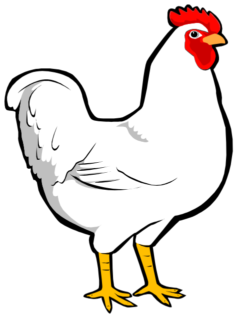
Animal & Plant Health Agency



SRUC

GB avian quarterly report

Disease surveillance and emerging threats

Volume 24: Q4 – October-December 2020

Highlights

- **Update on HPAI in the UK and Europe – page 3**
- ***Streptococcus equi* subspecies *zooepidemicus* in layers – page 7**
- **Runting and stunting syndrome in broiler chickens – page 8**
- **Short beak and dwarfism syndrome in ducks – page 11**

Contents

Editor: David Welchman
Phone: 02080 267640
Email: David.Welchman@apha.gov.uk

Introduction and overview

This quarterly report reviews disease trends and disease threats for the fourth quarter of 2020, October to December. It contains analyses carried out on disease data gathered from APHA, Scotland's Rural College (SRUC) Veterinary Services and partner post mortem providers and intelligence gathered through the Avian Expert Group. In addition, links to other sources of information including reports from other parts of the APHA and Defra agencies are included. A full explanation of how data is analysed is provided in the Annex available on GOV.UK.

https://www.gov.uk/government/publications/information-on-data-analysis

Issues & Trends

Industry trends – chick and poult placings

Broilers

There was a 7.6% increase in placings of broiler chicks from UK hatcheries during December 2020 compared with the available figure* for December 2019 (Figure 1), at 97.5 million chicks, representing an average of 22 million chicks per week for the quarter.

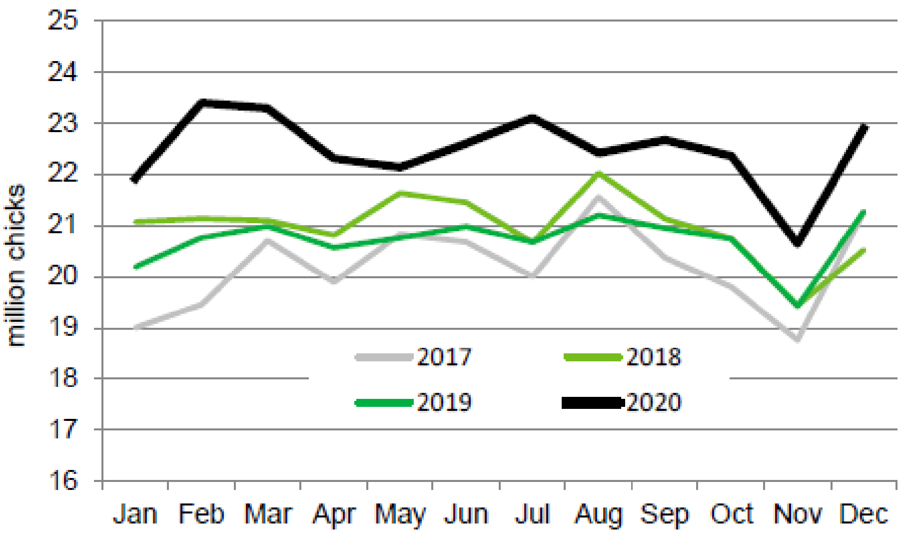


Figure 1 Average number of broiler chicks placed per week in the UK from UK hatcheries

Turkeys

There was an increase of 1.1% in the number of turkey poults placed during December 2020 compared with the available figure* for December 2019 (Figure 2), at 0.9 million, representing an average of 0.25 million poults placed per week for the quarter.

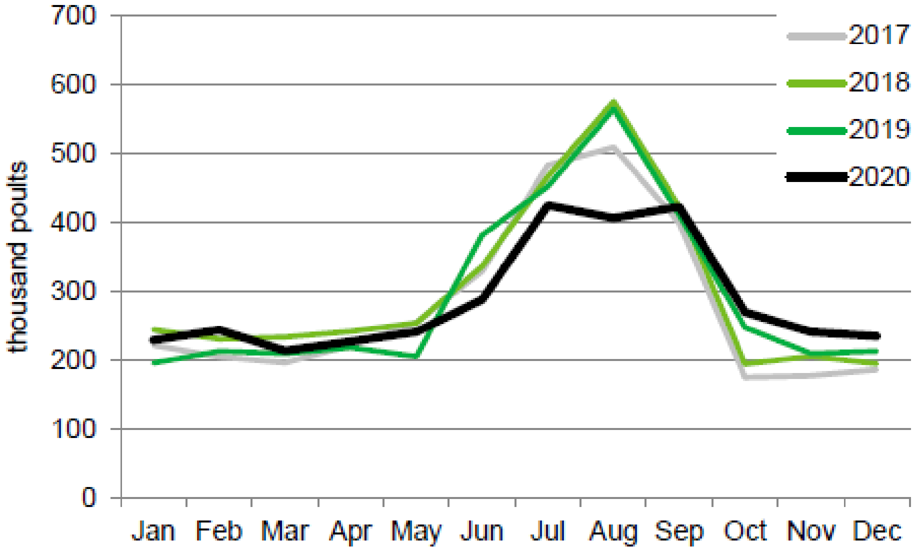


Figure 2 Average number of turkey poults placed per week in the UK by UK hatcheries

Layers

The number of layer chicks placed during December 2020 was 27.0% higher than the corresponding available figure* for December 2019, at 3.0 million chicks (Figure 3). UK packing station egg throughput in Q4-2020, at 8.0 million cases, was 2.3% higher than in Q4-2019 and 3.5% higher than Q3-2020. Free range eggs accounted for 55.6% of eggs packed in Q4-2020, compared with 52.6% in Q4-2019. Free range egg output during Q4-2020 exceeded enriched colony system output by 43.0%, similar to the previous quarter. Barn and organic production remained at low levels. Average UK farm gate prices for eggs in Q4-2020 were 0.6% higher than the preceding quarter, and 12.4% higher than Q4-2019.

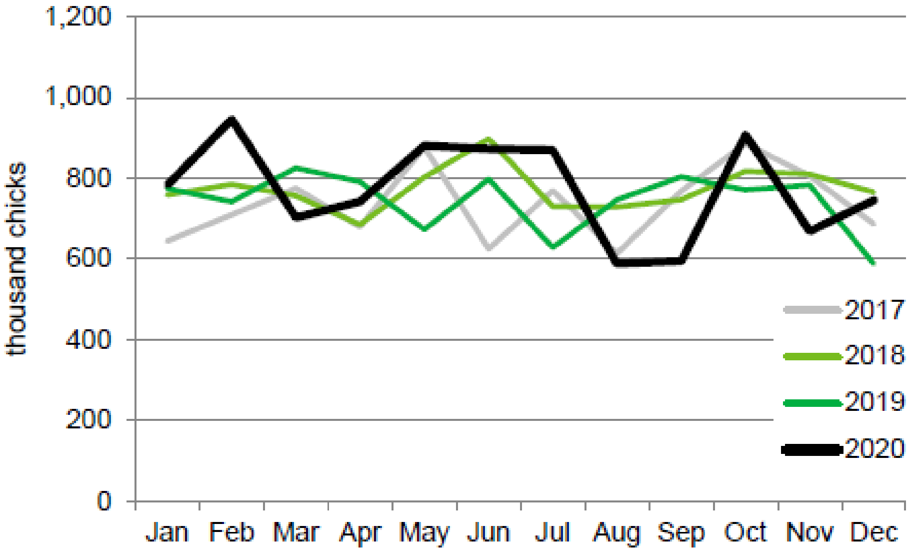


Figure 3 Average number of layer chicks placed per week in the UK by UK hatcheries

The poultry industry statistics are available online at:

Poultry and poultry meat statistics*:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/955279/poultry-statsnotice-25jan21.pdf [accessed 9 February 2021]

***There has been a change in the way the hatchery data have been collected in 2020 so that data from before January 2020 will not be directly comparable with data for January 2020 onwards.**

Egg statistics:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/956301/eggs-statsnotice-28jan21.pdf [accessed 9 February 2021]

New and re-emerging diseases and threats

Please refer to the annex on GOV.UK for more information on the data and analysis.

Highly Pathogenic Avian influenza (HPAI) in Europe

Several outbreaks of Highly Pathogenic Avian Influenza (HPAI) were confirmed in poultry in the UK during Q4-2020; there were 14 outbreaks of HPAI H5N8 in poultry, two outbreaks in captive birds (other than poultry) and one case of HPAI H5N1 in backyard chickens. Up to 4 January 2021 there were 280 cases of HPAI in wild birds in the UK, comprising 262 cases of HPAI H5N8, five cases of HPAI H5N1, six cases of HPAI H5N5 and seven awaiting full typing (H5Nx) (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/949894/hpai-europe-update-11-210105.pdf)

Situation update to 15 February 2021

At the time of writing there have been 22 outbreaks of HPAI in poultry and/or captive birds in the UK since November 2020, of which 20 have been H5N8 and two have been H5N1. The first case in the UK was confirmed on 3 November in broiler breeder chickens, and other cases have been confirmed in turkeys, ducks, gamebirds, backyard birds and captive birds other than poultry. All outbreaks have been reported to the OIE and where disease is confirmed, measures have been put in place in accordance with Council Directive 2005/94/EC. The outbreaks are summarised in the International Disease Monitoring (IDM) Updated Outbreak Assessment dated 15 February 2021: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/962780/Highly_pathogenic_avian_influenza__HPAI__in_the_UK__and_Europe_15_February_2021.pdf

There have also been 310 outbreaks of HPAI in wild birds in the UK, comprising 284 cases of H5N8, 10 of H5N1, six of H5N5, one of H5N1 and nine of H5Nx. The largest number of cases (176) have been in mute swans (*Cygnus olor*), followed by other swans and geese. Thirteen cases have been identified in raptors. Only two cases have been identified in ducks, one each in a common shelduck (*Tadorna tadorna*) and a Eurasian wigeon (*Mareca penelope*). In contrast, in mainland Europe there have been larger numbers of confirmed cases in barnacle geese (*Branta leucopsis*) and greylag geese (*Anser anser*), particularly early in the course of the outbreaks.

The initial findings of HPAI in wild birds in the UK, of H5N8 HPAI, were from the first week of November onwards, in four Canada geese (*Branta canadensis*) and a greylag goose (*Anser anser*) which were found dead in Gloucestershire and reported on 2 November. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/936805/ai-findings-2020.csv/preview

There have also been a large number of confirmed outbreaks of HPAI in poultry, captive and wild birds in **Western Europe** (Figure 4). In the period 8-15 February these included outbreaks in Austria (H5N1 and H5N3 in wild birds), Denmark (H5N3 and H5N8 in wild birds), France (H5N8 in wild birds), Germany (H5N8 in poultry), Luxemburg (H5N8 in poultry) as well as outbreaks in Northern and Eastern Europe. Outbreaks occurring up to 17 November 2020 were summarised in the previous quarterly report (APHA 2020a). The distribution of confirmed cases in Europe up to 15 February and the relation to wild bird migration flyways is shown in Figure 4.

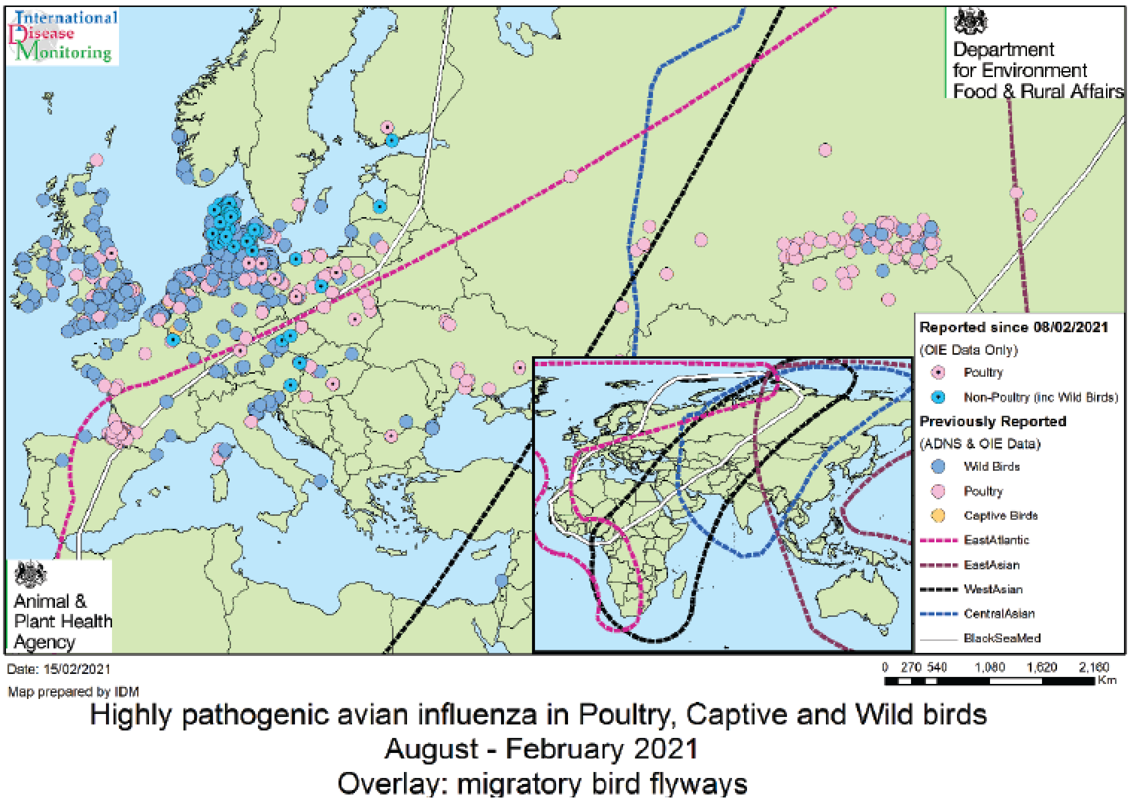


Figure 4 Outbreaks of highly avian pathogenic influenza in poultry, captive and wild birds in Europe and western Asia between August 2020 and up to 15 February 2021. The migration flyways are shown as dotted lines, with the UK being in the East Atlantic flyway

The outbreaks in western Europe followed a series of detections of H5N8 HPAI in poultry and wild birds in southern Russia (described in the IDM preliminary outbreak assessment dated 4 September,
https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/915180/poa-avian-influenza-H5N8-russia-Sep20.pdf and the neighbouring part of Kazakhstan, and the strains are genetically closely related. Public Health England has confirmed that the risk to public health is very low and the Food Standards Agency has said that avian influenza does not pose a food safety risk for UK consumers.

The IDM Updated Outbreak Assessment dated 15 February, referred to above, notes that "The detection of four HPAI H5 subtypes [H5N8, H5N5, H5N1 and H5N3] in the same epidemic event is unparalleled in the UK. All these viruses are genetically closely related through their H5 haemagglutinin gene, which is the key viral gene influencing pathogenesis, host range, transmission, and host immunity. Continued virus change by genetic reassortment in wild birds is not unexpected, and further genetic variation at genome level may be expected as the epidemic progresses. Surveillance within the disease control zones continues, and results of investigations will be published in a comprehensive epidemiological report.'

'The migration season for wild waterfowl to overwinter in the UK has ended. A large population of migratory waterfowl are still present and will not be leaving the UK until March/April. Moreover, the higher survival rate of the virus in the environment during winter means the risk of environmental transmission remains, and hence the continued risk of secondary spread into indigenous UK wild bird species.' "

It concludes "The risk of HPAI incursion in wild birds in GB remains **VERY HIGH**. The overall risk of exposure of poultry in GB remains **MEDIUM** (with stringent biosecurity) **TO HIGH** (where biosecurity is not adequate).'

'An Avian Influenza Prevention Zone is in place in England, Scotland and Wales and the UK Chief Veterinary Officer, alongside the CVOs from Scotland, Wales and Northern Ireland are urging bird keepers across the UK to take additional biosecurity measures; in order to prevent further outbreaks of avian influenza in the UK.'

'It is a legal requirement for all bird keepers to keep their birds indoors and to follow strict biosecurity measures in order to limit the spread of and eradicate the disease. These housing measures build on the strengthened biosecurity regulations that were brought in as part of the Avian Influenza Protection Zone (AIPZ) on 11 November 2020.'

'If you keep poultry (including game birds or as pets), you should follow our biosecurity best practice advice, which can be found here:
https://www.gov.uk/guidance/avian-influenza-bird-flu#biosecurity-advice Remain vigilant for any signs of disease in your flock and report any sign of avian influenza to Defra Rural Services Helpline on 03000 200 301.'

'Further information is available here: https://www.gov.uk/guidance/avian-influenza-bird-flu https://gov.wales/avian-influenza http://gov.scot/avianinfluenza including updated biosecurity advice for poultry keepers for England; for Wales; and for Scotland.' ”

The gene sequences of the current strains of H5N8 HPAI circulating in Western Europe are distinct from the H5N8 HPAI detected in Bulgaria earlier in 2020, referred to in the previous quarterly report (APHA 2020a) and indicate a separate introduction and evolutionary history, and are also distinct from those detected in the UK in 2016-2017 (https://science.vla.gov.uk/flu-lab-net/docs/H5_SituationReport_021120.pdf). A phylogenetic tree of H5N8 strains is provided in this report.

Low Pathogenicity Avian Influenza

One outbreak of **notifiable** Low Pathogenicity Avian Influenza (LPAI) H5N2 was identified in Q4-2020 in the UK, as described in the previous quarterly report (APHA 2020a).

Avian notifiable disease exclusion testing scheme ('Testing To Exclude', TTE, Testing For Exclusion) in Great Britain (GB)

The scheme started in May 2014 (Gibbens and others 2014) and is ongoing (http://apha.defra.gov.uk/vet-gateway/tte/nad.htm ; accessed 24 February 2021). There was one exclusion testing investigation during Q4-2020, relating to egg drop in breeding poultry, in the absence of other signs. Cloacal and oropharyngeal swabs were tested and gave negative M-gene (AI virus) PCR results. Avian notifiable disease was therefore excluded.

The scheme is very valuable in enabling possible LPAI to be investigated where it is considered to be a differential diagnosis for the clinical signs seen in birds on a site. The scheme currently only applies to chickens and turkeys.

Differential diagnosis of negated notifiable disease report cases in GB

This scheme was introduced in autumn 2018 to offer differential diagnostic testing through APHA and its partners in cases where suspicion of Notifiable Avian Disease (NAD) has been reported and are subsequently negated on either clinical grounds or by laboratory testing. The scheme is also available for TTE cases referred to above where NAD has been ruled out by laboratory testing. The scheme is described in more detail by Welchman and others (2019).

One differential diagnostic investigation was carried out, in a small layer flock in which suspicion of notifiable disease had been reported following the deaths of birds after showing respiratory signs. Following negation of notifiable disease, post-mortem examination of an affected bird by APHA showed lesions suggestive of infectious laryngotracheitis (ILT) and the disease was confirmed by demonstration of typical syncytia and intranuclear inclusion bodies in the trachea and lung.

Pigeon paramyxovirus investigations

There were three submissions of material tested for Pigeon Paramyxovirus-1 (pAAvV-1, formerly PPMV-1)) at APHA Weybridge during Q4-2020, all of which were from birds submitted as report cases. PAAvV-1 was detected by PCR in samples from two of these submissions, in one of which the virus was isolated, all in December.

Other diseases

Experimental infection of turkeys, chickens and chicken embryos with SARS-CoV-2

SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus-2), a beta coronavirus, is the aetiological agent of Coronavirus Disease-19 (COVID-19) which emerged in 2019 and has caused a major public health emergency across the world. Given the severity of this disease in people, it is important to investigate the susceptibility of production animals, including poultry, for their susceptibility to this newly emerged virus. A recent paper by Berhane and others (2020) describes the experimental infection of poultry with SARS-CoV-2. Briefly, four-to-six-week old chickens and turkeys were infected by the conjunctival, oral and nasal routes with a SARS-CoV-2 derived from a person with the disease early in the pandemic. The birds were checked for signs of disease and shedding of virus. None of the birds developed any clinical signs and no virus was detected in any of the oral or cloacal swabs during the study period of 12 days. All the viscera collected on days 3, 5 and 7 post-infection were negative for virus using real time PCR. Furthermore, no virus neutralising antibodies were detected in any of the turkeys and chickens on days 7, 14 and 21 days post-infection. These data further support the work of other investigators that chickens and turkeys are not susceptible to SARS-CoV-2.

In addition, embryonated eggs were inoculated by various routes on Day 6, 9 and 11, monitored for embryonal survival and tissues checked by PCR for the presence of the virus. Whilst the RNA which was inoculated into the eggs persisted during the first and second passage, the virus was not found to be viable when checked in cell culture. The finding that embryonated eggs do not support viral replication has also been shown by other authors (Swayne and others 2004; Barr and others 2020).

While the studies on SARS-CoV-2 are ongoing around the world, the data available from laboratories indicate that this virus does not infect chickens and turkeys. This reinforces the conclusion reached following earlier research as summarised in the Q1-2020 report published last year (APHA 2020b).

Unusual diagnoses

Streptococcus equi subsp. zooepidemicus in layer chickens

Rising mortality was reported in a free-range layer flock of 28,000 birds at 69 weeks of age, and reached a peak of approximately 100 deaths a day. Initially the birds were medicated with trimethoprim and sulfamethoxazole but the situation did not improve. Post-mortem examinations by the private veterinary surgeon showed a caseous, exudative peritonitis in all the birds examined, and bacteriological culture resulted in the identification of *Streptococcus equi* subsp. *zooepidemicus*. A culture was not available for further characterisation. Following the diagnosis, mortality was markedly reduced after treatment with a penicillin product. The litter was reported to be dry and loose, and egg quality was normal. Egg production remained stable, although it had never been a high performing flock. Food and water intake had been stable. When walking the sheds, most birds looked fine but a few were hunched up and lethargic, and affected birds died very quickly. It is understood that the owner apparently kept horses but it was unsure whether they had ever had access to the ranging area of if any horse manure had ever been spread on it. The owner was advised of the potential zoonotic implications of this organism.

S. equi subsp. *zooepidemicus* is an opportunist pathogen found on the mucous membranes of horses and can cause disease both in horses, humans and animals including poultry. It has rarely been confirmed by APHA in poultry in the UK. A recent report described high mortality in a 44-week-old free range layer flock on a farm in Belgium where calves and horses were also kept (Garmyn and others 2020). A range of lesions were reported including fibrinous peritonitis. Bacterial culture demonstrated both *S. equi* subsp. *zooepidemicus* in septicaemic distribution and co-infection with *E. coli*. *S. equi* subsp. *zooepidemicus* was not detected in nasal or vaginal mucosal samples taken from the horses on the farm (although the authors indicate that false negative results could not be excluded), but the organism was identified in large numbers in the caecum of a healthy chicken on the farm. This suggested the possibility of faecal transmission of the organism in chickens, and also the possibility of asymptomatic carriage in a chicken.

Changes in disease patterns and risk factors

Runting and stunting syndrome in broiler chickens

Runting and stunting (RS) is a well-recognised problem of the broiler industry in Great Britain and around the world. The syndrome is characterised by enteric disease resulting in poor growth and an uneven flock. Whilst the morbidity is high and many birds may need to the culled out, the condition is usually not associated with significant mortality. Due to reduced growth rate and poor feed conversion, RS results in significant losses for the broiler industry throughout the world.

Multiple factors contribute to the occurrence of RS: chick quality and good management of the young chick are paramount for correct development of the alimentary tract and hence the whole bird. In addition, a number of infectious agents have been associated with RS, most commonly rotaviruses, parvoviruses, astroviruses and reoviruses.

In a recent paper from Brazil, de Oliveira and others (2021) investigated the presence of viruses in RS-affected broiler chickens between 0 and 11 days of age. The strength of their study is that they used histological examination which allowed them to differentiate between birds with lesions attributable to RS and those birds without lesions within the same flock. Histopathology of small intestine from affected birds was characterised by abnormalities of the crypts and villous stunting. Initially, the authors performed next generation sequencing for RNA and detected avian nephritis virus and Group F and D rotavirus in chicks both with and without histological lesions whereas there was an association between picornavirus detection and histological lesions. Further analysis of the picornavirus RNA showed it to be a novel chicken Gallivirus. Galliviruses have been detected throughout the world, but their clinical significance is still under investigation.

In the UK, colleagues from Northern Ireland have carried out an extensive genetic analysis of the viriome of RS-affected and RS-unaffected chickens between the ages of 13 and 21 days (Devaney and others 2016). The authors found a large number of known and unknown viruses, in particular picornaviruses, Astroviridae, Caliciviridae and Parvoviridae were commonly detected in RS affected broilers. Whilst there were some differences between affected and unaffected chickens, more work is required to determine role of the various viruses for the UK broiler industry. Similar investigations have been carried out in other parts of the world.

APHA regularly receives samples for histopathology from the gastrointestinal tract of broilers with a history of gastrointestinal disease (Table 1). We have not received any gastrointestinal samples from birds younger than 8 days during the last three calendar years. This is likely to be due to the fact that the effects of RS and other gastrointestinal diseases usually become apparent after the acute phase of the disease has passed in the first few days of life, or are seen during post-mortems carried out as part of routine health screens. A coccidial challenge is the most common enteric condition recorded in broilers, particularly in birds between 19 and 33 days of age (data not shown). Interestingly, one feature which has been increasingly recorded in small intestinal samples over the last three years are changes in crypt appearance (Table 2), sometimes associated with some villous atrophy. Whilst this observation is by no means specific, it has been associated with intestinal viral infections, particularly in younger birds and the pathology detected is comparable with the one described by de Oliveira and others (2021).

Age	2018	2019	2020	2018-20 overall
8-12 d	48.3%	27.3%	66.7%	49.0%
13-15 d	65.4%	38.8%	73.2%	56.9%
16-20d	71.0%	49.5%	57.6%	58.0%
> 21d	55.9%	40.9%	47.8%	47.5%
Grand Total	58.4%	41.4%	53.5%	50.2%

Table 1 Broiler submissions to APHA for the investigation of gastro-intestinal health by age group in 2018-2020 as a percentage of all submissions for that age group and year

Age group	2018	2019	2020	2018-20 overall
8-12 d	nd	11.1%	53.6%	31.4%
13-15d	17.6%	21.1%	20.0%	19.7%
16-20d	2.0%	2.0%	10.2%	4.7%
> 21d	1.2%	0.0%	1.4%	0.8%
Grand Total	2.4%	2.5%	11.2%	5.4%

Table 2 Broiler submissions with crypt pathology observed at histopathology as a percentage of submissions received in 2018-2020 for the investigation of gastrointestinal health in broilers between 8 and 42 days of age

Whilst APHA does not currently carry out molecular analysis of intestinal content or histological material as a routine test, the Agency does offer electron microscopy on intestinal/faecal samples. During the last three years, 295 samples from chickens were examined for virus particles (Table 3). Rotavirus particles were by far the most common virus detected in those samples. Unfortunately, the age and production details of those samples were not available and we are working on improving the data collection system. However, the data give a good overview of the viruses currently circulating in British chickens, although the virus may not always be significant particularly in older chickens.

Overall, the data show that intestinal health is an important issue detected and investigated in British boiler chickens. There is a trend of an increase in potentially viral associated enteritides in young broiler chicks, although this may be due to the fact that we are encouraging the submission of samples earlier in the production cycle to detect potential viral causes of RS.

Result	2018	2019	2020	% of total
Rotavirus detected	39.5%	28.9%	25.3%	31.9%
Calicivirus detected	1.8%	1.1%	1.1%	1.4%
Enterovirus detected	0.9%	2.2%	2.2%	1.7%
Parvovirus-like particles detected	-	-	1.1%	0.3%
Reovirus detected	-	5.6%	-	1.7%
Reovirus-like particles detected	-	-	-	0.3%
Rota/Enterovirus-like particles detected	-	-	1.1%	0.3%
No virions detected	57.0%	62.2%	69.2%	62.4%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Table 3 Results of electron microscopy (EM) on intestinal and faecal samples from chickens as a percentage of the samples examined in 2018-2020 (no details on production or age are available)

Horizon scanning

Short beak and dwarfism syndrome in ducks caused by novel Goose Parvovirus (nGPV)

Short beak and dwarfism syndrome (SBDS) is a disease which has been recognised in mule ducks (*Anas platyrhynchos x Cairina moschata)* in Europe and elsewhere since the 1970s although it has apparently not been reported in the UK. As the name suggests SBDS is characterised by relative short beaks, often with protruding tongues, and growth retardation. The condition is usually observed in two- to four-week old ducks frequently associated with feather abnormalities. Enteritis which often precedes the typical clinical signs can be observed as early as 4-7 days of age.

The syndrome is caused by a water fowl parvovirus. Based on phylogenetic analysis, these parvoviruses can be divided into two main groups: Goose Parvoviruses (GPV) and Muscovy Duck Parvovirus (MDPV). Classical GPV is the causative agent of Derzsy's disease in young goslings and muscovy ducks (*Cairina moschata)*. GPV was detected in the early cases of SBDS, although it has been recognised since 2009 that the GPV from mule ducks with SBDS was different from the one causing Derzsy's disease in goslings and muscovy ducks (Palya and others 2009). In the same paper, the authors showed that SBDS could not be reproduced with the classical GPV strain from a Derzsy's disease case.

Since 2015, SBDS has been reported as a significant disease in Chinese domestic ducks (*Anas platyrhynchos domestica*) where it has resulted in severe economic losses (Chen and others 2016a). Further studies of the disease observed revealed that the condition was caused by a novel Goose Parvovirus (nGPV) (Chen and others 2015; Chen and others 2016b). A novel duck picornavirus (nDPiV) has also been isolated from domestic ducks in China with SBDS, but its role still needs to be investigated (Li and others 2021). In many instances, SBDS-affected ducks are also infected with a duck circovirus.

In a recent paper, Matczuk and others (2020) described the investigation of the disease and virological findings of SBDS in eight Polish flocks of Pekin ducks (*Anas platyrhynchos domestica*) in 2019 and 2020. The clinical signs included difficulty in moving and feeding from 7-10 days of age. At around 3-4 weeks, typical shortening of the beaks and unevenness of the flock were detected. Morbidity varied between 15 and 40% with a mortality ranging from 4 to 6%. GPV was detected by PCR in samples of pooled liver/spleen or cloacal swabs. Molecular analysis showed that the Polish GPV is distinct from the classical strains causing Derzsy's disease and grouped together with the Chinese nGPV. Interestingly, the Chinese and the Polish nGPV formed two distinct clusters within this group. Furthermore, the Polish strains clustered together with a strain which was initially isolated from a French mule duck with SBDS in 2002 and characterised by Palya and others (2009). Unfortunately, no other European strains of GPV were available for comparison. In six of the outbreaks, duck circovirus was also detected, one flock was negative for this virus and, in another, testing was not carried out. During 2019 and 2020, similar outbreaks were described in Egyptian mule and Pekin ducks (Soliman and others 2020). On phylogenetic analysis, the Egyptian nGPV clustered in a separate group from the Chinese strains. A phylogenetic analysis including both the European and Egyptian strains has not yet been published.

In summary, SBDS is present in both mule and domestic ducks in Europe and the causative agent is nGPV. Whilst the duck industry is relatively small in the UK, it is useful to be aware of this condition in the event of its occurrence in the UK.

References

APHA (2020a) GB Avian quarterly report – Disease surveillance and emerging threats, vol 24, Q3 (July-September 2020) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/949745/pub-survrep-a0320.pdf

APHA (2020b) GB avian quarterly report – Disease surveillance and emerging threats, vol 24, Q1 (January-March 2020) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/889973/pub-survrep-a0120.pdf

Barr, I G, Rynehart, C, Whitney, P, Druce, J. SARS-CoV-2 does not replicate in embryonated hen's eggs or in MDCK cell lines. *Eurosurveillance* 2020; 25: 2001122

Berhane, Y, Suderman, M, Babiuk, S, Pickering, B. Susceptibility of turkeys, chickens and chicken embryos to SARS-CoV-2. *Transbound Emerg Dis* 2020; https://onlinelibrary.wiley.com/doi/full/10.1111/tbed.13970

Chen, S, Wang, S, Cheng, X, Xiao, S, Zhu, X, Lin, F, Wu, N, Wang, J, Huang, M, Zheng, M, Chen, S, Yu, F. Isolation and characterization of a distinct duck-origin goose parvovirus causing an outbreak of duckling short beak and dwarfism syndrome in China. *Arch. Virol.* 2016a; 161: 2407-2416

Chen, H, Dou, Y, Tang, Y, Zhang, Z, Zheng, X, Niu, X, Yang, J, Yu, X, Diao, Y. Isolation and Genomic Characterization of a Duck-Origin GPV-Related Parvovirus from Cherry Valley Ducklings in China. *PLoS One* 2015; 10: e0140284

Chen, H, Dou, Y, Tang, Y, Zheng, X, Niu, X, Yang, J, Yu, X, Diao, Y. Experimental reproduction of beak atrophy and dwarfism syndrome by infection in cherry valley ducklings with a novel goose parvovirus-related parvovirus. *Vet. Microbiol.* 2016b; 183: 16-20

Garmyn, A, Van de Velde, N, Braeckmans, D, Ronsmans, S, Boyen, F, Verlinden, M. (2020) An Outbreak Associated with *Streptococcus equi* Subsp. *zooepidemicus* in Layers: Evidence of Fecal Transmission. *Avian Dis.* 2020; 64: 343-346

Gibbens, N., Brown, I.H. & Irvine, R.M. (2014) Testing for exclusion of notifiable avian disease. *Veterinary Record* 174, 534-535

Li, C, Shan, T, Chen, Z, Zhou, J, Li, H, Tong, G, Liu, G. Isolation and complete genome analysis of a novel duck picornavirus in China. *Vet. Microbiol.* 2021; 253: 108950

Matczuk, A K, Chmielewska-Władyka, M, Siedlecka, M, Bednarek, K J, Wieliczko, A. Short Beak and Dwarfism Syndrome in Ducks in Poland Caused by Novel Goose Parvovirus. *Animals (Basel)* 2020; 10:

Palya, V, Zolnai, A, Benyeda, Z, Kovacs, E, Kardi, V, Mato, T. Short beak and dwarfism syndrome of mule duck is caused by a distinct lineage of goose parvovirus. *Avian pathology : journal of the W.V.P.A* 2009; 38: 175-180

Soliman, M A, Erfan, A M, Samy, M, Mahana, O, Nasef, S A. Detection of Novel Goose Parvovirus Disease Associated with Short Beak and Dwarfism Syndrome in Commercial Ducks. *Animals (Basel)* 2020; 10:

Swayne, D E, Suarez, D L, Spackman, E, Tumpey, T M, Beck, J R, Erdman, D, Rollin, P E, Ksiazek, T G. Domestic Poultry and SARS Coronavirus, Southern China. *Emerging Infectious Disease journal* 2004; 10: 914

Welchman, D., Hansen, R. & Schock, A. (2019) Differential diagnosis of negated avian notifiable disease cases in Great Britain. *Veterinary Record* 184, 276, http://dx.doi.org/10.1136/vr.l938

This publication is available at:

https://www.gov.uk/government/collections/animal-disease-surveillance-reports

Any enquiries regarding this publication should be sent to us at SIU@apha.gov.uk

http://apha.defra.gov.uk/vet-gateway/surveillance/index.htm

The Animal and Plant Health Agency (APHA) is an executive agency of the Department for Environment, Food & Rural Affairs, and also works on behalf of the Scottish Government and Welsh Government.