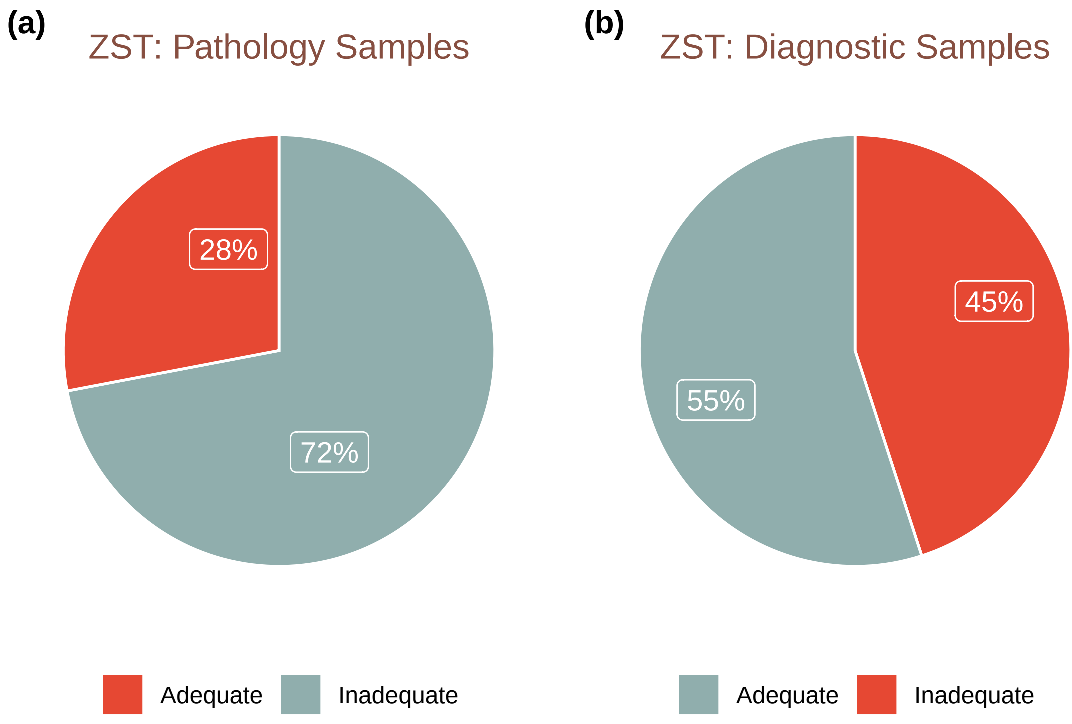

Figure 26.1.: Results of Zinc Sulphate Turbidity tests performed by AFBI in 2023 from bovine calf serum samples taken (a) at *post mortem* (n=155) and (b) submitted as diagnostic samples (n=347). Adequate colostral immunity is defined as greater than or equal to 20 units.

AFBI carries out ZST tests on serum samples submitted by veterinary surgeons, and on samples collected at *post mortem* examination on calves up to two weeks of age. A ZST result of 20 units is considered to represent adequate immunoglobulin absorption from colostrum; anything below this is considered inadequate, and indicates likely failure of passive transfer of immunity. In 2023, a total of 502 serum samples were tested (Figure 26.1) ; this represents a year on year decrease in total samples tested from over 640 in 2021 and 539 in 2022; of those tested, 347 were diagnostic samples submitted from live calves, and 155 were obtained at *post mortem* examination.

The results are shown in Figure 26.1 and Figure 26.2, where it can be seen that of the diagnostic samples tested, 45 *per cent* were inadequate while 55 *per cent* were adequate, whereas of those sampled at *post mortem*, only 28 *per cent* were adequate while 72 *per cent* of samples tested less than 20 units and therefore indicated inadequate transfer of immunoglobulins. The results from neonatal calves submitted for *post mortem* were similar to previous years, with consistently high proportions of calves tested having inadequate ZST levels suggesting a link between failure of passive transfer and neonatal mortality.

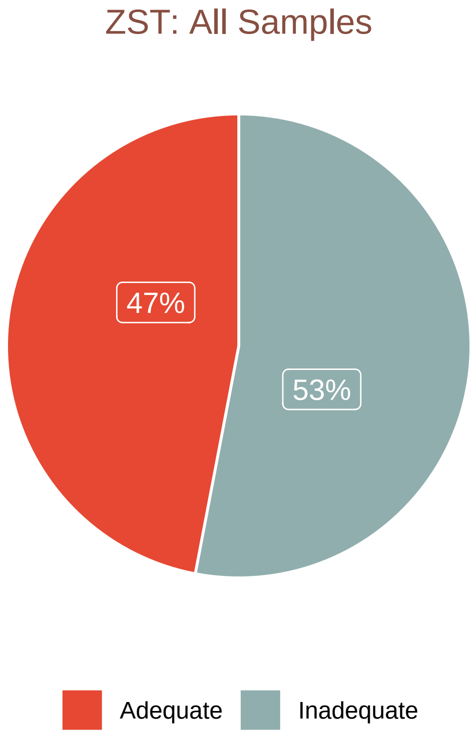

Figure 26.2.: Results of Zinc Sulphate Turbidity tests performed by AFBI in 2023 from bovine calf serum samples (n=502). Adequate colostral immunity is defined as greater than or equal to 20 units.

In recent years the trend for diagnostic samples has been for the proportion of adequate results to be higher than those with inadequate results, however in 2022 this trend was reversed. The 2023 results have returned to the previous form with more samples testing adequate than inadequate.

Overall, however, the results are similar from year to year which indicates that failure of passive transfer of immunity to neonates continues to be a problem in herds, and so highlights the need to continue to reiterate the importance of good colostrum management. It is recommended that every calf receives three litres of good quality colostrum within the first two hours of life. A useful on farm tool for measuring the concentration of immunoglobulins in colostrum is a Brix refractometer and so can aid in the overall picture of colostrum management in the herd.

27. Bovine Neonatal Enteritis, AFBI

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Enteritis in neonatal calves is the leading cause of dairy calf morbidity and mortality worldwide, and beef calves are also frequently affected. Affected calves suffer dehydration, metabolic acidosis and electrolyte depletion which frequently results in death, but the long term effects include reduced weight gain and development, increased time to first calving and reduced milk production in the first lactation in dairy heifers, resulting in significant economic consequences for individual farms and the national herd. This trend is reflected in the submissions received to AFBI from calves up to one month of age, in which enteritis has for many consecutive years been the most commonly diagnosed condition in calves of this age. Submissions are made up of both faecal samples submitted by PVPs and carcasses of calves submitted for *post mortem* examination. Often calves present with a clinical history of diarrhoea, however in some cases death can occur without significant diarrhoea.

A number of causative viral, bacterial, protozoal and parasitic organisms are responsible for disease, but differentiation of the specific cause cannot be made on clinical signs, or on gross *post mortem* findings alone and laboratory testing is necessary. Often in the case of a herd outbreak, mixed infections occur with multiple pathogens being present, so in order for a comprehensive diagnosis to be made and appropriate preventative and prophylactic measures to be taken, it is important that submissions are made from multiple untreated calves in the early stages of clinical disease that are representative of the herd problem.

Often the disease agents are only transiently present and the changes produced are rapidly obscured by autolysis, so in the case of carcases submitted for *post mortem* examination, these should be as fresh as possible to get the maximum diagnostic value. As with all diagnostic samples, a good clinical history which includes farm type, calves affected, age of calves when first affected and management practices can improve the diagnostic value of the submission. Investigations into outbreaks of neonatal enteritis should always include an assessment of adequacy of passive transfer of colostral immunoglobulins as failure of passive transfer is a main risk factor for neonatal enteritis.

Table 27.1.: The frequency of common enteropathogenic agents identified in calf faecal samples tested by AFBI in 2023.

Organism	No. Tested	Positive	Percentage
Cryptosporidium species	381	132	**34.6**
Rotavirus	391	117	**29.9**
Coronavirus	411	56	**13.6**
Escherichia coli K99	232	23	**9.9**

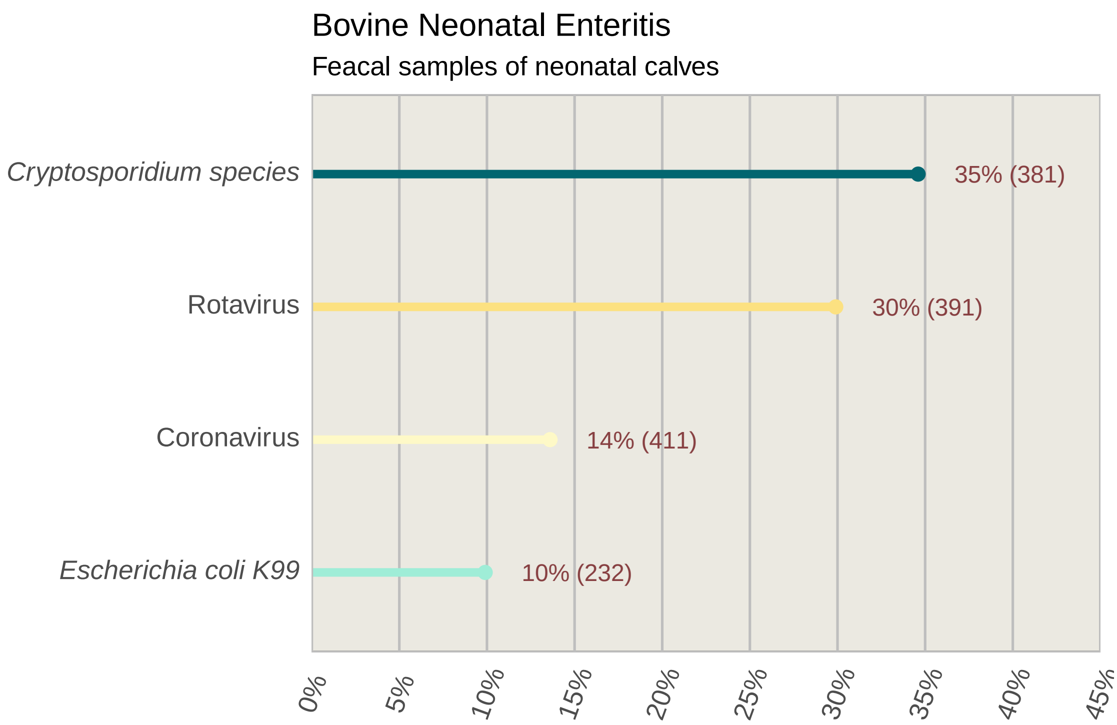

Figure 27.1.: Frequency of common enteropathogenic agents identified in calf faecal samples tested by AFBI in 2023. Total sample tested varies with the agent (between parentheses).

For the last number of years, two pathogens have consistently been identified as the most commonly detected in submissions to AFBI (Table 27.1 and Figure 27.1); *Cryptosporidium* and Rotavirus. In 2023, 35 *per cent* of samples tested positive for *Cryptosporidium* and Rotavirus was detected in 30 *per cent* of samples. Coronavirus was the third most commonly detected pathogen at 14 *per cent*, and *E. Coli* expressing the K99 fimbrial antigen was detected in ten *per cent* of samples tested. Testing for *E coli* K99 is carried out in calves up to 2 weeks old.

Frequently more than one pathogen is detected in a single sample, or from different samples from the same outbreak, and often where mixed infections are present the disease severity and mortality rate is greater than where single infections are present.

Cryptosporidiosis, most commonly caused by *Cryptosporidium parvum*, a single-celled parasite, produces a watery diarrhoea in calves, usually between seven and thirteen days of age. The organism infects cells of the small intestine and heavy colonisation occurs quickly through rapid replication. Animals are infected through ingestion of oocysts which have been produced in large numbers by other infected calves.

The oocysts have a tough outer shell and can survive for long periods in the environment, being resistant to many commonly used disinfectants and able to withstand a wide range of temperatures, thus are difficult to remove from the environment. In addition, only a small number of oocysts are required for infection to occur, and oocysts shed by infected calves are immediately infective for other susceptible calves. To put this into perspective, a 2013 study demonstrated that as few as 17 oocysts was sufficient to cause diarrhoea and oocyst shedding, and infected calves can shed up to 30 billions of oocysts over a six day period.

The only licensed product for treatment of cryptosporidiosis in calves is halofuginone lactate, and it is approved for both prevention and treatment, however it cannot be used if animals have had signs of diarrhoea for more than 24 hours. It must be administered within 48 hours of birth for use as a prophylactic agent, and for use as a treatment it must be given within 24 hours of the onset of diarrhoea, and administered daily for seven consecutive days, which can be difficult to manage particularly for beef calves kept with their dams. It does not completely prevent or cure disease but can reduce oocyst shedding and the duration of diarrhoea.

These factors make it difficult to control exposure to the parasite on farm. Infection is usually self-limiting when present as a single pathogen, however when present with another agent, often Rotavirus, mortality can be high, and in recovered calves there have shown to be long term detrimental effects on weight gain for several months following infection. Control of infection relies on strict hygiene measures, separating infected and non-

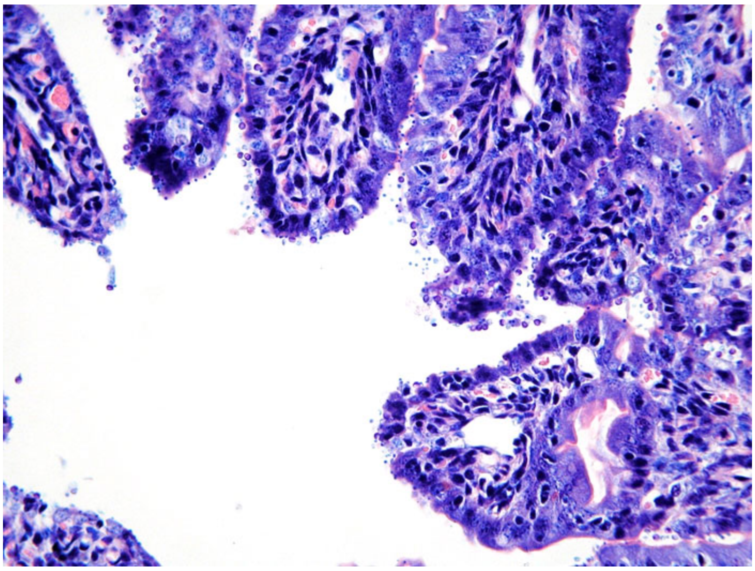

Figure 27.2.: Histopathology of the gut wall showing adhered cryptosporidial organisms. Photo: Bob Hanna.

infected calves and proper cleaning and disinfection of calf accommodation using an ammonia based substance, followed by drying out and ideally leaving empty for a prolonged period.

Cryptosporidium spp can cause zoonotic infections in humans, particularly young children, elderly people and those who are immunocompromised, so a diagnosis of cryptosporidiosis should be accompanied by advice regarding zoonotic precautions.

Rotavirus and coronavirus are ubiquitous in the environment and are passed by adult cows. Both cause villous atrophy which results in diarrhoea due to maldigestion and malabsorption in calves one to three weeks old. Maldigestion leads to undigested food in the colon which causes bacterial overgrowth and increased osmotic pressure which exacerbates the diarrhoea. Rotavirus affects the upper small intestine whereas coronavirus affects a larger proportion of the small intestine, and also frequently causes necrosis of the epithelial cells lining the colon and so causes a more severe diarrhoea.

E Coli K99 is so-called due to the fimbrial antigen it possess which allows it to attach to the epithelial cells of the small intestine. Here it produces a toxin which causes an efflux of fluid into the small intestinal lumen. The attachment factors are only present on the cells of the very immature small intestinal villi, and so the organism usually causes disease in the first six days of life.

The severity of the fluid loss into the intestine can be such that the calves die of dehydration and electrolyte imbalance before diarrhoea is detected. Faecal samples submitted to AFBI from calves less than two weeks old are routinely tested for *E Coli* K99 by Enzyme Linked Immunosorbent Assay (ELISA) which detects the K99 attachment factor; this means that the attachment factor can be detected on dead bacteria and therefore is useful on calves which have received antibacterial therapy.

Prevention of enteritis in neonatal calves involves following good hygiene practices in calf houses to reduce the pathogen load, good colostrum management and vaccination of dams.

References:

- Shaw et al. (2020): *Long term production effects of clinical cryptosporidiosis in neonatal calves.* International journal for Parasitology. In press.
- Thomson et al. (2017) : *Bovine cryptosporidiosis: impact, host-parasite interaction and control strategies.* Vet Res 48, 42.
- Blanchard (2012) : *Diagnostics of Dairy and Beef Calf Diarrhoea.* Vet Clinics Food Animals 28 443-464

28. Bovine Parasites, AFBI

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Parasitic gastroenteritis

Ostertagia ostertagi, *Cooperia oncophora* and *Trichostrongylus spp.* are parasitic nematodes which can cause gastroenteritis in cattle. The main source of infection for calves is L3 larvae of *O. ostertagi* on the pasture, derived from eggs shed earlier in the year by older cattle harbouring infection that they acquired the previous year. Infection with *Trichostrongylus spp.* and *C. oncophora* is usually acquired from L3 larvae on the pasture that have survived from the previous autumn due to mild over-winter conditions.

In calves, cycles of autoinfection in the summer and early autumn (June to September) are associated with Type 1 parasitic gastroenteritis (PGE: persistent watery diarrhoea and weight loss up to 100 kg). Later in the season, from September onwards, L4 larvae of *O. ostertagi* become inhibited in the abomasal lining and will give rise to next year's crop of adult worms. Maturation of these worms is associated with Type 2 PGE (intermittent diarrhoea and anorexia in yearling calves in spring, with shedding of eggs on early pasture). Diagnosis of PGE is carried out by Faecal Egg Counts (FEC) on diarrhoeic faeces samples, and ideally several individual samples (up to 10) should be submitted from each group of scouring calves. Samples with a FEC of 500 eggs per gram (epg) and greater indicate clinically significant PGE.

In 2023, 6.4 *per cent* (number of samples examined, n = 2216) of bovine faeces samples submitted to AFBI for parasitological examination had a FEC ≥500epg (Figure 28.1), compared to 13.2 *per cent* of samples examined in 2022, 4.0 *per cent* of samples submitted in 2021 and 5.1 *per cent* of samples submitted in 2020. The peak period for clinically significant gastrointestinal nematode infection was autumn (perhaps corresponding with incidence of Type 1 PGE in calves having reached the limit of anthelmintic cover by long-acting products administered early in the year). The reasons for these year-to -year differences are likely to be climatic variation between the years, and perhaps changing anthelmintic usage.

Control of PGE in calves is usually carried out using anthelmintic drugs which may be administered therapeutically (to treat calves when scouring and immediately eliminate clinical signs of infection) or prophylactically. In the latter situation, calves are usually grazed until July, then treated with a long-acting anthelmintic to reduce faecal egg output and avoid subsequent rise in infective larvae on pasture.

Anthelmintic treatment would normally be repeated at housing, but when using long-acting products, care should be taken not to inhibit the normal development of immunity. Whilst at present resistance of cattle nematode parasites to commonly used anthelmintic drugs is not a major problem in Northern Ireland, it is advisable for stockholders to be aware of best practices for sustainable use of anthelmintics on their premises. Up-to-date guidelines regarding sustainable control of parasitic worms in cattle is provided by the COWS initiative[1].

Liver fluke

In 2023, *Fasciola hepatica* incidence was 4.0 *per cent* (n = 2018) in bovine faecal samples submitted to AFBI, compared to 3.8 *per cent* in 2022, 7.0 *per cent* in 2021 and 6.0 *per cent* in 2020. It is likely that this reflects the availability of the infective metacercarial cysts on pasture in the late autumn and early winter of 2022. This, in turn,

[1] https://www.cattleparasites.org.uk/

Trichostrongyle eggs

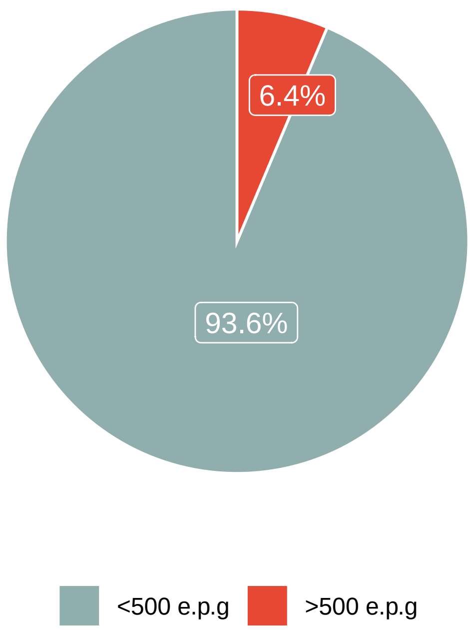

Figure 28.1.: Relative frequency of detection of trichostrongyle eggs in bovine faecal samples examined by AFBI in 2023 (n=2216).

relates to the influence of rainfall and surface moisture in the preceding 6 months on the abundance and spread of the intermediate host, *Galba truncatula* (Figure 28.2), and the development of the fluke infective stages within it.

The risk of fluke infection each year, based on climatic data, is predicted by AFBI staff and published in the farming press in October. Pathogenesis of liver fluke depends on the number of metacercariae ingested and the stage of parasite development within the liver. The acute phase of infection, which is rarely symptomatic in cattle, occurs while parasites migrate through the hepatic parenchyma.

Fluke eggs are not present in faecal samples during this phase, and diagnosis of infection rests on blood testing for evidence of liver damage. The chronic phase of infection corresponds to the presence of adult parasites in the bile ducts, leading to characteristic calcification of ducts and the pipe-stem liver appearance visible on *post mortem* examination. Fluke eggs are present in faecal samples at this stage, and diagnosis is often confirmed by ELISA testing to demonstrate fluke coproantigens in the faeces. Liver fluke infection, fasciolosis, has major economic implications for livestock productivity due to the resulting morbidity and mortality.

Carcases that have been infected by liver fluke have poorer conformation and lower cold weight than those free of liver fluke. When clinically significant fasciolosis has been diagnosed in a herd by examination of representative faecal samples by FEC or coproantigen testing (ten individual samples is recommended for each group of cattle sharing common pasture), treatment is usually recommended using any of several products containing anthelmintic active against the mature flukes (eg. clorsulon, oxyclozanide, albendazole, nitroxynil), bearing in mind the relevant withdrawal periods. Triclabendazole, while active against all stages of fluke including the early migrating immatures, may not be fully effective on many farms, particularly where sheep are also kept, due to the widespread occurrence of fluke resistance to the drug. It is important to treat infected cattle prior to turn-out in spring, in order to prevent pasture contamination with fluke eggs.

Rumen fluke

Adult *Calicophoron daubneyi* flukes (also known as paramphistomes) (Figure 28.4a) are found in the reticulum and rumen and are generally well tolerated, even with heavy burdens. Any pathogenic effect is usually associated with the intestinal phase of infection, where immature flukes, hatched from ingested metacercariae, attach to

Figure 28.2.: *Galba truncatula*. Photo: Bob Hanna

the duodenal mucosa before migrating to the forestomachs; diarrhoea, anorexia and rectal haemorrhage may be noted.

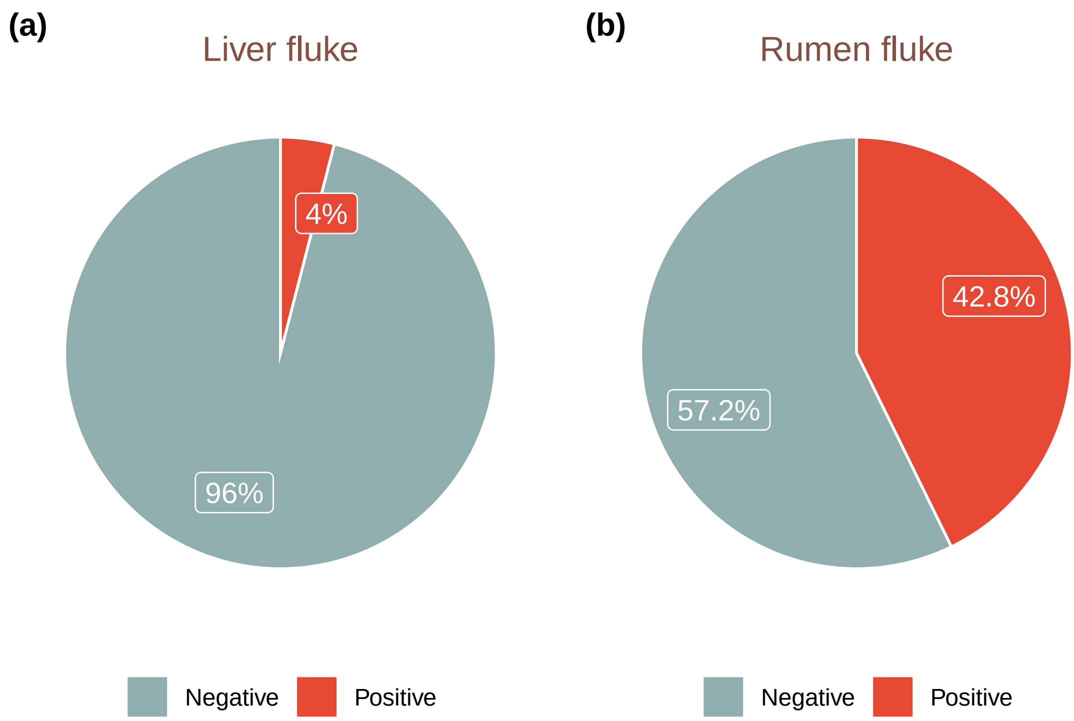

Figure 28.3.: Relative frequency of detection of (a) liver fluke eggs (n=2018) and (b) rumen fluke eggs (n=2021) in bovine faecal samples examined by AFBI in 2023.

Young animals at pasture in late summer or autumn may be affected if the climatic conditions earlier in the year, or localised flooding, have favoured population build-up of the snail intermediate host, *Galba truncatula* (the same as for *F. hepatica*). However, a large number of animals with rumen fluke eggs detected in their faeces show few, if indeed any, clinical signs of disease. Incidence of positive bovine faecal samples in 2023, at 42.8 *per cent* (2021), Figure 28.3 shows a slight decrease compared with that in 2022 (46.4 *per cent*), but is similar to than recorded in 2021 (43.0 *per cent*). In previous years, the incidence of paramphistomosis was higher (in 2020, 48.5 *per cent* and in 2019, 52.6 *per cent*). In faecal examinations, the eggs of *C. daubneyi* can be distinguished from those of *F. hepatica* by their characteristic clear appearance (Figure 28.4b). Treatment of animals for paramphistomosis is not usually considered necessary, although occasional reports, mainly anecdotal, have indicated an improvement in condition and productivity of dairy cattle following administration of oxyclozanide in response to positive FEC diagnosis. In the event of acute outbreaks of clinical infection in calves, the use of oxyclozanide is indicated.

(a) *Calicophoron duabneyi*

(b) Liver and rumen fluke eggs

Figure 28.4.: Adult *Calicophoron duabneyi* (a) in the rumen of the dairy cow. (b) Liver and rumen fluke eggs in a faecal sample. Photos: Bob Hanna.

Coccidiosis

Calves are usually infected by ingesting oocysts from contaminated pasture. Coccidiosis can cause significant economic losses to farmers due to reduced performance and mortality in younger animals. During 2023, coccidian oocysts were seen in 25.1 *per cent* of bovine faecal samples examined (n=2227, Figure 28.5), with 5.8 *per cent* in the moderate or high categories. This is slightly higher than in previous years (21.5 *per cent* in 2022, 21.0 *per cent* in 2021 and 21.6 *per cent* in 2020, with less than 5 *per cent* in the moderate or high categories each year). The relatively low level of oocysts in the moderate or high categories is often because the peak of oocyst shedding from the infected animals had passed before the samples were collected.

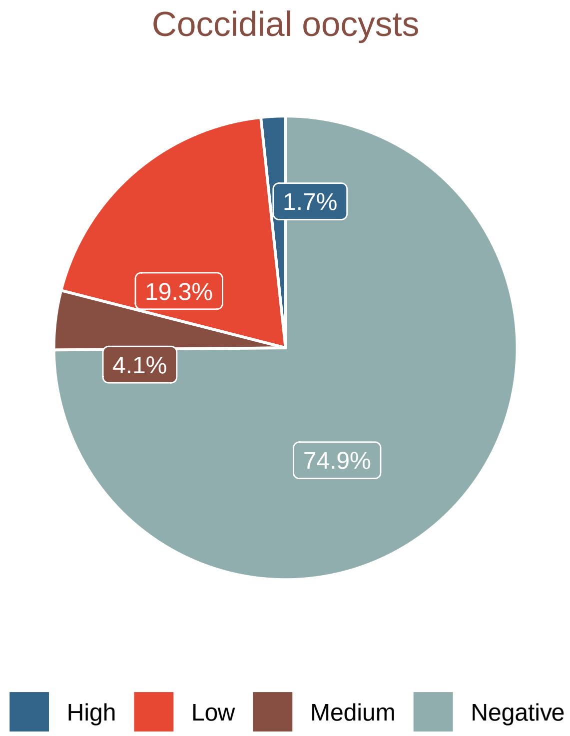

Figure 28.5.: Results for bovine faecal samples tested for coccidial oocysts during 2023 (n=2227).

Examination of the faeces for oocysts of coccidians is an important element of diagnosis, and it may be significant to distinguish the species of parasite present (usually on the basis of the dimensions of the oocysts), and thus predict the likely pathogenicity of the infection. In cattle, coccidiosis caused by *Eimeria zuernii*, *E. bovis* and *E. alabamensis* usually affects calves under 1 year old, but occasionally yearlings and adults are infected if they have not experienced infection in early life. Disease occurs following a massive intake of oocysts from the environment, and this would be associated with large numbers of animals sharing unhygienic yards, or where animals congregate at pasture round water troughs and feeders.

The parasitic infection attacks the caecum and colon, producing severe blood-stained diarrhoea (dysentery) with straining. Massive asexual multiplication of the parasite takes place, and following a sexual phase, oocysts are shed in the faeces in large numbers for a short period of time. After this, the host animal develops substantial immunity to the particular species of coccidian with which it was infected. However, subclinically infected animals often have a low level of intermittent shedding of oocysts and can act as a reservoir of infection for younger näive individuals.

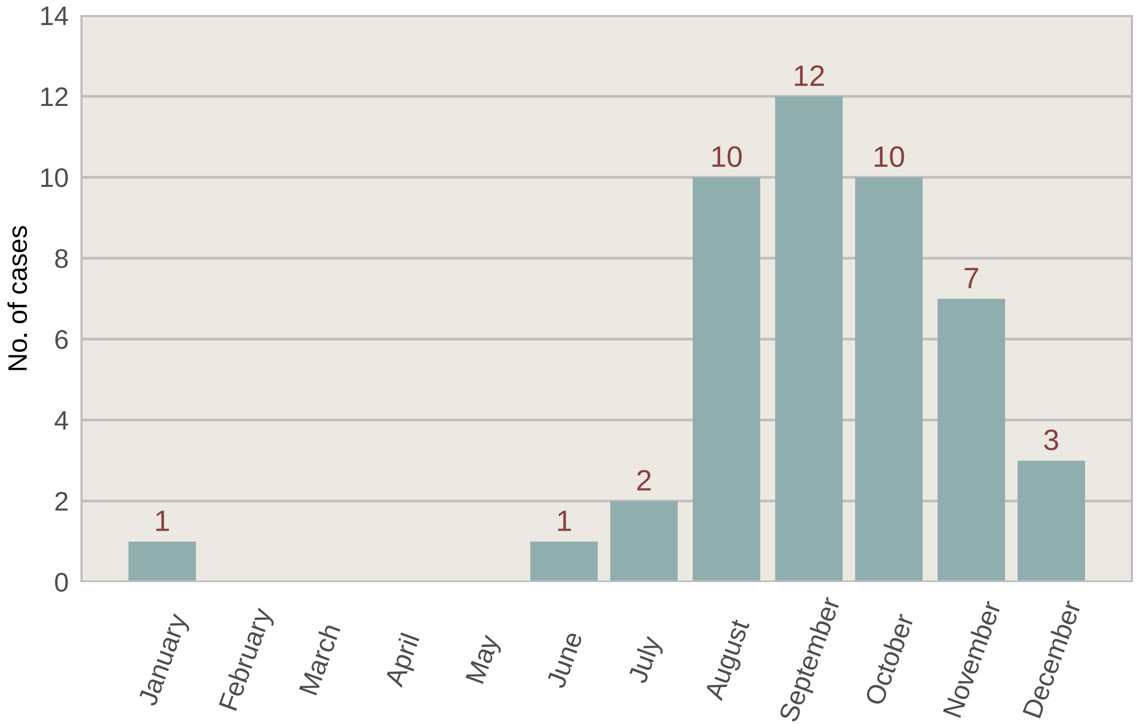

Figure 28.6.: Number of lungworm cases diagnosed during *post mortem* by AFBI per month in 2023, (n=46).

Environmental conditions must be appropriate for development of the oocysts to the infective stage. The presence of moisture is essential for this to occur, and the speed of development of the oocysts depends on temperature, but typically takes 2–4 days.

Prevention of coccidiosis in cattle is based on good management practices, in particular the avoidance of wet underfoot conditions in houses and at pasture. Food troughs and water containers need to be moved regularly to avoid local build-up of oocyst numbers, and bedding should be kept dry. Avoidance of stress, especially due to overcrowding, is important for prevention of coccidiosis in young animals, and adequate uptake of colostral antibodies will also help prevent overwhelming coccidial infection.

Dictyocaulus viviparus (lungworm)

Bovine lungworm *Dictyocaulus viviparus* is the cause of parasitic bronchitis (husk/hoose) in cattle. The disease is characterised by coughing and respiratory distress, and typically affects young cattle during their first grazing season, following which the surviving animals usually develop a strong immunity. Occasionally, if an older animal with acquired immunity is suddenly exposed to a massive larval challenge from a heavily contaminated field, severe clinical signs may result.

Amongst 377 *post mortem* diagnoses of pneumonia in 2023, where the aetiological cause was identified, 46 cases (12.2 *per cent*) involved *D. viviparus* infection, similar to the level reported in 2022 (13.0 *per cent*). Amongst

328 faecal samples examined for lungworm larvae in 2023, 83 (25.3 *per cent*) were found to be positive. The peak incidence of lungworm infection was in August to October (Figure 28.6). In recent years there has been a tendency for lungworm infection to occur in older cattle because treatment with long-acting anthelmintics during the first grazing season has prevented calves from being sufficiently exposed to lungworm infection to develop immunity.

29. Johne's Disease, AFBI

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Johne's disease (JD) or paratuberculosis is a disease of ruminants primarily, which occurs worldwide, commonly in cattle, and to a lesser extent in sheep and goats. The disease classically presents as severe wasting of body condition and diarrhoea, leading eventually to death, but such severe clinical cases are relatively infrequent and represent the very tip of the JD iceberg. Substantial insidious economic losses in JD infected herds result from decreased productivity, increased infertility, increased incidence of mastitis, increased incidence of lameness and decreased lifetime production caused by premature culling. There is no effective treatment for JD, which adversely impacts animal welfare and significantly increases greenhouse gas emissions from infected animal groups.

The causative agent is *Mycobacterium avium* subspecies *paratuberculosis* (MAP), a resilient, slow growing acid-fast bacterium (Figure 22.7a and Figure 29.1). The effects of this slow growth are that the disease has a very long incubation period, and the immune response of an infected animal is also slow. This represents a challenge for diagnostics, and current available methods perform poorly until later in the course of the infection. MAP is known to survive for longer than 1 year in the environment.

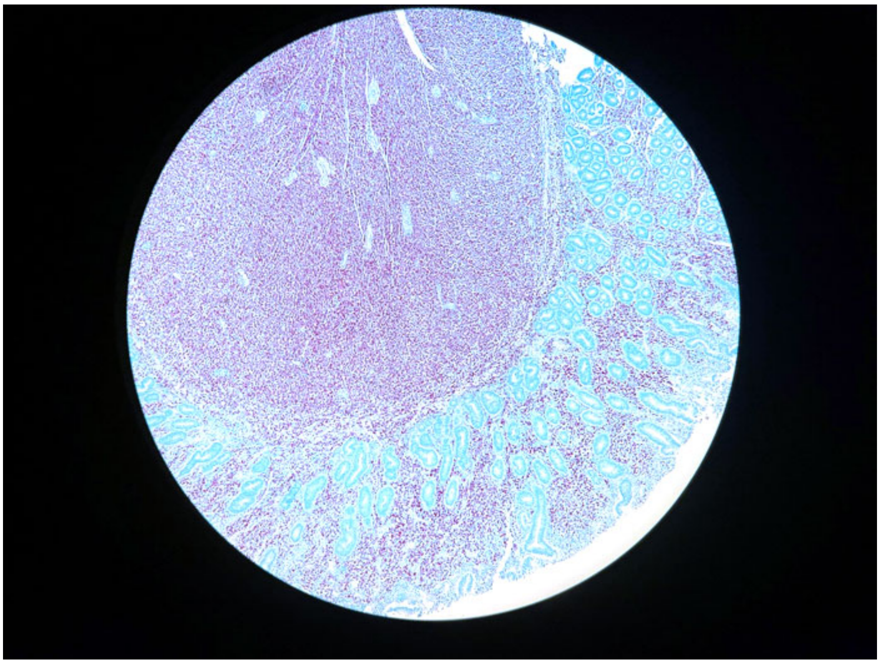

Figure 29.1.: In the Ziehl-Neelsen stained section of ileum, the ileal wall is infiltrated by macrophages containing very large numbers of acid-fast bacteria. Photo: Catherine Forsythe, AFBI.

Transmission is primarily by the faecal-oral route, and ingestion of MAP by susceptible animals via oral uptake of contaminated milk, water, feed products or from the environment. Neonates are most susceptible to the infection. Vertical transmission *in-utero* is also well established in cattle. Progression of infection is usually promoted by stress. Shedding of MAP in faeces will usually precede overt clinical signs of disease in an infected individual, propagating the disease cycle and facilitating spread.

During 2023 10,786 blood and milk samples were submitted to AFBI for MAP antibody (ELISA) testing. Of the bovine samples screened 892 (8.75 *per cent*) were positive, with a further 146 (1.43 *per cent*) returning inconclusive results.

1955 faecal samples were submitted to AFBI for MAP PCR screening. MAP was identified in 349 of the 1829 (19.08 *per cent*) bovine samples tested. MAP infection was also confirmed in 6 of 16 caprine faecal samples tested, and 2 of 56 ovine faecal samples tested.

Figure 29.2.: The gross finding is of diffuse thickening of the mucosal folds in the ileum. Photo: Catherine Forsythe, AFBI.

The Northern Ireland Johne's Disease Control Programme for Dairy Herds is a voluntary programme managed by Animal Health & Welfare NI (AHWNI). The programme complies with the requirements of the Red Tractor Farm Quality Assurance Scheme. It is compulsory for all participants in the programme to undertake a standardised Veterinary Risk Assessment and Management Plan (V-RAMP). These are delivered by approved veterinary practitioners who have undergone AHWNI training. By the end of 2023, 251 veterinary practitioners had been trained to deliver V-RAMPs. In total 1198 V-RAMPs were carried out during 2023 and uploaded to the AHWNI online system.

30. Ovine Diseases, AFBI

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30.1. Overview

The number of sheep submissions in Northern Ireland decreased in 2023 compared to 2022 with 441 submissions being received compared to 654. In 2023, parasitic disease, septicaemia and respiratory disease were the most diagnosed causes of death in sheep of all ages in Northern Ireland. The relative rise in importance of respiratory disease in 2023 compared to 2022 was notable with ovine pasteurellosis and ovine pulmonary adenomatosis (OPA) being the most common and important causes.

Figure 30.1 shows the diagnostic analyses for the most frequent causes of sheep mortality in animals under 12 months in Northern Ireland during 2023. The data are presented on a disease category basis and as a percentage of the total diagnoses excluding abortions.

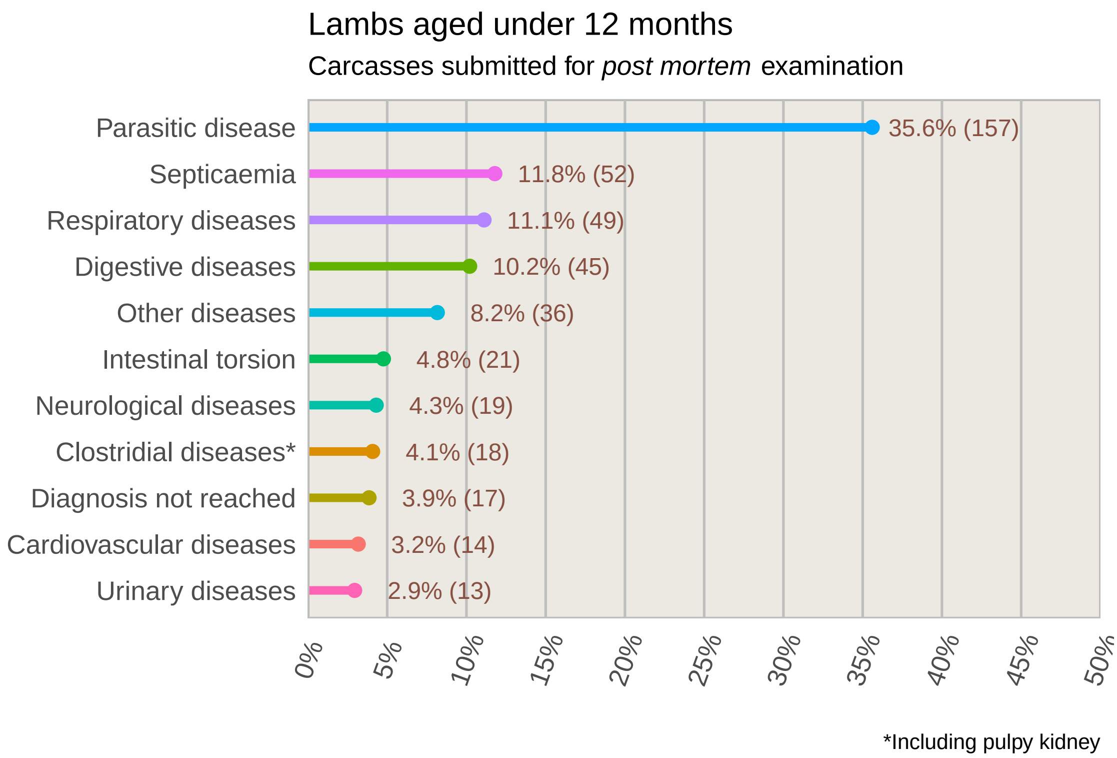

Figure 30.1.: Conditions most frequently diagnosed in small ruminants aged under 12 months submitted for *post mortem* by AFBI in 2023. (n=441). The absolute number of cases is between brackets.

Parasitic disease was very important in sheep in Northern Ireland with parasitic gastroenteritis being the most frequently diagnosed condition in animals under one year. It was noted that the trend for nematodirosis to be present throughout the summer and autumn as well as the spring continued. The temperature adaptation of *N.battus* now appears to be much less apparent than before. *Haemonchus contortus* infection is becoming a more frequent diagnosis in Northern Ireland.

In 2023, unprecedented, a localised increase in *Haemonchus* infection in sheep was noted, likely linked to the mild wet climatic conditions. As a result, pasture in affected areas is likely to be contaminated by parasite eggs surviving from the 2023 season, and yearling animals are likely to be carrying hypobiotic larvae, which will be a source of infection for growing stock in the 2024 season. This trend is therefore expected to continue into 2024. *Haemonchus* infection causes profound anaemia in lambs, often with scour which may be blood-stained. Animals succumb rapidly, and numerous losses can occur in affected flocks.

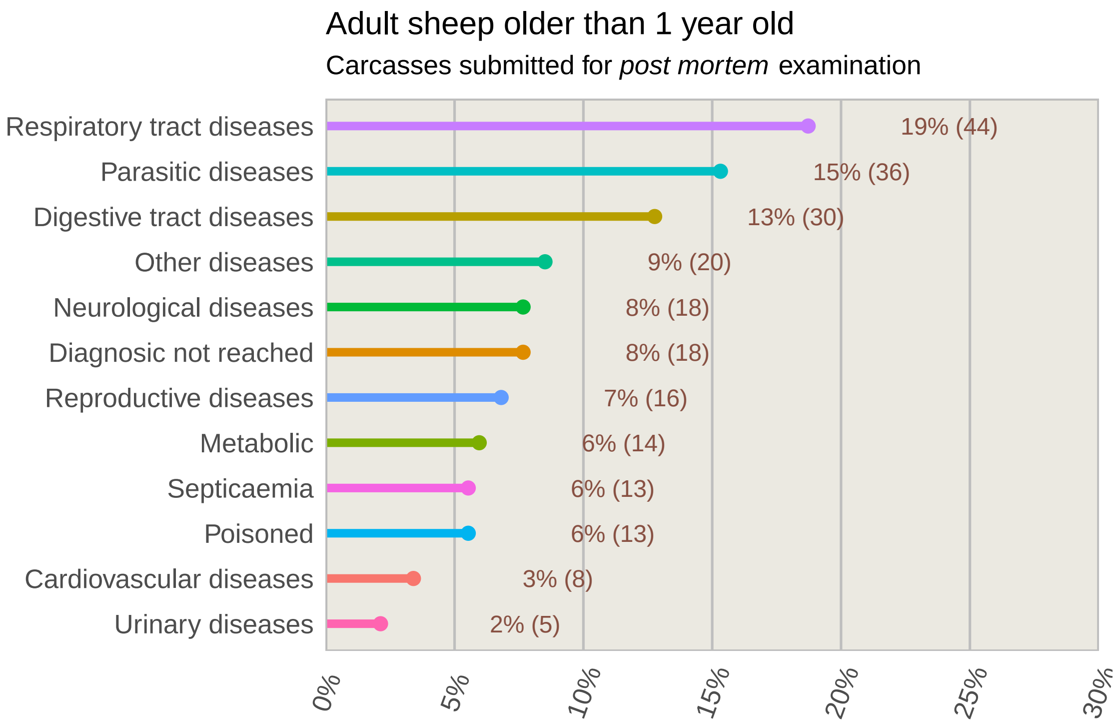

Figure 30.2.: Relative frequency of the different aetiological agents identified in cases of parasitic disease of small ruminants over 12 month of age diagnosed during *post mortem* by AFBI in 2023 (n=235). The absolute number of cases is between brackets.

31. Ovine Abortion, AFBI

It was noted that both toxoplasmosis and enzootic abortion remain very frequent cause of ovine abortion despite the availability of several vaccines (Table 31.1 and Figure 31.1). In some flocks control of EAE is attempted by the prophylactic use of long acting oxytetracycline during the *pre-lambing* period. Whilst useful in the face of an outbreak or abortion storm, this method has limitations for routine control and serves to increase antibiotic usage in a way that is difficult to justify.

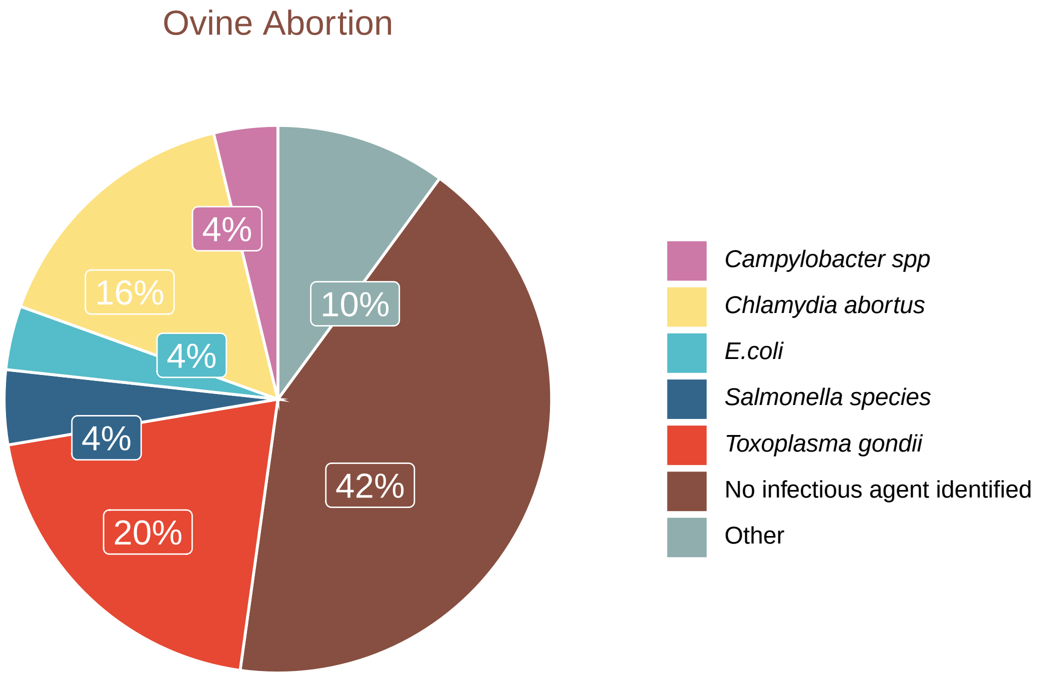

Figure 31.1.: Relative frequency of the identified infectious agents of ovine abortion from submitted foetal *post mortems* in 2023 (n= 159). Note: Categories with 5 or fewer cases have been included in the 'Other' category. The absolute number of cases is between brackets.

Table 31.1.: Relative frequency of the identified infectious agents of ovine abortion from submitted foetal *post mortems* in 2023 (n= 159).

Diagnoses	No. of cases	Percentage
No infectious agent identified	67	**42.1**
Toxoplasma gondii	32	**20.1**
Chlamydia abortus	25	**15.7**
Salmonella species	7	**4.4**
E.coli	6	**3.8**
Campylobacter spp	6	**3.8**
Other	3	**1.9**
Streptococcus	3	**1.9**
Listeria monocytogenes	3	**1.9**
Bacillus licheniformis	2	**1.3**
Pasteurella species	2	**1.3**
Trueperella pyogenes	1	**0.6**
Leptospirosis	1	**0.6**
Staphylococcus	1	**0.6**

32. Ovine Parasites, AFBI

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Parasitic gastroenteritis

The nematode parasites mainly responsible for causing parasitic gastroenteritis in sheep in Northern Ireland are *Teladorsagia circumcincta, Trichostrongylus spp., Cooperia spp.* (all of which produce trichostrongyle-type eggs) and, in young lambs, *Nematodirus battus*. Faecal samples from sheep are examined in the Parasitology laboratory, AFBI, for trichostrongyle eggs, *Nematodirus* eggs, and for coccidial oocysts (Figure 32.1).

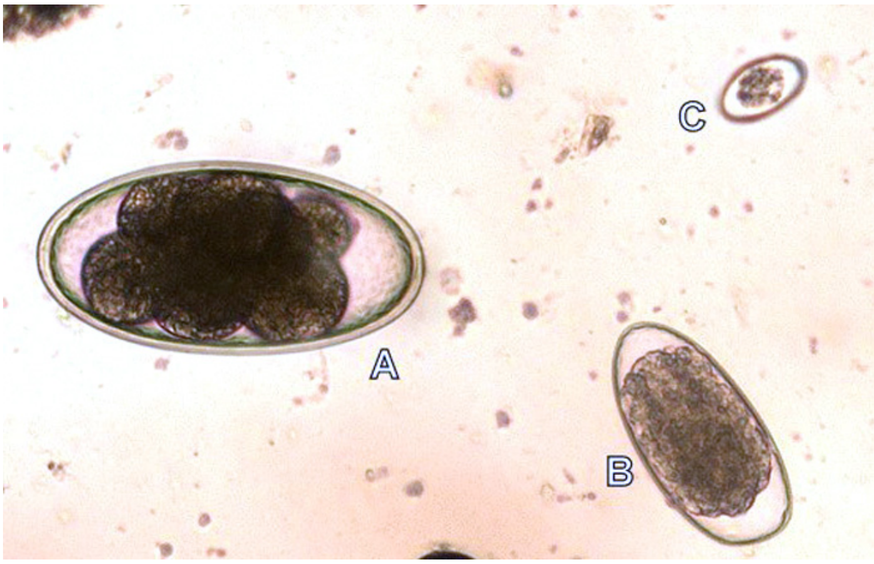

Figure 32.1.: *Nematodirus* eggs (A), trichostrongyle egg (B) and coccidian oocyst (C) in a faecal sample. Photo: Bob Hanna.

The number of trichostrongyle eggs detected is consistently higher in sheep when compared to cattle (Figure 32.2 and Figure 28.1 respectively). There may be a number of reasons for this, such as inherent resistance, age profile of the animals sampled, type of pasture grazed and the fact that it is more common for sheep to be out wintered than cattle. Further, the number of ovine samples tested each year is smaller than the number of bovine samples. It is likely that sheep farmers are more selective in the submission of samples, which therefore are more likely to contain worm eggs. However, the data may also point towards a greater focus on parasite control in cattle herds and suggests that this is an area which requires further attention amongst sheep producers.

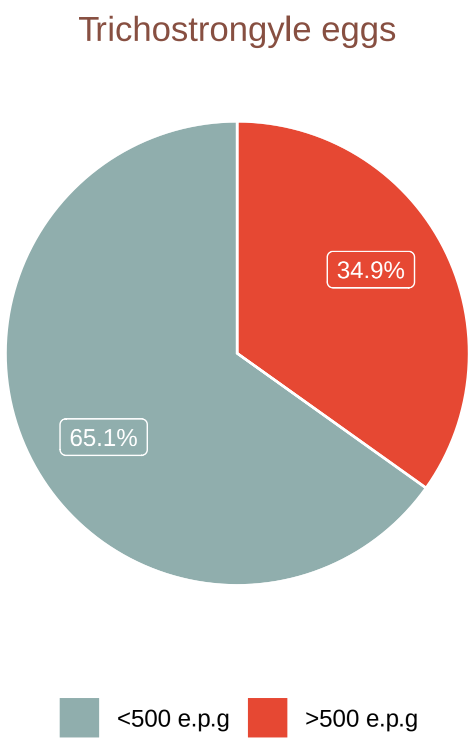

Figure 32.2.: Relative frequency of detection of Trichostrongyle eggs in ovine faecal samples examined by AFBI in 2023 (n=878).

The percentage of ovine samples containing ≥500 trichostrongyle eggs per gram, which increased from 28.0 *per cent* in 2021 to 32.3 *per cent* in 2022, showed a further increase to 34.9 *per cent* in 2023 (number of samples examined, n = 878; Figure 32.2). Peak faecal egg counts (FECs) occurred in late summer and autumn (corresponding to parasitic gastroenteritis in lambs at pasture). It has been found that the rates of diagnosis for *Teladorsagia* and *Trichostrongylus* are tending towards a uniform year-round distribution, suggesting consistent levels of larval survival throughout the year, with extension of the traditionally expected seasonal windows of transmission. Changes in the temporal and spatial distribution pattern of nematode parasites that cause parasitic gastroenteritis in sheep can be related to recent changes in local temperature and rainfall, with year-on-year prolongation of conditions suitable for worm egg and larval development and enhanced over-winter survival of infective larvae.

Anthelmintic resistance testing throughout the province has indicated that worm resistance to benzimidazoles, levamisole, avermectins and milbemycin is 81 *per cent*, 14 *per cent*, 50 *per cent* and 62 *per cent*, respectively, amongst sheep flocks tested, with *Trichostrongylus* the most resistant worm genus. As yet, no significant resistance has been recorded against the newer anthelmintic categories, the amino-acetonitriles (orange drenches) and the spiroindoles (purple drenches).

On particular farms, the resistance status of nematode populations in groups of sheep can be determined by submission of ten individual faecal samples prior to treatment (*pre-treatment* samples) followed by a further ten individual samples (ideally from the same sheep) at a pre-determined period of time after anthelmintic treatment (*post-treatment* samples). Comparison of FECs in the *pre-* and *post-treatment* samples will enable determination of anthelmintic efficacy. Advice on sample submission and interpretation of findings is available from the Parasitology laboratory, AFBI.

Farmers' responses to questions relating to the management of emerging anthelmintic resistance on their premises have revealed that the published SCOPS guidelines have not been widely adopted in practice, and that there is a need for improved stockholder education and closer interaction with informed veterinary practitioners, sheep advisers and laboratory staff. The latest edition of the SCOPS (Sustainable Control of Parasites in Sheep) guidelines is accessible here[1].

[1] https://www.scops.org.uk

Nematodirus

Nematodirosis can be a significant cause of diarrhoea in sheep, particularly in young lambs. Development to the L3 larval stage takes place within the egg, and in the case of *Nematodirus battus* (the most significant species seen in Ireland), a prolonged cold period is usually required before hatching from the egg occurs. It is common therefore that large numbers of L3 larvae appear in April, May and June on those pastures where lambs have grazed the previous year.

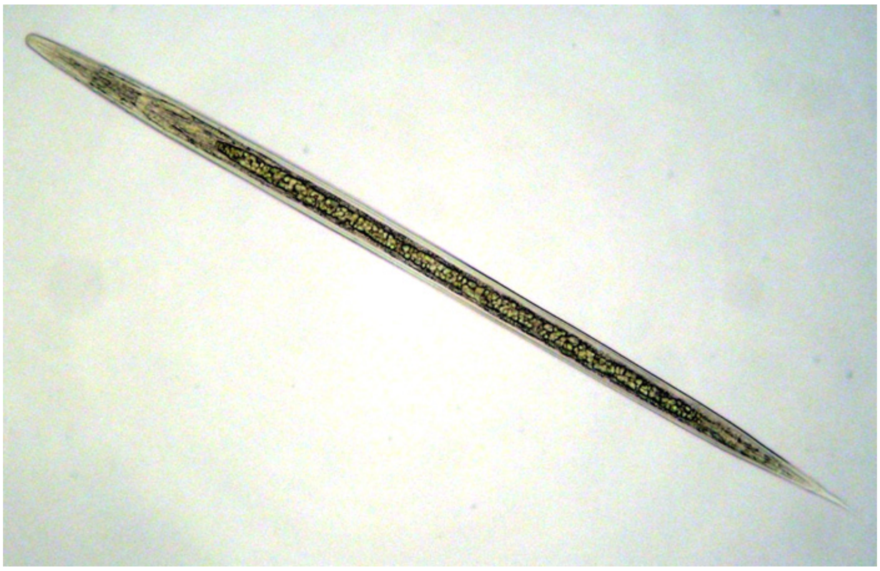

Figure 32.3.: L3 larva of *Nematodirus*. Photo: Bob Hanna

When lambs are weaned and are beginning to eat more grass, these L3 larvae are ingested. If enough larvae are taken in, severe clinical disease can result. Faecal egg counts of more than 200 characteristic *Nematodirus* eggs per gram (Figure 32.4) are considered clinically significant in sheep, and in late spring and early summer, deaths of lambs due to enteritis are common. It is advisable that any carcases are submitted to VSD for *post mortem* examination in order to determine if the cause of enteritis is nematodirosis, other nematode infection, coccidiosis or bacterial infection, since this information is necessary to inform appropriate treatment. Of the 871 faecal samples examined for *Nematodirus* eggs in 2023, 6.3 *per cent* were found to contain ≥200 epg (Figure 32.4), a decrease from the levels recorded in 2022 (8.7 *per cent*) and 2021 (9.0 *per cent*), but still markedly higher than the level recorded in 2019 (4.6 *per cent*).

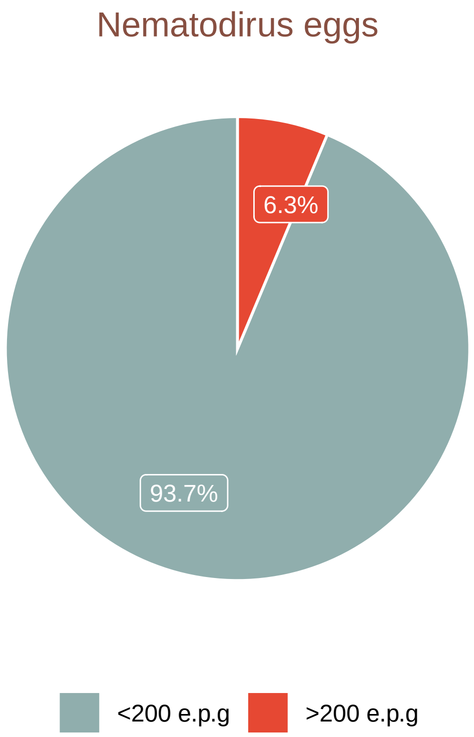

Figure 32.4.: Relative frequency of detection of Nematodirus eggs in ovine faecal samples examined by AFBI in 2023 (n=871).

A limited study has revealed that in Northern Ireland, anthelmintic resistance in *Nematodirus battus* populations to benzimidazoles, levamisole, avermectins and moxidection is present in, respectively, 36 *per cent*, 50 *per cent*, 33 *per cent* and 75 *per cent* of flocks tested. Benzimidazole administration, on a therapeutic or prophylactic basis, remains the preferred treatment option, and the timing of dosing is guided by annual prediction of the peak egg hatching period, calculated by AFBI parasitologists using climatic data. In recent years, a trend is emerging for a second autumnal peak in *Nematodirus battus* infection in sheep. The reason for this appears to be flexibility in the hatching behaviour of the eggs, with a significant proportion hatching in autumn, in response to climatic change.

Haemonchus

Haemonchosis is an important gastrointestinal worm infection of sheep and goats in regions where conditions of high humidity coincide with high temperature. The larvae of *Haemonchus contortus* ('Barber's pole worm') hatch and mature in faeces on the ground before migrating to fresh grass for intake by grazing animals. This migration requires warm moist conditions, and the larvae are quite susceptible to desiccation and low temperatures. In the British Isles, outbreaks of haemonchosis may occur in the summer months if rainfall is sufficient to enable the larvae to survive on pasture. Most cases are reported from the south, and the disease is only occasionally reported in Northern Ireland. However, global warming could mean that the incidence of haemonchosis might increase here. In 2023, following the particularly wet conditions of mid-summer, an unusual increase in the number of cases of *Haemonchus* diagnosed was noted by staff in VSD, AFBI.

Typically, dead lambs submitted for *post mortem* examination showed signs of severe scour, often with fly-strike, and invariably there was severe anaemia. Indeed, clinical diagnosis of haemonchosis in the field relies on the observation of very pale mucous membranes, including the conjunctivae of the eyes.

Faecal egg counts on samples submitted to the laboratory from flocks where haemonchosis is suspected show high levels of strongyle-type eggs. However, since strongyle eggs cannot easily be differentiated on a species basis, these counts represent the combined output of *Cooperia*, *Haemonchus* and *Ostertagia/Telodorsagia* infections. If worms persist in lambs, particularly after dosing with benzimidazole ('white drench'), anthelmintic resistance may be an issue on the premises, and administration of moxidectin, together with an iron-containing tonic, may be advisable.

The main risk for lambs in the next grazing season is from hypobiotic larvae that may remain in the replacement stock reared this year. Early-season anthelmintic dosing of replacement stock can help to reduce the risk of pasture contamination for naïve lambs, while careful attention to quarantine and dosing of bought-in stock is essential.

Coccidiosis

In 2023, as in previous years, coccidial oocysts were detected more frequently in sheep than in cattle faeces samples. Of the sheep samples examined in 2023, 65.4 *per cent* (n=877) were positive for oocysts (compared to 68.8 *per cent* in 2022, 63.0 *per cent* in 2021 and 69.2 *per cent* in 2020), but only 28.2 *per cent* exhibited moderate or high levels (Figure 32.6). However, as with infections in cattle, the oocyst count may not accurately reflect the pathological significance of the infection because the peak of shedding may have passed before samples were collected, and because there is variation in the pathogenicity of the various species of *Eimeria* involved.

Coccidiosis is an insidious disease and is frequently associated with poor thrive in lambs and calves as well as with more serious clinical disease. In sheep, the important pathogenic coccidians in Northern Ireland are *E. crandallis* and *E. ovinoidalis*. As in calves, infection can cause severe diarrhoea, often with blood, and the caecum and colon are the main parts of the intestine affected. If the animals recover, chronic damage to the intestine can lead to malabsorption problems later, with associated failure to thrive. During the acute phase of the disease the integrity of the intestinal lining is disrupted (Figure 32.5), and deaths may result from septicaemia caused by ingress of bacteria through the damaged intestine wall.

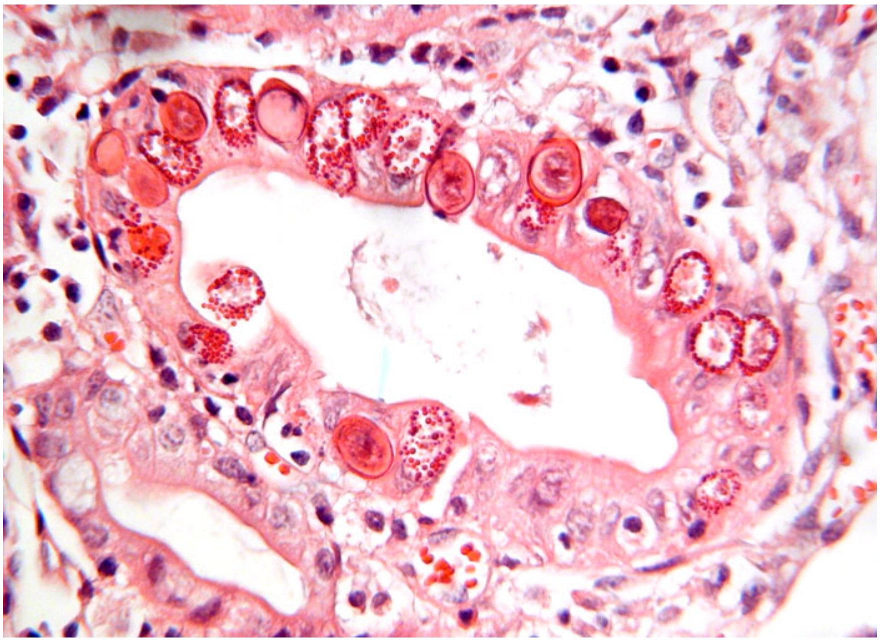

Figure 32.5.: Histopathology section of coccidiosis in the gut wall of a lamb. Photo: Bob Hanna.

Lambs are usually affected between four and seven weeks of age, and outbreaks of disease are usually associated with intensive housing or grazing of ewes and lambs in unhygienic and wet conditions. Adult sheep, especially ewes in the periparturient period, often shed low numbers of oocysts, and these can be the primary source of infection for lambs, although oocysts on the pasture can survive over-winter and infect näive animals in springtime. Feeding of concentrates in stationary troughs around which high concentrations of oocysts build up, can be a precipitating factor.

Prevention of coccidiosis in sheep, as in cattle, is based on good management practices, in particular the avoidance of wet underfoot conditions in houses and at pasture. Food troughs and water containers need to be moved regularly to avoid local build-up of oocyst numbers, and bedding should be kept dry.

Avoidance of stress, especially due to overcrowding, is important for prevention of coccidiosis in young animals, and adequate uptake of colostral antibodies will also help prevent overwhelming coccidial infection. Lambs with severe scouring will need supportive rehydration. It is always advisable to avoid grazing young and older lambs together, and if possible young lambs should not be grazed on pasture that has carried ewes and lambs in the past two to three weeks.

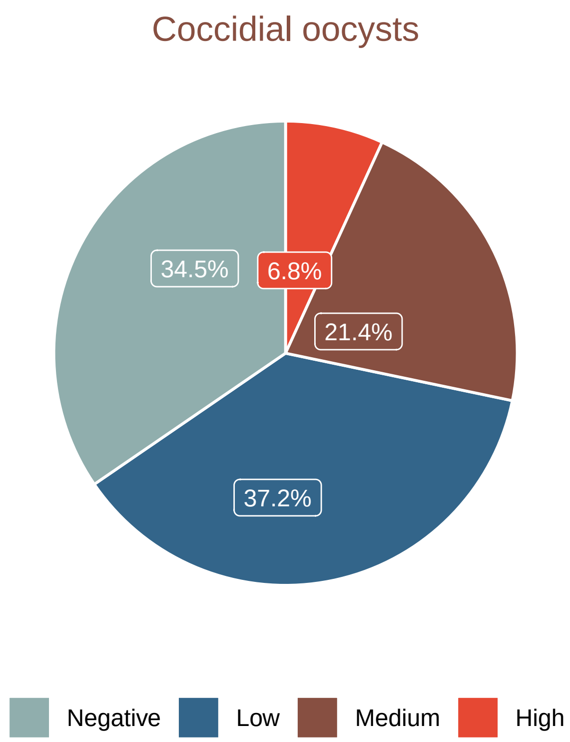

Figure 32.6.: Results for ovine faecal samples tested for coccidial oocysts during 2023 (n=877).

While prophylactic treatment of ewes around the lambing period with anticoccidial drugs such as toltrazuril or decoquinate can help reduce pasture contamination by oocysts, it should be remembered that the promotion of natural immunity in young animals needs to be safeguarded by strategic dosing and by the choice of a product that controls disease while permitting development of immunity.

The timing of treatment of lambs should be adjusted depending on the management practice (indoor, outdoor, pasture etc.) and the history of disease occurrence in previous years. Treatment is usually given to lambs as soon as diarrhoea is seen in several individuals. If it is delayed until most lambs are affected, recovery time can be prolonged due to intestinal damage.

Liver fluke and Rumen Fluke

In the ovine faecal samples examined in 2023, rumen fluke eggs and liver fluke eggs were detected in 24.3 *per cent* and 7.8 *per cent* respectively of 765 faecal samples examined (Figure 32.7 and Figure 32.9). The percentage with liver fluke eggs detected therefore showed a significant decrease from 2022 (19.5 *per cent*), 2021 (11.0 *per cent*) and 2020 (17.1 *per cent*). In contrast, the percentage of faecal samples positive for rumen fluke eggs in 2023 (24.3 *per cent*) was similar to that recorded in 2022 (20.2 *per cent*), 2021 (26.0 *per cent*) and 2020 (24.1 *per cent*). Bearing in mind that the molluscan intermediate host (*Galba truncatula*) is the same for both types of fluke, the perceived decrease in liver fluke incidence compared to rumen fluke incidence is difficult to explain.

It is likely that the findings may reflect local climatic differences or changes in stockholder behaviour in sample submission between 2020 and 2023. The possibility of intra-molluscan competitive effects between liver fluke and rumen fluke larval stages has yet to be researched fully. There is increased awareness of triclabendazole resistance in flukes in Northern Ireland, resulting in a shift towards control of *F. hepatica* by use of alternative products (containing for example closantel) to kill adult fluke in sheep and cattle in late winter and early spring. Of the available drugs, only oxyclozanide has proven efficacy against rumen fluke.

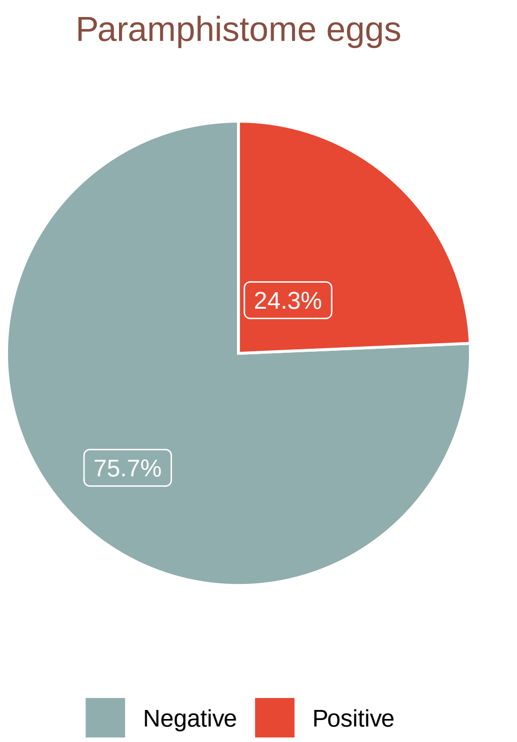

Figure 32.7.: Relative frequency of detection of paramphistome eggs in ovine faecal samples examined by AFBI in 2023 (n=765).

Liver fluke disease can occur in either acute or chronic forms. The acute form occurs in sheep in the autumn and early winter of those years when the climatic conditions from April to September have favoured the breeding and resulting population expansion of the intermediate host. Disease is caused by the migration of large numbers of immature flukes through the liver, frequently resulting in fatal haemorrhage (Figure 32.8).

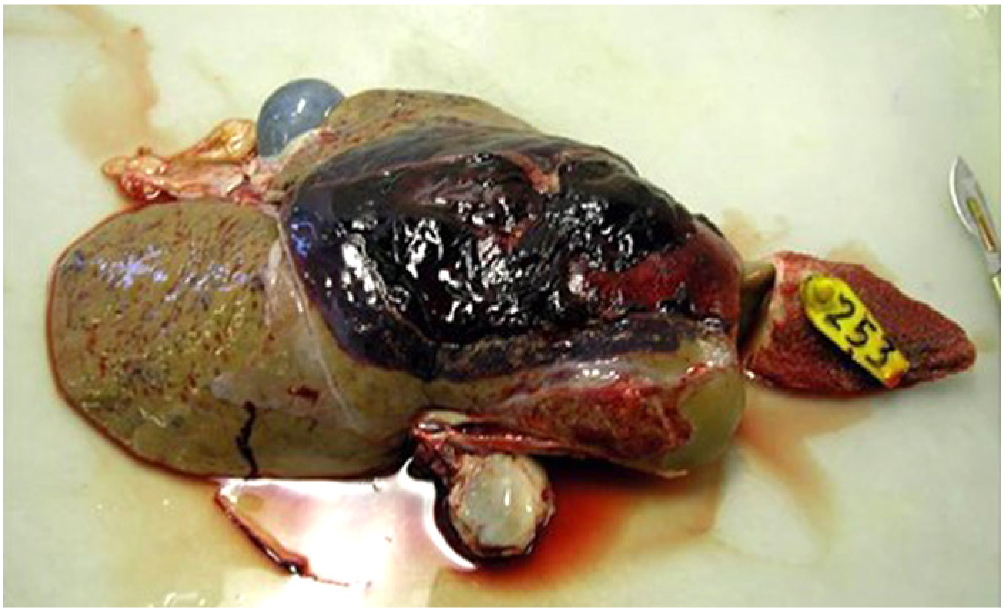

Figure 32.8.: Liver haemorrhage in acute fasciolosis. Photo: Bob Hanna.

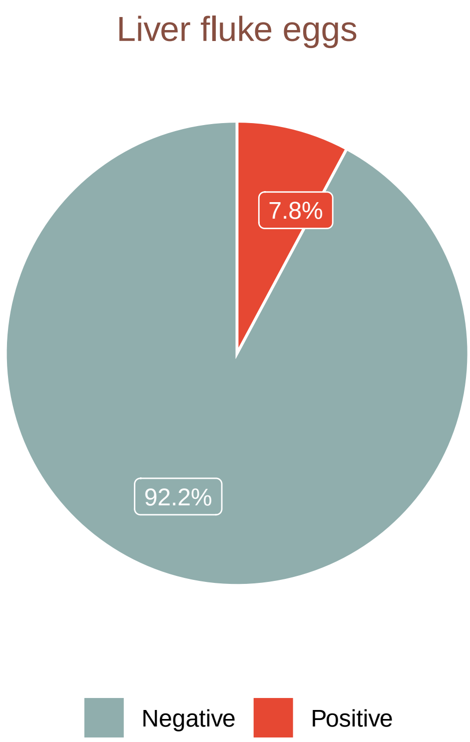

Figure 32.9.: Relative frequency of detection of liver fluke eggs in ovine faecal samples examined by AFBI in 2023 (n=765).

Chronic liver fluke disease is more common than the acute form and occurs in both sheep and cattle, usually during the winter and spring, although infection can persist throughout the year (Figure 32.10).

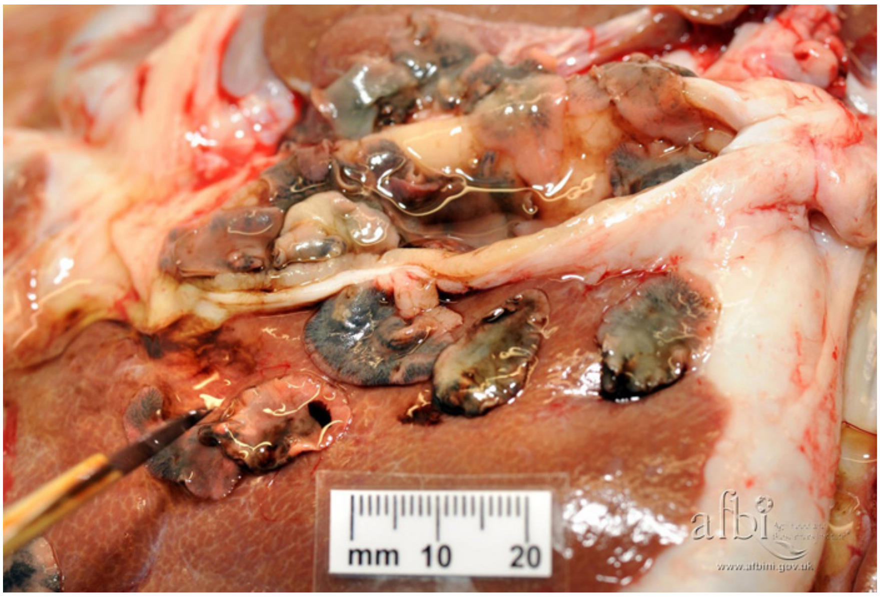

Figure 32.10.: Adult liver fluke in the main bile duct of a sheep. Photo: Bob Hanna.

Chronic fluke infection can cause a reduction of 30 *per cent* in the growth of fattening animals and can also predispose to metabolic conditions and infectious diseases such as salmonellosis and clostridial infection. Cattle and sheep in fluke-affected areas should be fully vaccinated against clostridial disease.

All sheep farmers should review their fluke control measures in autumn. Access to snail habitats (wet and poorly drained areas) should be reduced or sheep taken off the potentially infected land and housed or moved to new clean pasture. However, in most cases, control will be based on the strategic use of anthelmintics, employing a product effective against the life cycle stages likely to be present in the flock or herd at the time of treatment.

Resistance to fluke treatments is a continuing problem in Northern Ireland. On some premises, products containing triclabendazole (the only flukicide currently licensed in UK and Ireland that is effective against the immature stages of liver fluke) have been used almost exclusively for many years. On such farms it is likely that triclabendazole-containing products will now be less effective in controlling fluke infection, and for treating acutely ill animals. The effectiveness of anthelmintic treatment on individual farms can be checked by taking dung samples 3 weeks after treatment, from approximately 10 animals in each affected group, and submitting them for laboratory examination. Further information is available from the Parasitology laboratory, AFBI.

Treatment of chronic (adult) infections in cattle as well as sheep during the winter and/or early spring is important to help reduce pasture contamination with fluke eggs, and this is particularly relevant if triclabendazole is no longer effective in controlling fasciolosis on the premises. Use of an anthelmintic with activity mainly against adult flukes (closantel, nitroxynil, albendazole, oxyclozanide) is likely to be appropriate in these circumstances. However, the flukicide programme used must be on a 'know-your-farm' basis and no one set of recommendations will cover all flocks or herds.

Adult rumen flukes are less damaging to sheep and cattle than liver flukes, but heavy infections of immature worms may cause diarrhoea, ill-thrift and, exceptionally, death in young animals. Heavy burdens of adult rumen flukes have been reported to result in poor productivity in dairy or meat-producing animals, but few scientific studies have been completed. Liver flukes, particularly in acute infections, are potentially a much more serious risk to the welfare and productivity of sheep than rumen flukes, and the choice of which flukicides to use must reflect this. Oxyclozanide is the only locally available flukicide with proven efficacy against immature and adult rumen flukes, but treatment should be first aimed with liver fluke in mind and only then, if need be, for rumen fluke. Further information on fluke disease in cattle and sheep may be found on the AFBI website[2].

[2] www.afbini.gov.uk

33. Porcine and Avian Diseases, AFBI

Note

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33.1. Porcine disease

The total pig numbers in Northern Ireland recorded in the June 2023 Agricultural census was 682,339 a decrease of 8 *per cent* from June 2022 DAERA, Department of Agriculture, Environment and Rural Affairs[1]. The decrease in numbers was primarily due to a reduced number of weaners, growers and suckling piglets. A small number of highly productive businesses make up a large proportion of the Northern Ireland pig industry (DAERA Agricultural Census of Northern Ireland 2023). Whilst most of the pig medicine is carried out by a few specialist pig veterinarians there are also many pigs kept on smaller holdings as farm pigs or even as pets and these animals may be seen by any veterinary practice. Septicaemia and neurological diseases made up the majority of conditions diagnosed in pig submissions for *post mortem*.

Bacterial infections due to *Streptococcus spp.*, *E. coli* and *Salmonella* species were common diagnoses. Neurological conditions were predominantly due to suppurative meningitis, particularly of young pigs. Neonatal bacterial suppurative meningitis (NBSM) is an important clinical entity in pigs with *Streptococcus suis* commonly isolated.

Most pigs carry *Streptococcus suis* in their upper respiratory tract and development of bacteraemia will depend on several factors including the virulence of the strain present, stress factors such as high stocking density and mixing of groups and concurrent infections and diseases. *Streptococcus equisimilis* infection was also diagnosed in growing pigs in a single herd. This organism occasionally causes septicaemia, valvular endocarditis and meningitis in finishing pigs.

African Swine Fever Alert

African Swine Fever (ASF) is a highly contagious viral disease of pigs which can cause a high mortality rate. It is a notifiable epizootic disease. African Swine Fever is spreading in Europe and all those involved in pig production should be aware of the disease and their role in preventing its spread.
Anyone who suspects ASF must immediately alert DAERA. Further information on ASF is available on the {DAERA website](https://www.daera-ni.gov.uk/).
DAERA also has an epizootic hotline available: **0300 200 7840**.

Multicentric lymphosarcoma

Multicentric lymphosarcoma was diagnosed based on histological examination of liver, spleen, small intestine and mesenteric lymph nodes from a slaughtered pig. Generally, tissue architecture was replaced and effaced by sheets of small dark round cells with large basophilic nuclei and very little cytoplasm (Figure 33.1). There was a high number of mitotic figures.

[1] https://www.daera-ni.gov.uk/publications/agricultural-census-northern-ireland-2023

Multicentric lymphosarcoma is occasionally diagnosed in pigs with animals under one year usually affected. The disease is considered to be sporadic occurring only in isolated cases. A possible viral aetiology has been considered. One study did determine an outbreak of the disease in a herd was associated with an autosomal recessive gene (McTaggart et al. 1979).

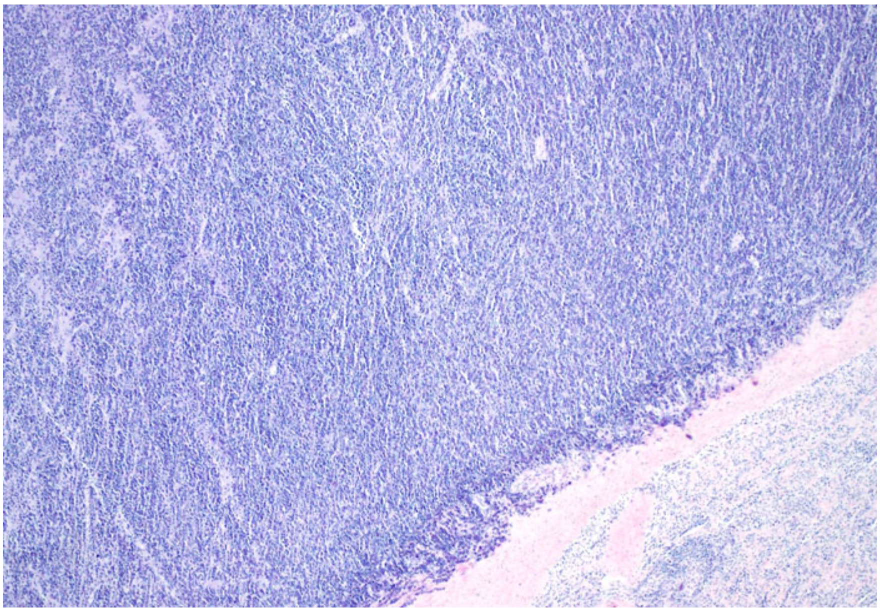

Figure 33.1.: Sheets of small dark round cells with large basophilic nuclei have effaced and replaced normal tissue architecture. Photo: Siobhan Corry AFBI.

Liver avulsion

Avulsion of the liver was diagnosed in a ten-month-old sow. At *post mortem* examination, much free blood was present in the abdomen. A large clot was attached to the liver, over a fresh rupture which appeared to represent an avulsion lesion. The sow had recently given birth to a small litter, and a dead foetus remained in the uterus.

Salt poisoning

Salt poisoning was diagnosed in a herd of pigs where 15 weaned pigs from a single house had died suddenly. Histology of the brain showed perivascular cuffing with lymphocytes and in particular eosinophils along with laminar loss of neurons (Figure 33.2). These brain lesions are consistent with sodium ion toxicity *salt poisoning*. Indirect salt poisoning is a neurological disease, causing apparent blindness and convulsions.

33.2. Avian Disease

AFBI receives avian submissions every year from commercial and backyard farms for disease diagnosis, and also from the PSNI for the investigation of wildlife crime as well as submissions from the Department of Agriculture, Environment and Rural Affairs (DAERA) for the investigation of notifiable and epizootic disease in domestic and wild birds.

Submissions consist of either single carcases, groups of up to six birds from a flock or diagnostic samples such as faeces or swabs taken on farm by private practitioners or DAERA vets. The number of birds kept on commercial poultry farms in Northern Ireland in 2023 totalled approximately 25.6 million birds an increase of 24 *per cent* from June 2022 (DAERA Agricultural census of Northern Ireland 2023). Whilst most of the commercial poultry medicine is carried out by a few specialist poultry veterinarians there are also many birds kept in backyard flocks and these animals may be seen by any veterinary practice.

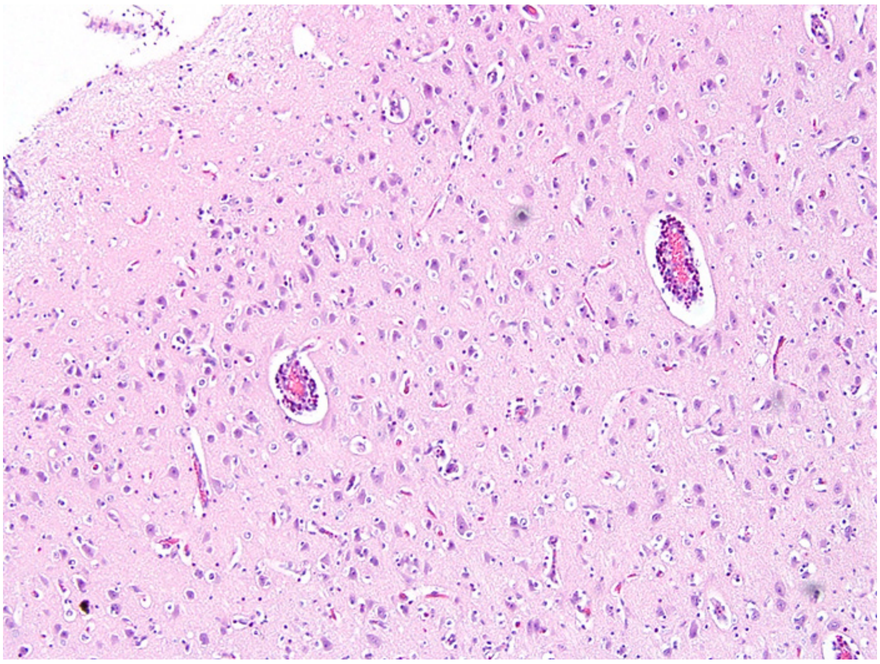

Figure 33.2.: Perivascular cuffing of vessels in the brain of a pig by lymphocytes with eosinophils the predominant cell type evident. Photo: Siobhan Corry.

Capillaria infection in geese.

Three geese were submitted from a backyard flock of seven, having died following reduced mobility and collapse. At *post mortem* the carcases were emaciated, pale, and avian influenza virus (AIV) testing by RT-PCR gave negative results. Faecal examination revealed severe *Capillaria* species infection. *Capillaria* are mucosal-invading intestinal nematode parasites, which can cause diphtheritic inflammation, leading to inappetence and emaciation. Some species require the involvement of earthworms in the life-cycle, and therefore occur commonly among birds kept outdoors.

(a) Acanthocephalan worms

(b) Acanthocephalan worms

Figure 33.3.: Acanthocephalan worms (a) on the surface of the intestinal mucosa of a swan. Photograph B. Hanna AFBI. (b) The serosal view of the intestines in figure (a) shows the vesicles corresponding to the attachment points – this is where the probosis is stuck through the gut wall, and inflated to anchor the worm in place. Photos: Bob Hanna.

Acanthocephalan infection in a swan.

A whooper swan was submitted by DAERA under the wild bird survey for avian influenza virus (AIV) testing by RT-PCR which returned a negative result. On *post mortem* examination numerous serosal cyst-like structures corresponding to acanthocephalan parasites were evident in the intestinal lumen attached to the mucosal aspect of the gut wall (Figure 33.3a).

Acanthocephalan parasites are sometimes referred to as 'thorny headed worms' due to the presence of a hook covered proboscis which attaches to the intestinal tract (Figure 33.3b). There are a couple of genera of Acanthocephalans that cause enteritis in aquatic fowl such as swans.

Bird Flu Alert

Avian Influenza is a notifiable disease. Poultry keepers (including backyard poultry, game birds and pets) should remain vigilant for any signs of the disease in their animals. If a notifiable disease is suspected in a domestic or wild bird contact the DAERA Helpline on **0300 200 7840** or your local DAERA Direct Regional Office. Failure to do so is an offence. More information can be found in the DAERA website[a].

[a] https://www.daera-ni.gov.uk/ai

34. Zoonotic Diseases, AFBI

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There are over 200 known types of zoonoses. Zoonoses comprise a large percentage of all newly identified infectious diseases as well as many existing ones. They can cause sporadic cases, recurring outbreaks and global pandemics.

During 2023 AFBI laboratories isolated and positively identified a number of zoonotic agents in the course of disease diagnostics. A few of them are discussed in this section.

World Health Organisation 2024

A zoonosis is an infectious disease that has jumped from a non-human animal to humans. Zoonotic pathogens may be bacterial, viral or parasitic, or may involve unconventional agents and can spread to humans through direct contact or through food, water or the environment. They represent a major public health problem around the world due to our close relationship with animals in agriculture, as companions and in the natural environment. Zoonoses can also cause disruptions in the production and trade of animal products for food and other uses.

34.1. Erysipelas

Erysipelas is a bacterial infection caused by the agent *Erysipelothrix rhusiopathiae*. Infections tend to be sporadic and whilst it can infect a wide range of avian and mammalian hosts (including humans) it particularly affects pigs, sheep and poultry.

During 2023 AFBI diagnosed *Erysipelothrix rhusiopathiae* from samples submitted from a chicken flock, two turkey flocks and a pig herd. Clinical manifestations of erysipelas most commonly include septicaemia but cutaneous infections, endocarditis and polyarthritis can also occur.

Asymptomatic carriers occur and the infection is shed in faeces, urine, saliva and oronasal secretions. Direct infections occur through breaks in the skin and through the mucosal membranes. Indirect infections can occur by the ingestion of contaminated food stuff and possibly via biting insects such as the poultry red mite *Dermanyssus gallinae*.

In poultry infections have a high mortality and tend to cause sudden death due to septicaemia. Clinical signs, when evident, include weakness, depression, diarrhoea and a marked drop in egg production in laying hens. In turkeys, vegetative endocarditis is sometimes seen.

Subclinical infected carrier pigs are the main reservoir for infection in pig herds. Swine erysipelas can be acute with septicaemia or the cutaneous 'diamond skin' form seen or chronic resulting in arthritis or vegetative endocarditis. In diamond skin disease cutaneous lesions progress from small purple raised areas to the characteristic diamond shaped erythematous plaques. In humans *E. rhusiopathiae* can cause the cutaneous skin infection erysipeloid, cellulitis or in more severe cases can cause a septicaemia with endocarditis.

34.2. *Chlamydia abortus*

Chlamydia abortus is the agent responsible for ovine chlamydiosis, a bacterial disease that can cause abortion in sheep and goats (known as enzootic abortion in ewes).

The main source of infection to naïve sheep is from material shed by infected sheep at lambing time in birth fluids. This can happen from newly infected sheep or recovered carrier sheep that aborted during a previous pregnancy.

Disease most commonly initially arrives on farm through bought in animals, although wildlife can also be a source by carrying infected placenta from farm to farm. Infection causes a placentitis rending the pregnancy non-viable with resultant abortion. Commonly there is oedema (thickening) of the intercotyledonary area of the placenta overlain by a purulent exudate. A diagnosis can be made by examining smears of the placenta for *C. abortus* organisms. In 2023 *C. abortus* was identified in 16 *per cent* of ovine foetal material submitted for *post mortem* examination to AFBI.

Farms can prevent a disease outbreak by having a closed flock policy. In the face of an outbreak, strict hygiene, isolation of cases and disposal of infective material will limit the spread of infection. Vaccination is available however due to latent infections vaccination will not result in an immediate prevention of abortion in every flock. *C abortus* is a zoonotic disease. If infected, in most humans it may lead to mild flu like disease but in pregnant women it can cause a severe life-threatening disease in the mother and lead to stillbirth or miscarriage of the unborn child.

34.3. Listeriosis

Listeria species are widely distributed in the environment, including in soil, decaying vegetation, and fodder such as silage in which the bacteria can multiply. In humans the disease most commonly occurs in pregnant women, neonates, elderly people, and those with a range of underlying medical conditions including cancer and diabetes. There are six species within the genus but only *L. monocytogenes* and *L. ivanoii* are pathogenic. Consumption of contaminated foods is the main route of transmission to humans. Zoonotic infection acquired directly from animals is also possible, although cases reporting animal contact are rare.

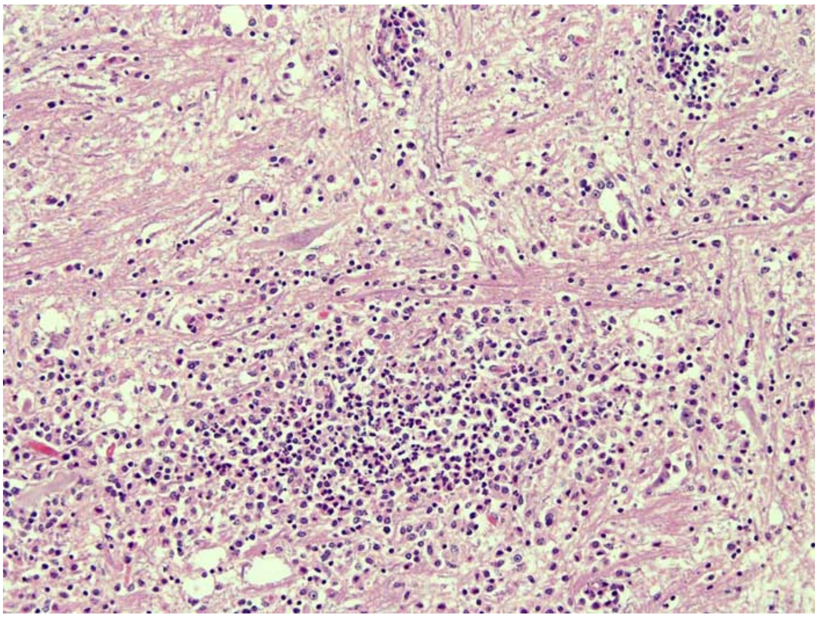

Figure 34.1.: Encephalitis in the brain from which *Listeria monocytogenes* was cultured. Note the perivascular cuffing of vessels by inflammatory cells with extension into surrounding neural tissue to form areas of microabscessation. Photo Seán Fee AFBI.

In animals, listeriosis is chiefly a disease of farmed ruminants, with cattle and sheep considered the most frequently clinically infected species. Infection is opportunistic and may occur through umbilical infection in the neonatal period, or more commonly though the ingestion of soil or soil-contaminated feed, notably poor-quality silage. Infections can lead to abortion, encephalitis (Figure 34.1) septicaemia and eye infections.

During 2023, there were 33 incidents of listeriosis confirmed in submissions of clinical material by private veterinarians for diagnostic investigation at AFBI. There were 12 incidents reported in cattle and 20 incidents (including 5 from cases of abortion) in sheep. *Listeria monocytogenes* was isolated in 22 samples, *Listeria ivanovii* was isolated from seven samples and an unspecified *Listeria spp.* was isolated from four samples.

34.4. Toxoplasmosis

Toxoplasmosis is a disease caused by the agent *Toxoplasma gondii*, a protozoan parasite that is mainly spread via cats' faeces. Toxoplasmosis is a particular problem in sheep. During 2023 *Toxoplasma gondii* antibodies were detected in the foetal fluids of 32 ovine abortions submitted for *post mortem* examination, a relative frequency of 20 *per cent*. This may indicate that the foetus was exposed to infection and seroconversion occurred. However some prenatal transfer of maternal antibodies can occur if a placentitis is present.

A diagnosis of abortion due to toxoplasmosis is best done by histological examination of the brain to look for lesions (Figure 34.2) with immunohistochemistry performed to check for the presence of *Toxoplasma gondii* organisms within these lesions. Animals acquire toxoplasmosis from feed, hay or pasture that has been contaminated by cat faeces.

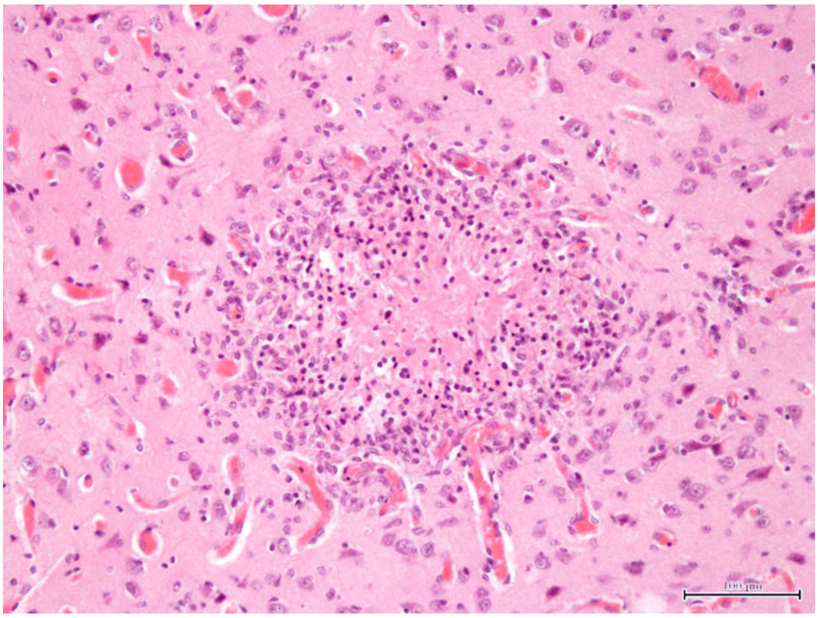

Figure 34.2.: Focal area of necrosis and gliosis in the brain of a lamb caused by *Toxoplasma gondii* infection. Photo Seán Fee AFBI.

An animal that has become infected will soon develop immunity. It is only when infection occurs for the first-time during pregnancy that abortions can occur Toxoplasmosis is endemic in the Northern Ireland sheep population and cases are regularly diagnosed in goats and on occasion in other species.

Vaccination is carried out in some sheep flocks and goat herds. The disease is not notifiable or reportable. The clinical signs of *Toxoplasma* infection in people are usually mild, however infection can be associated with serious sequelae including eye diseases and disability. People who are immunocompromised and pregnant women newly infected with *Toxoplasma gondii* are particularly vulnerable; in the latter, miscarriage, stillbirth and deformities of the child can occur.

The zoonotic agents discussed above are often of greater concern for vulnerable people such as the young, the elderly or the immunocompromised. And some agents such as *Toxoplasma gondii*, *Chlamydia abortus* and *Listeria monocytogenes* are of particular risk to pregnant woman and the unborn child.

To avoid the possible risk of infection pregnant women should:

• Not help ewes to lamb, or to aid with a cow that is calving or a nanny goat that is kidding.
• Avoid contact with aborted or new-born lambs, calves or kids or with the afterbirth, birthing fluids or materials (e.g. bedding) contaminated by such birth products.
• Avoid handling (including washing) clothing, boots or any materials that may have come into contact with animals that have recently given birth, their young or afterbirths. Potentially contaminated clothing will be safe to handle after being washed on a hot cycle.
• Ensure contacts or partners who have attended lambing ewes or other animals giving birth take appropriate health and hygiene precautions, including the wearing of personal protective equipment and clothing and adequate washing to remove any potential contamination.

Pregnant women should seek medical advice if they experience fever or influenza-like symptoms, or if concerned that they could have acquired infection from a farm environment. Farmers, livestock keepers and veterinarians have a responsibility to minimise the risks to pregnant women, including members of their family, the public, their staff and any students they may have with them.

35. Northern Ireland BVD Eradication, AFBI

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35.1. Overview

An industry led eradication programme for Bovine Viral Diarrhoea (BVD) managed by Animal Health and Welfare Northern Ireland (AHWNI) has been operating voluntarily in Northern Ireland since 2013, turning compulsory in March 2016.

The programme aims to remove BVD persistently infected (PI) cattle from the population through

- Testing of all new-born calves including those stillborn calves for the presence of BVD virus, primarily using ear notch samples taken at the time of ear tagging.
- Identification of cattle with non-negative BVD results and isolation of high infectious risk animals.
- Improving stakeholder knowledge of BVD and awareness of biosecurity principles through a continuous flow of information.
- Private veterinary practitioner involvement through the provision of herd test information, advice to herd owners and follow-up testing.
- Restrictions on the movement of non-negative animals (and a voluntary abattoir ban on the slaughter of BVD Positives).
- Voluntary removal of BVD Persistently Infected cattle.

In November 2023 BVD became a notifiable disease in Northern Ireland. This enhancement to the BVD eradication programme allows new infections and outbreaks to be identified at an early stage.

In 2023, 545812 animal tests were carried out with 1176 (0.22 *per cent*) returning an initial positive or inconclusive result. Due to the programme, the BVD animal incidence has reduced from 0.68 *per cent* in 2016 (March to December of the first year of the compulsory phase of the eradication programme) to 0.21 *per cent* in 2023 (Figure 35.1). This is a reduction of 69 *per cent*, showing that the measures in place have significantly reduced the BVD incidence in Northern Ireland.

Related to this the percentage of testing herds that had BVD positive animals has reduced from a peak of 9.63 *per cent* for the period March 2016 to Feb 2017 to 2.83 *per cent* in 2023 (Figure 35.2), a reduction of 71 *per cent*.

At the end of 2023, 98.18 *per cent* of all cattle alive in NI had an ascribed Negative or Indirect Negative BVD status. Of the animals born before the start of the compulsory phase approximately 1100 (0.07 *per cent*) did not have a direct or indirect (dam of a BVD negative calf) BVD status at the end of 2023.

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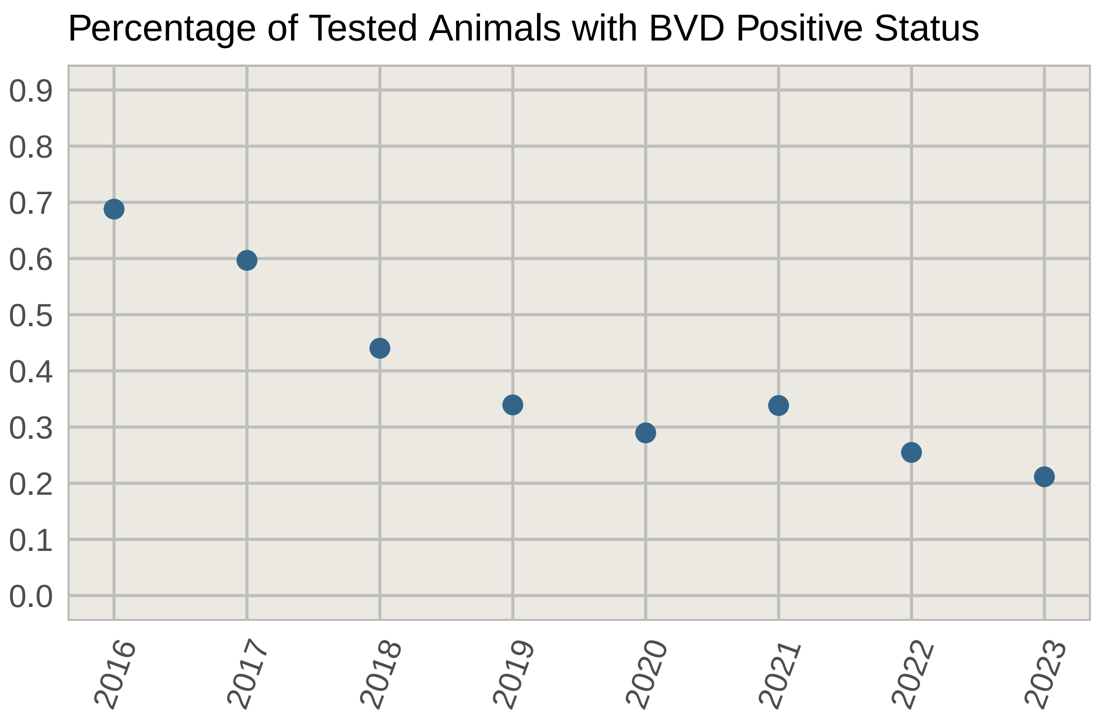

Figure 35.1.: Annual Incidence of Animals Disclosing as BVD Positive.

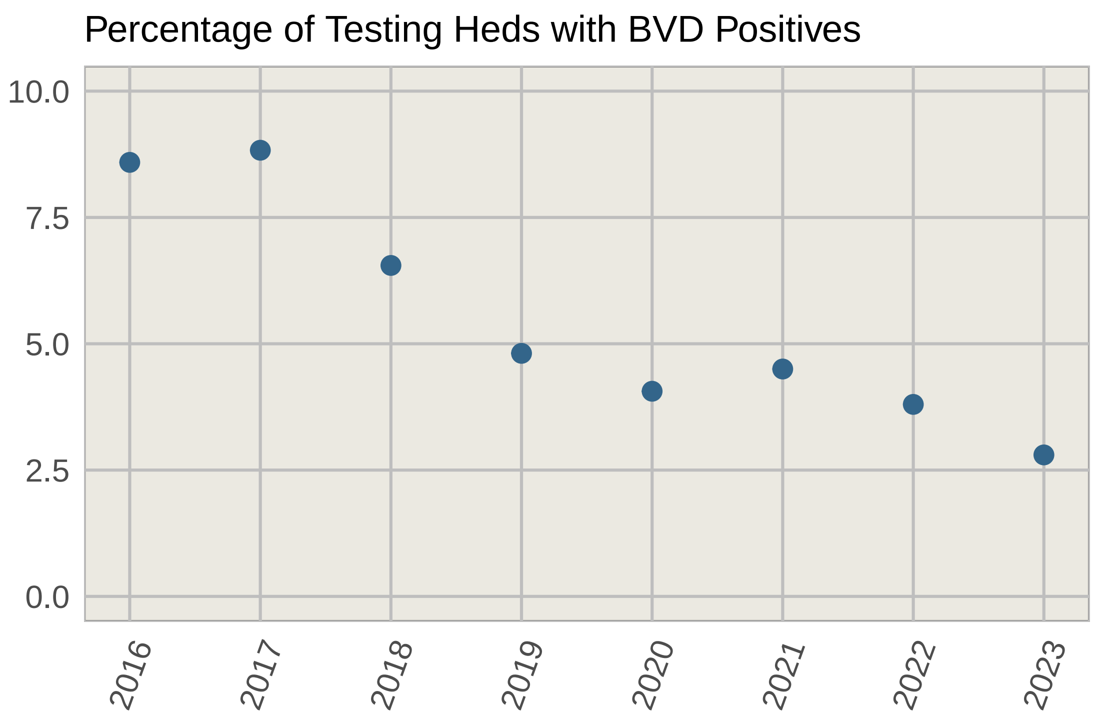

Figure 35.2.: Percentage of Testing Herds with BVD virus Positive Animals Disclosed Annually (2016 figures March – December).

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A. R packages

The analysis, construction of graphics and visualisation of data for this 2022 *All-Island Animal Disease Surveillance* report have been conducted by using the R programming language, R version 4.2.2 (2023-02-21) (R Core Team 2021), and Quarto[1] integrated development environment of Poxit](https://posit.co/).

Extensive use of the collection packages of the tidyverse universe[2] (Wickham et al. 2019,) and the LaTeX[3] systems were utilised in this report for formatting and typesetting the final HTML and LaTeX documents.

Most of the data analysis was carried out with the packages included in *tidyverse* (Wickham 2022b); the charts were plotted using the package *ggplot2* (Wickham 2016) and the tables constructed with *kableExtra* (Zhu 2021) and *finalfit* (Harrison, Drake, and Ots 2021).

Many other R packages and LaTeX packages were also used in the preparation and compilation of this report, for further information see the references below.

[1] https://quarto.org/
[2] https://joss.theoj.org/papers/10.21105/joss.01686
[3] https://www.latex-project.org/