

SURVEILLANCE OF INFECTIOUS DISEASES IN ANIMALS AND HUMANS IN SWEDEN 2017



Editors: Ann Lindberg, Thomas Rosendal

Department of Disease Control and Epidemiology, National Veterinary Institute (SVA), SE-751 89 Uppsala, Sweden.

Authors: Anton Andreasson, Charlotte Axén, Mia Brytting, Jonas Carlsson, Erika Chenais, Arianna Comin, Helena Eriksson, Linda Ernholm, Eva Forsgren, Gittan Gröndahl, Gunilla Hallgren, Gete Hestvik, Marika Hjertqvist, Mia Holmberg, Helena Höök, Cecilia Hultén, Cecilia Jernberg, Jerker Jonsson, Pontus Juréen, Elina Lahti, Ann Lindberg, Mats Lindblad, Ylva Lindgren, Emma Löf, Margareta Löfdahl, Anna Lundén, Marie Jansson Mörk, Oskar Nilsson, Maria Nöremark, Faruk Otman, Karin Persson-Waller, Moa Rehn, Thomas Rosendal, Christoffer Sjölund, Kaisa Sörén, Karl Ståhl, Lena Sundqvist, Magnus Thelander, Kerstin de Verdier, Catrin Vesterlund-Carlson, Helene Wahlström, Anders Wallensten, Per Wallgren, Stefan Widgren, Elsie Ydring, Beth Young, Nabil Yousef, Siamak Zohari, Erik Ågren

Cover Photo: Karin Bernodt

Copyright of map data: ©EuroGeographics for the administrative boundaries

Layout: The production of this report continues to be accomplished using a primarily open-source toolset. The method allows the source text, produced by authors, to be edited independently of the template for the layout which can be modified and reused for future reports. Specifically, the chapter texts are authored in Microsoft Word and then converted using pandoc to the LaTeX typesetting language. All figures and maps are produced using R software for statistical computing. Development for 2017 further formalised the report generation tool in an R-package available on GitHub which has streamlined the report building and integrates quality control into the process. The report generating toolset and process was designed and written by Thomas Rosendal and Stefan Widgren.

Print: TMG Tabergs AB.

Printing and part of the production was financed by the Swedish Board of Agriculture. Text, tables, figures and maps may be cited and reprinted only with reference to this report.

Suggestion citation: Surveillance of infectious diseases in animals and humans in Sweden 2017, National Veterinary Institute (SVA), Uppsala, Sweden. SVA:s rapportserie 52 ISSN 1654-7098.

This report may be subject to updates and corrections. The latest version is always available for download at www.sva.se.

Contents

Introduction	3	Listeriosis	50
Overview of active surveillance 2009-2017	4	Maedi-visna	53
Livestock population and trade in live animals	5	Nephropathia epidemica	55
Animal registers and datasources used in surveillance	9	Paratuberculosis	57
Institutions, organisations and laboratories involved in monitoring	10	Porcine reproductive and respiratory syndrome	60
Disease Surveillance 2017	13	Psittacosis	62
Atrophic rhinitis	14	Q fever	63
Aujeszky's disease	15	Rabies	65
Bluetongue	17	Salmonellosis	67
Bovine spongiform encephalopathy	19	Scrapie	79
Bovine viral diarrhoea	21	Strangles	81
Brucellosis	23	Tick borne encephalitis	83
Campylobacteriosis	25	Trichinellosis	85
Chronic wasting disease	29	Tuberculosis	87
Classical swine fever	31	Tularaemia	90
Coccidiosis and clostridiosis	33	Verotoxinogenic <i>Escherichia coli</i>	92
Echinococcosis	34	Yersiniosis	96
Alveolar echinococcosis	34	Additional Surveillance 2017	99
Cystic echinococcosis	36	Clinical surveillance	100
Enzootic bovine leucosis	37	Poultry health control programme	103
Footrot	38	Infectious diseases in wild boars	106
Infectious bovine rhinotracheitis	40	Infectious diseases and parasites in honeybees	108
Influenza	41	Infectious diseases in fish crustaceans and molluscs	112
Avian influenza	41	Examinations of abortions in food producing animals	116
Swine influenza	45	Post mortem examinations in food producing animals	117
Leptospirosis	48	Post mortem examinations in wildlife	120
		Antimicrobial resistance in bacteria from animals and food	122

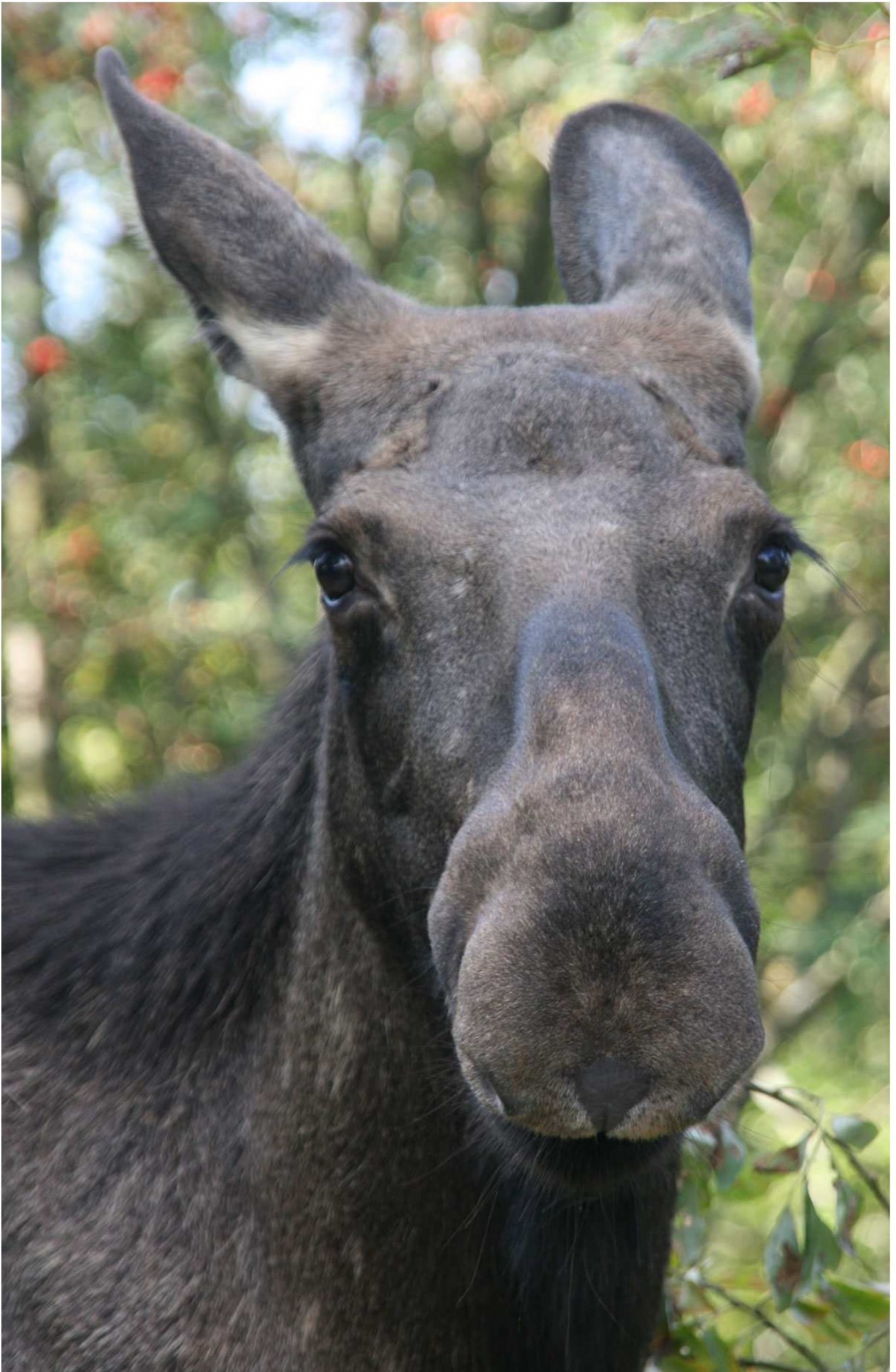


Photo: Karin Bernott

Introduction

Surveillance of infectious diseases in animals and humans 2017 is the annual report on surveillance activities carried out in Sweden during the year, and their output. The report covers surveillance for important animal diseases and zoonotic agents in humans, food, feed and animals, carried out and compiled by public and private actors with surveillance mandates along the entire food chain, from stable to table.

The report is subject to constant improvement and development. This year we have introduced a chapter which provides a 10-year retrospective overview of active surveillance, as well as a new chapter on strangles; a disease which is endemic in horses in Sweden and constitutes a recurring threat to the horse industry. Furthermore, a chapter on infectious diseases and parasites in honeybees has been added to describe the extensive activities conducted to maintain a good health status in this important animal species.

The information generated by animal disease surveillance is of key importance to demonstrate the good health and welfare of Swedish animals. Some benefits of surveillance activities are inherent, such as the prevention of animal disease and promotion of public health. However, many surveillance activities are in place primarily to ensure safe trade and movement of animals, thereby facilitating trade and giving access to foreign markets. This is also where the major costs can appear as a result of outbreaks of regulated diseases; by the restrictions put in place to maintain trust between trading partners. Consequently, to reinstate a favourable status it is necessary to provide evidence of high quality surveillance data that the disease is once again absent from the country, region or sector, or at least under control.

Surveillance activities require resources for planning and design as well as for implementation, to organise the of the collection of samples or other types of data from different groups in a representative way; to identify and use accurate and timely diagnostics; and finally, to analyse the data and communicate it to relevant stakeholders for decision making. Investments in surveillance are costly, and may be difficult to justify, in particular when the disease burden or the perceived threat is low. This is sometimes referred to as the “good health status paradox”, where it is challenging to motivate investments to maintain a favourable disease situation. Surveillance investments are similar to insurance in that the benefit accrues in the appearance of negative events. Therefore, a national surveillance plan is being put in place with the purpose to ensure that long-term needs to maintain a favourable situation are balanced with more short-term needs to manage emerging issues.

Surveillance activities also have to evolve to incorporate new diagnostic methods, new knowledge of the disease and

new technology for information capture and analysis. Several national and international projects are currently running where the developments will contribute to more efficient surveillance in the future. Of particular importance is a 5-year One Health European Joint Programme (OHEJP) that, from the Swedish side, involves both the National Veterinary Institute (SVA), the National Food Agency and the Public Health Agency of Sweden. The first two integrative projects launched under this programme focus on improving the interoperability of animal and public health surveillance systems, as well as the capacity to conduct joint risk assessments. The Swedish partners in these projects receive co-funding from the Swedish Civil Contingencies Agency, who supports the development of crisis preparedness within the Swedish food chain. Research into new innovative surveillance methods is also underway within the OHEJP, with SVA as coordinator.

The need for further strengthening an integrated One Health surveillance and response in Sweden can be exemplified by the large outbreak of human campylobacteriosis, which started in 2016 and lasted into 2017. The coordinated and joint collection, isolation and subtyping of isolates from humans, animals and chicken meat provided a richer understanding of the associations, and contributed strongly to triggering the necessary action.

Also in focus during 2017 was the planning for surveillance of Chronic Wasting Disease (CWD), which appeared for the first time in Europe in early 2016, in Norway. Surveillance targeting fallen and road-killed wildlife as well as clinical suspicions is in place, and during 2018 additional surveillance components targeting deer populations entering the food chain are being implemented. Other examples where wildlife surveillance is of great importance for early warning and protection of domestic populations are African Swine Fever (ASF) and highly pathogenic avian influenza (HPAI). The former advanced into new European territory during 2017, and has continued to spread during 2018. Measures to prevent further spread are now imperative, with the aim to increase awareness among the public as well as to engage the hunting community to strengthen the capacity for early detection.

As an EU member state, Sweden shares the implications and consequences of exotic disease introduction with many other European countries. We are part of a pan-European surveillance system, where our efforts contribute, directly and indirectly, to the understanding of risks that emerging diseases pose to other EU countries. Openness, transparency and pro-activeness are key for effective early warning and control, and it is important for trust and for joint European preparedness to which we actively contribute. In line with this, our understanding of the Swedish disease situation in 2017 is provided in this report.

Overview of active surveillance 2009-2017

BACKGROUND

Since 2009, Sweden has reported the outcome of its active surveillance programmes in an annual report on surveillance of infectious diseases in animals and humans. This yearly description of active disease surveillance programmes is important as it contributes to the international community's understanding of how Sweden's animal and zoonotic disease status is determined. While passive surveillance for important diseases occurs continuously, active surveillance for each disease does not necessarily occur on an annual basis. Surveillance activities are regularly evaluated and the

decision to conduct active surveillance for a specific disease in any given year is based on a number of factors, such as the findings of previous years' surveillance activities, changes in the disease status of other countries and the emergence of new diseases. Table 1 provides information on the years in which, active surveillance was undertaken for various diseases of importance. More detailed information about the active surveillance that was conducted during a specific year between 2009-2016 can be found by consulting that year's annual surveillance report, which can be found at www.sva.se.

Table 1: Historical overview of active surveillance activities from 2009-2017. Filled circles (●) indicate that active surveillance was carried out.

Disease	Year									
	2009	2010	2011	2012	2013	2014	2015	2016	2017	
African swine fever	○	○	○	●	○	○	○	○	○	
Atrophic rhinitis	●	●	●	●	●	●	●	●	●	
Aujeszky's disease	●	●	●	●	●	●	●	●	●	
Bluetongue	●	●	●	●	●	●	●	●	●	
Bovine spongiform encephalopathy	●	●	●	●	●	●	●	●	●	
Bovine viral diarrhoea	●	●	●	●	●	●	●	●	●	
Brucellosis	●	●	●	●	●	●	●	●	●	
Campylobacteriosis	●	●	●	●	●	●	●	●	●	
Chronic wasting disease	●	●	○	○	○	○	○	●	●	
Classical swine fever	●	●	●	●	●	●	●	●	●	
Coccidiosis and clostridiosis	●	●	●	●	●	●	●	●	●	
Echinococcosis	●	●	●	●	●	●	●	●	●	
Enzootic bovine leucosis	●	●	●	●	●	●	●	●	●	
Footrot	●	●	●	●	●	●	●	●	●	
Infectious bovine rhinotracheitis	●	●	●	●	●	●	●	●	●	
Avian influenza	●	●	●	●	●	●	●	●	●	
Swine influenza	○	●	○	○	○	○	●	○	●	
Leptospirosis	○	●	○	●	●	○	○	●	●	
Listeriosis	○	○	○	○	○	○	○	○	○	
Maedi-visna	●	●	●	●	●	●	●	●	●	
Nephropathia epidemica	○	○	○	○	○	○	○	○	○	
Paratuberculosis	●	●	●	●	●	●	●	●	●	
Porcine reproductive and respiratory syndrome	●	●	●	●	●	●	●	●	●	
Psittacosis	○	○	○	○	○	○	○	○	○	
Q fever	●	●	●	○	○	○	○	○	○	
Rabies	●	●	●	●	●	●	●	●	●	
Salmonellosis	●	●	●	●	●	●	●	●	●	
Swine vesicular disease	○	○	●	○	●	○	○	○	○	
Schmallenbergvirus	○	○	○	●	○	○	○	○	○	
Scrapie	●	●	●	●	●	●	●	●	●	
Strangles	○	○	○	○	○	○	○	○	○	
Tick borne encephalitis	○	○	○	○	○	○	●	○	○	
Transmissible gastroenteritis	○	●	○	○	●	○	○	○	○	
Trichinellosis	●	●	●	●	●	●	●	●	●	
Tuberculosis	●	●	●	●	●	●	●	●	●	
Tularaemia	○	○	○	○	○	○	●	○	●	
Verotoxigenic <i>Escherichia coli</i>	●	○	○	●	○	○	●	○	○	
Yersiniosis	○	○	○	○	○	●	○	●	○	

Livestock populations and trade in live animals

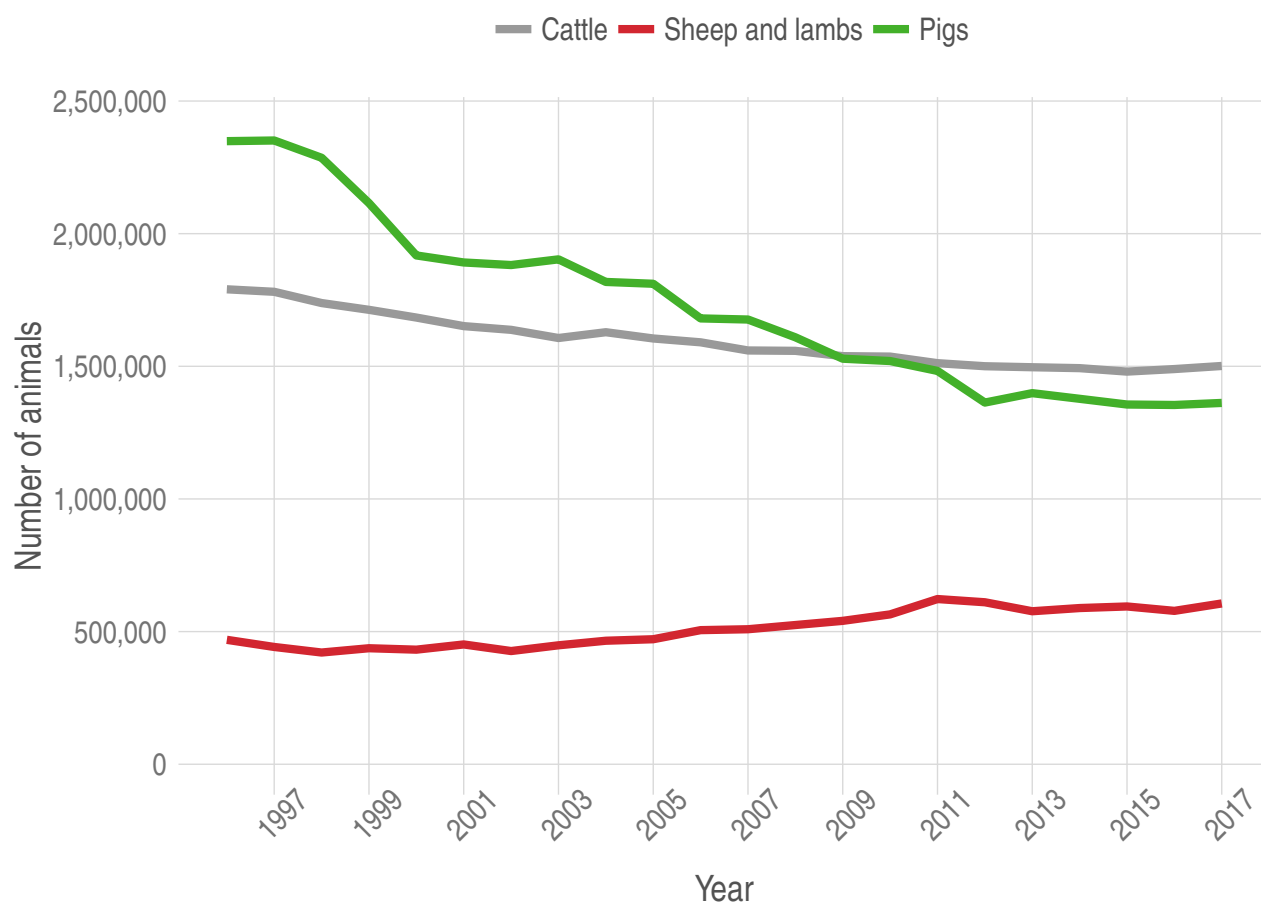


Figure 1: Number of Swedish livestock 1996-2017.

The Swedish agriculture industry is concentrated in the southern and central parts of the country. The largest sectors are meat and dairy and in northern Sweden, farms are mainly small. During the last decade the number of holdings with livestock has decreased, but the average size of those remaining has increased. In the current description of the livestock industry we define a holding as livestock production under a single management.

Figures 1, 2, 3 and 4 give an overview of the livestock population in Sweden in 2017. The statistics for aquaculture reflect 2016.

CATTLE

There are approximately 16,700 holdings with a total number of 1.5 million cattle (dairy cows, cows for calf production, heifers, bulls, steers and calves younger than one year) in Sweden (Figure 2).

The number of holdings with dairy cows as well as the number of dairy cows has decreased consistently over a long period. In 2017, there were 322,000 dairy cows in 3,600 holdings with an average of 89 cows per herd. Eight percent

of the holdings have 200 or more dairy cows. The number of cows for calf production was 207,600; this is an increasing number, with an average herd size of 20 cows.

In total, approximately 392,000 adult cattle and 14,400 calves were slaughtered during 2017. The total milk delivered in 2017 was 2,817 million kg, which is a decrease of 5% since 2016 and the lowest production since 1995.

PIGS

The total number of pigs was 1,362,000 (Figure 3) in 2017. The total number of pigs has decreased over a long period of time, but in recent years the decline has stopped. The number of holdings with pigs was 1,272 of which 1,014 held fattening pigs. About 2,576,000 pigs were slaughtered during 2017.

SHEEP

In 2017, there were 9,278 sheep holdings with a total of 301,468 ewes and rams (Figure 4). Sheep holdings in Sweden are usually small-scale enterprises with an average herd size of 33 adult sheep. During 2017, approximately 261,000 sheep were slaughtered of which 224,000 were lambs.

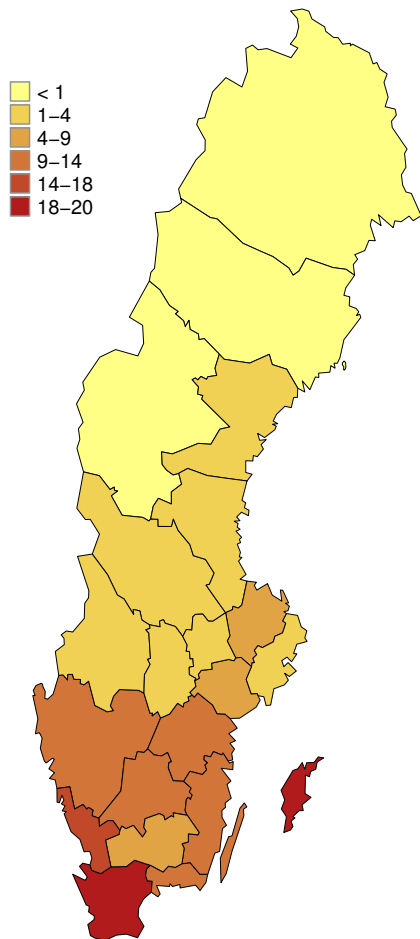


Figure 2: Number of cattle per km² in 21 Swedish counties as of June 2017.

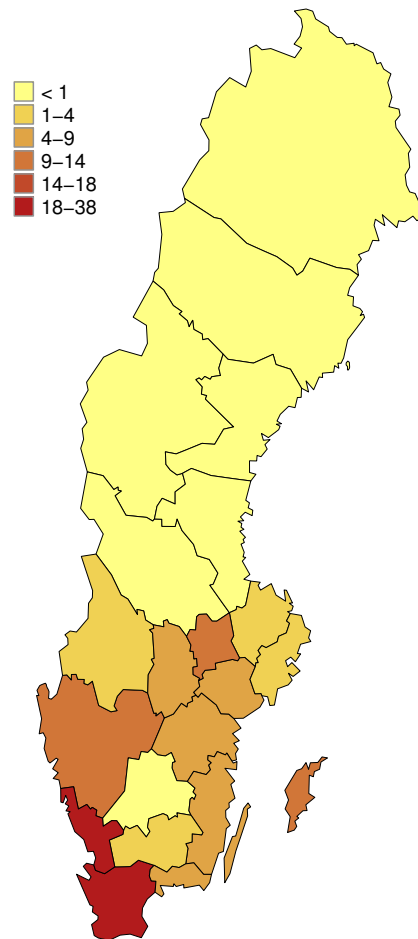


Figure 3: Number of pigs per km² in 21 Swedish counties as of June 2017.

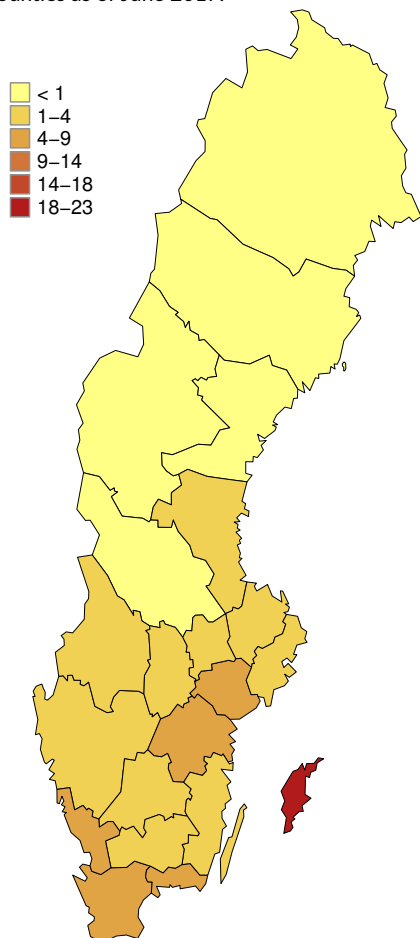


Figure 4: Number of sheep per km² in 21 Swedish counties as of June 2017.

GOATS

The reported number of goats in January 2018 was 17,498. They were kept on 2,478 different holdings.

POULTRY

To provide animals for the broiler industry, grandparent stock (Ross, Kobb) and parents (other hybrids) are brought to Sweden. For the egg industry parent stock are brought into the country. These animals are the top of the commercial breeding pyramid in Sweden.

The number of fowl has increased continuously during the last two decades.

In June 2017, there were 7.3 million hens (chicken not included) in 2,900 commercial holdings, which indicates that the population decreased but the total number of holdings remained stable compared to the previous year.

Eggs delivered to wholesalers amounted to 118.2 million kg during 2017.

The number of holdings with broiler production in June 2017 was 283 and approximately 102 million chickens were sent for slaughter during the year. During 2017, 526,000 turkeys were slaughtered.

The production of geese and ducks is very small. In 2017, 15,330 geese and 11,822 ducks and no guineafowl were slaughtered.

FISH AND SHELLFISH

Rainbow trout are the most common farmed fish in Sweden, followed by char, brown trout, eel and salmon where salmon and brown trout are mainly for restocking of feral populations. Swedish shellfish production is dominated by cultivated blue mussels; 2,317 tonnes were produced in 2016.

In 2016, there were 64 holdings with production of food fish, 56 holdings with fish for restocking, 17 with crayfish for consumption and five with crayfish for restocking. There were 17 holdings with production of blue mussels and two with oyster production.

The production was 11,417 tonnes of food fish, which when converted to round fresh weight is the equivalent of 13,451 tonnes. This production represents a 25% increase from the previous year. The increase is due to some recently established holdings as well as increased production in some large holdings. Rainbow trout represented the largest production, with 86% of the total production of fish for consumption. The total production of fish for restocking was estimated to 860 tonnes; a decrease of 20% from 2015. The most common species produced for restocking was also the rainbow trout.

To compensate for a decrease in natural reproduction caused by the establishment of hydroelectric power plants, 2.9 million salmon fry and sea trout were released, mainly in rivers running into the Baltic sea.

REINDEER

In 2017, there were 254,275 reindeer in Sweden including 61,676 calves. During the season 2016/2017, 58,740 reindeer were slaughtered. There are no wild reindeer in Sweden, only semi-domesticated. There is cross-border reindeer

husbandry between Sweden and Norway.

HORSES

In 2016, there were approximately 355,500 horses in Sweden of which 18,300 were held at riding schools and 101,000 at agricultural holdings. The number of premises with horses on 2 June, 2016 was 77,800. Approximately, 2,000 horses were slaughtered in Sweden in 2017.

BEEES

In 2017, the number of apiaries in Sweden was 17,409 and the number of colonies was 92,954. These figures are approximated by the bee inspectors and in the last five years the bee population has increased.

TRADE IN LIVE ANIMALS (LIVESTOCK)

The trade of livestock into and from Sweden is limited. In 2017, 137 pigs were brought into Sweden from Norway and 13 pigs from UK, 35 cattle came from Denmark and 8 sheep from the Netherlands, 19 sheep from UK, 19 sheep from Germany, all ARR/ARR. Furthermore, 493 reindeer were brought from Finland and two alpacas from Germany and Czech Republic. Furthermore, 114 pigs from Denmark were brought to be used for scientific purposes.

Approximately 300,000 day-old chicks (*Gallus gallus*) were brought into Sweden from France and Great Britain.

In addition, 8,528 turkeys (*Meleagris gallopavo*) from Great Britain and 6,400 ducks from Denmark and the Netherlands, were brought in as day-old chicks. The trade with adult poultry is infrequent, only 12 adult poultry, 16 geese and 16 adult ducks were brought from Germany to Sweden.

Hatching eggs of different species were brought to Sweden from Germany (*Gallus gallus* (SPF)), Poland (*Phasianidae*), France (*Phasianidae*) and Denmark (*Phasianidae*, *Anas sp.*). Data on the quantities of hatching eggs brought into Sweden was not available.

Approximately 121,600 bees were brought to Sweden for breeding purposes from Denmark, Italy, Malta, Norway, Austria, Poland, Slovenia and Germany. The consignment from Poland included 120,000 bees.

The number of animals that left Sweden for intra-Union trade during 2017 were: 69 cattle, 4 pigs, 41 sheep, 8 alpacas and 889 reindeer. In addition, 219 reindeer were exported to Norway. There is cross-border reindeer farming between Sweden and Norway.

Altogether, 5.2 million day-old chicks were sent from Sweden to Denmark, Estonia, Lithuania, Poland, Germany, Latvia, the Netherlands and Finland. About 306,000 live poultry (*Gallus gallus*) were sent to Poland and the Netherlands.

Hatching eggs (*Gallus gallus*) were sent to Poland, Finland, Denmark, Belgium, Germany, Spain, Hungary, Norway and Russia from Sweden. No data was available on quantities of exported eggs.

In total, 361,226 bees (*Apis mellifera*) left Sweden for intra-union trade, of which the great majority (360,000) belonged to the same consignment.

REFERENCES

TRACES (**TR**ade Control and **EX**pert System), a trans-European network, developed by EU COM, for veterinary health which notifies, certifies and monitors imports, exports and trade in animals and animal products. Data from TRACES was extracted by SBA.

Personal communication (goats) Jonas Jonsson, Swedish board of Agriculture, Mars 2018

Jordbruksverkets statistikdatabas (available at: <http://statistik.sjv.se/PXWeb/>)

Statistiska meddelanden JO 20 SM 1702, Livestock in June 2017 (available at: <https://www.jordbruksverket.se>)

Aquaculture in Sweden in 2016, JO 60 SM 1701, SBA (available at: <https://www.jordbruksverket.se>)

Livsmedelsverket (statistics on poultry slaughter)

Sametinget (<https://www.sametinget.se>)

Bitillsyn 2017 (available 20180509 at: <http://www.jordbruksverket.se>)

Animal registers and data sources used in surveillance

THE CENTRAL REGISTER OF HOLDINGS

The Swedish Board of Agriculture is responsible for the Central Register of Holdings (PLATS). Each holding is allocated a unique identification number (holding number). The register contains information on holdings with bovine animals, pigs, sheep, goats, laying hens and other poultry. Details on holding number, address, type of production, capacity and the geographical coordinates of the holding are included, as well as the name, address and telephone number of the keeper. All egg producers with a capacity of at least 350 laying hens and all those selling eggs for consumption must be registered. The register contains specific information about production method, capacity and the number of houses and sections on the holding.

THE CENTRAL DATABASE OF PIG, SHEEP AND GOAT MOVEMENTS

The Swedish Board of Agriculture is responsible for the Central Database of animal movements. It contains data on all holdings with pigs, sheep and goats and their movements between holdings. The data encompasses date, address and holding number as well as name and telephone number of the keeper. The database also contains information from the keepers and the abattoirs. It is also possible to register movements in the database via the internet, or in paper form. Animals are registered in groups in the database when moved. For sheep and goats both the keeper who dispatches the animals, and the keeper who receives the animals, are responsible for reporting to the database, within seven days of the movement.

THE CENTRAL DATABASE FOR BOVINE ANIMALS

The Swedish Board of Agriculture is responsible for the Central Database for Bovine animals (CDB), to which all bovine births, deaths and movements must be reported. The keeper is responsible for reporting any changes within seven days of the occurrence. The purpose of the register is to allow swift and efficient tracing of a contagious disease, verification of the country of origin of a meat product, as well as control and administration of cross compliance. The system enables the scanning of animal disease forms into the data system. For herds enrolled in the national milk recording scheme, managed by Växa Sverige, all reporting to the Central Database for Bovine Animals is done via reporting to the Database for Dairy Herds (see below).

THE SLAUGHTER REGISTER

The Slaughter Register (SLAKT) is administrated by the Swedish Board of Agriculture. The abattoirs are responsible for reporting all slaughtered animals including wild game.

The organisation number or personal identification number of the producer must be reported for all species except wild game. The holding number of the supplier is compulsory information for all species except horses and wild game. Reports must be made every week.

THE DATABASE OF DAIRY HERDS

The national coordinating organisation for dairy and beef production is Växa Sverige. The organisation is responsible for the database for dairy herds (Ko-databasen). The database includes milk recordings, fertility results and disease recordings for all animals at the dairy farm, as well as, meat inspection records. It forms the basis for the development of different management tools used by the farmers, advisers and veterinarians. It is also a valuable tool for research on topics such as: feeding, animal health and genetics. Approximately 85% of all dairy cows in Sweden are included in this recording program.

THE ANIMAL HEALTH DATABASE

The Swedish board of Agriculture is responsible for the Animal health database (Vet@) which is used by the veterinary services for the documentation of the health situation on farms, including details about health status, treatment and vaccinations of individual animals. It is based on reports from practitioners to the Swedish Board of Agriculture. All veterinarians are obliged to continuously report activities of their veterinary practice on production animals. The purpose of the database is to monitor the animal health situation in Sweden and use it as a basis for preventive measures.

CENTRAL AQUACULTURE REGISTER

All aquaculture premises authorised by the County Administrative Boards are registered in the Central Aquaculture Register. The register is administered by the Swedish Board of Agriculture. The data encompasses name and coordinates of the premise as well as type of production and species kept. It also contains results from official controls, information on the farm's water supply and discharge as well as date information on health status.

THE POULTRY REGISTER

The Swedish Board of Agriculture is responsible for the poultry register, which includes data on commercial holdings with ducks, pigeons, pheasants, geese, mallard ducks, chickens, turkeys, guinea fowl, partridges, ratites or quails. The purpose of the register is to allow swift and efficient tracing of contagious diseases (i.e. avian influenza and Newcastle disease). The register encompasses information about the location of the holding, contact information, type of production, species, maximum capacity, number of units on the site and more.

Institutions, organisations and laboratories involved in surveillance

SWEDISH BOARD OF AGRICULTURE

The Swedish Board of Agriculture (SBA) is an expert authority under the Ministry of Innovation and Enterprise, covering the field of agricultural and food policy, and is responsible for agriculture, aquaculture and horticulture, including animal and plant health. This includes monitoring, analysing and reporting to the Government on developments in these areas, and implementing policy decisions within its designated field of activities. The aim is to fulfil the overall goals of the agro-food policy and promote food production that is competitive, adapted to environmental and animal welfare concerns, and that benefits consumers.

The SBA promotes animal health by prevention and control of contagious animal diseases. This includes feed, animal by-products and animal health personnel. SBA is also the central authority for animal welfare issues. The SBA district veterinarians represent a substantial part of the organisation, and constitute the principal body for performing official veterinary controls and for emergency measures to combat contagious diseases. In addition to their official tasks, the district veterinarians also do clinical work and are involved in preventive health care.

NATIONAL VETERINARY INSTITUTE

The National Veterinary Institute, SVA, is a Swedish national expert authority with a mission to follow and communicate the situation regarding infectious diseases and antimicrobial resistance in domestic and wild animals, nationally and internationally. SVA strives for good animal and human health, a good environment and sustainable food production. The authority lies under the Swedish Ministry of Enterprise and Innovation, and is the nation's leading knowledge centre for infectious diseases in veterinary medicine with expertise within pathology, microbiology, diagnostics, risk assessment, prevention and control of contagious animal diseases and other serious transmissible hazards including zoonotic agents and antimicrobial resistance. SVA maintains 24/7 epizootic disease preparedness, has National Laboratory functions for several zoonotic and epizootic pathogens, and is also the EU reference laboratory (EURL) for *Campylobacter*.

Several control- and monitoring programmes are conducted in cooperation with stakeholder organisations and relevant authorities. SVA prepares the national surveillance plan that is confirmed and enacted by the SBA.

THE PUBLIC HEALTH AGENCY OF SWEDEN

The Public Health Agency of Sweden is a government agency under the Ministry of Social Affairs. This authority operates across the public health spectrum and integrates communicable disease control with other public health work. It aims to identify and highlight public health

issues where effective interventions can be made. The authority collaborates with other authorities, county councils and municipalities to develop a national knowledge support and to follow up interventions. The Public Health Agency of Sweden promotes health and prevents diseases by supporting communicable disease control with epidemiological and microbiological analyses. The authority also focuses on preparedness for outbreaks of severe infectious diseases, both within the country and outside the borders. Diagnostic analyses of different bacteria, viruses and parasites, as well as water and environmental analyses are carried out by the authority.

NATIONAL FOOD AGENCY

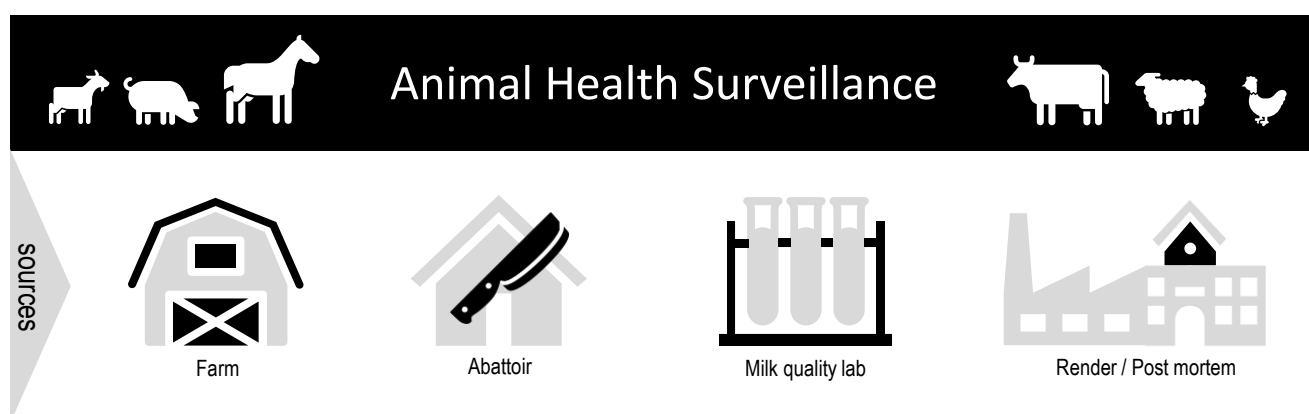
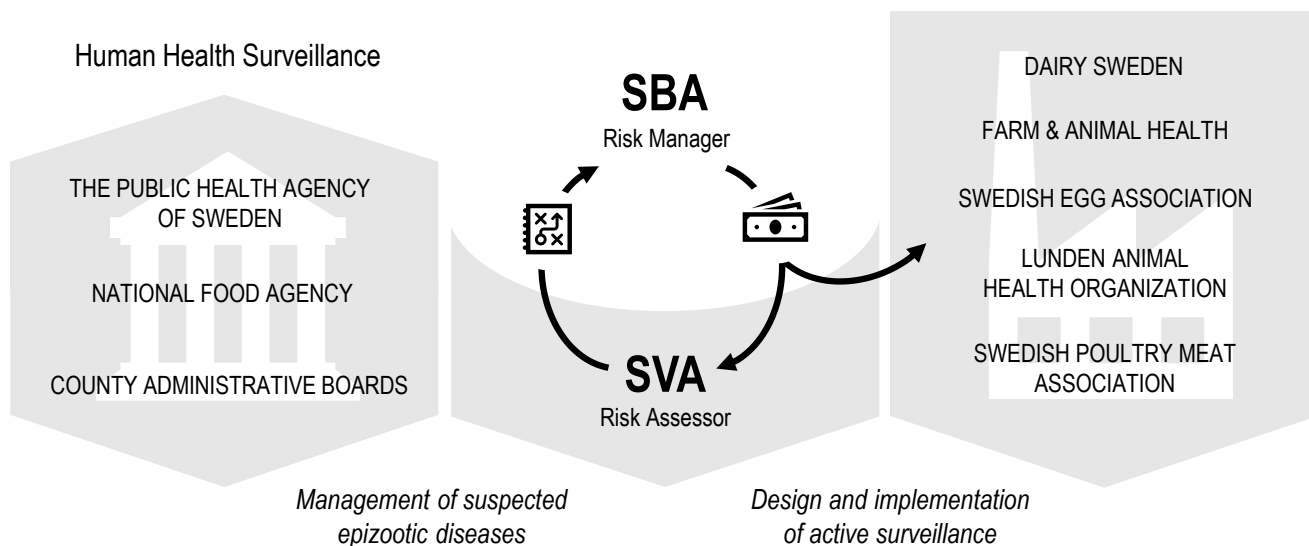
The National Food Agency (NFA) is a national agency under the Ministry for Enterprise and Innovation. The NFA works in the interest of the consumer to ensure food safety, to promote fair practices in food trade and to promote healthy eating habits. To accomplish this mission, the agency develops and issues regulations, advice and information as well as coordinates and carries out control. As a basis for these activities the agency performs risk and benefits analyses, collects data on food consumption and composition, and carries out microbiological, chemical and nutritional analyses on food and water. The NFA is also responsible for environmental issues, emergency preparedness, and co-ordination of drinking water control.

COUNTY ADMINISTRATIVE BOARDS

Sweden is divided into 21 counties, each of which has its own County Administrative Board (CAB) and County Governor. The CAB is an important link between the people and the municipal authorities on one hand and the government, parliament and central authorities on the other. The CABs have coordinating functions for prevention, surveillance and eradication of contagious animal diseases. Seven of the CAB's has a regional responsibility for bee health. They set the borders of the inspection districts and are responsible for appointing bee inspectors in all of the CAB counties. Collaboration with the County Medical Officers and veterinarians in clinical work in terms of zoonoses and "One Health" approach are also carried out by the CAB as well as regional supervision regarding animal health and welfare.

DAIRY SWEDEN

Dairy Sweden is the national industry organisation for Swedish dairy farmers and the Swedish dairy industry. Dairy Sweden works on behalf of its owners, who are the six largest dairy companies in Sweden. These companies represent more than 98% of Swedish milk production, including three livestock cooperatives (one of them is Växa Sverige).



Roles, responsibilities and relations between organisations involved in active surveillance in domestic livestock populations (cattle, pigs, poultry, sheep and goat), and their sources of animal health information. Infographic: Arianna Comin

Dairy Sweden gathers, develops and communicates knowledge relating to the entire chain from cow to consumer, including animal health. Växa Sverige is further organising the surveillance programmes for bovine leucosis and infectious bovine rhinotracheitis. It is also organising the eradication programme for bovine viral diarrhoea virus and a voluntary control programme for salmonellosis in bovines. Since the autumn of 2015 the programme for salmonellosis gradually is replaced with a more general biosecurity programme for bovines (Smittsäkrad besättning).

FARM & ANIMAL HEALTH

Farm & Animal Health is an advisory company owned by the main meat producing companies and the farmer organisations for pigs, beef and sheep in Sweden. The aim is to maintain a high level of health in an effective profitable production in the pig, beef and sheep sectors. The company's business idea originates from the 1960's and is to promote healthy animals for profitable farming. Focus is to prevent animal health problems for pigs, cattle (for meat production) and sheep as well as to improve animal welfare.

The activities are performed with a clear national focus and the consulting services are open to all farmers. A large part of the activities and services are based on officially approved animal health programmes for pigs, cattle and sheep. In addition, Farm & Animal Health is assigned

by the Swedish Board of Agriculture to perform specific disease control and surveillance programmes. Examples of such programmes are surveillance of porcine reproductive and respiratory syndrome virus in pigs, the control of maedi-visna in sheep and Johne's disease in cattle, monitoring of antimicrobial resistance in disease-causing bacteria and the national post mortem programme of livestock animals.

Applied research and development are important parts of the business and projects are often performed in collaboration with the National Veterinary Institute and the Swedish University of Agricultural Sciences.

LUNDEN ANIMAL HEALTH ORGANISATION

Lunden Animal Health Organisation is a veterinary consulting company working with pig health and welfare. The objective is to gather, develop and communicate knowledge on pig issues. The organisation is involved in the national surveillance programme for pig diseases and is assigned by the Swedish Board of Agriculture to perform health control as well as the on-farm national biosecurity programme.

SWEDISH POULTRY MEAT ASSOCIATION

Swedish Poultry Meat Association (SPMA) represents 99.5% of the poultry meat production of chicken and 95-97% of the turkey meat production in Sweden, with members from the entire production chain. The members are

obligated to participate in the animal welfare and health programmes, administered by SPMA such as control for Salmonella, Campylobacter, coccidiosis and clostridiosis, to meet high standards for food hygiene and safety.

The SPMA is multifunctional; the major task is the work associated with economic and political industry related matters important to its members. SPMA receives legislative referrals from the Swedish public authorities and EU institutions. The organisation also initiates and economically supports research.

THE SWEDISH EGG ASSOCIATION

The Swedish Egg Association is the national organisation for Swedish egg producers, hatcheries, rearing companies, egg packing stations and feeding companies and represents 94% of the total Swedish egg production.

The Swedish Egg Association is responsible for the organisation of the surveillance programmes for animal health and welfare in layers and for the voluntary *Salmonella* control programme. The objective is to support profitable egg production, with a high standard of animal welfare, food hygiene and safety.

SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES

The Swedish University of Agricultural Sciences (SLU) develops the understanding and sustainable use and management of biological natural resources.

The Ecology Centre at SLU, conducts research on sustainable agriculture, forest production and biological conservation. This includes both fundamental and applied research on communities and ecosystems and the influences of land use and climate on animals, plants, soil nutrient status and greenhouse gas balance. Active dissemination, outreach and frequent contacts with stakeholders are key activities.

Activities also include developing the topic of bee health and how it is affected by pathogens, environmental factors, pesticides and beekeeping methods. Also included is the National Reference Laboratory for bee health whose activities are carried out in close cooperation with relevant authorities and beekeepers.

BEE INSPECTORS

At the local level, bee inspectors (bitillsynsmän) are experienced beekeepers that are specially trained to examine bee colonies for disease. The main duties of bee inspectors are to examine bee colonies to detect diseases in case of disease suspicion; in connection with requests of moving bee colonies or in connection with the annual inspection. Bee inspectors also issue move-permits and carry out or impose control measures for specific diseases and inform beekeepers about *Varroa* treatment. Seven of the CAB's have a regional responsibility for bee health. They set the borders of the inspection districts and are responsible for appointing bee inspectors in all of the CAB counties. Sweden is divided into a little less than 500 bee districts and the bee inspectors are responsible for the practical control in each of these. The bee inspector system aims at combating American foulbrood and varroa mite.

REFERENCES

Anton Andreasson, Livsmedelsverket (www.slv.se)

Viveca Eriksson, Länsstyrelsen i Hallands län (www.lansstyrelsen.se)

Lena Hult, Jordbruksverket (www.slv.se)

Jonas Carlsson, Växa Sverige (www.vxa.se)

Andrea Holmström, Gård & Djurhälsan (www.gardochdjurhalsan.se)

Anders Wallensten, Folkhälsomyndigheten (www.folkhalsomyndigheten.se)

Pia Gustafsson, Svensk Fågel (www.svenskfagel.se)

Magnus Jeremiasson, Svenska Ägg (www.svenskaagg.se)

Erik Lindahl, Lundens djurhälsovård (www.lundens.com)

Ingrid Karlsson, Jordbruksverket

Disease Surveillance 2017

Atrophic rhinitis

BACKGROUND

Atrophic rhinitis (AR) is caused by toxin-producing strains of *Pasteurella multocida*. Since *P. multocida* is a secondary invader and not capable of penetrating an intact mucosa, it is dependent on other infections. Traditionally, *Bordetella bronchiseptica* has been considered the most important precursor, but other bacteria and viruses may also precede *P. multocida* infection. Atrophic rhinitis was a common disease in pig production but improvements in rearing and disease prevention have caused the disease to gradually fade away. Farm & Animal Health administers a control programme which has been in place since 1995.

DISEASE

When *P. multocida* penetrates the nasal mucosa, its toxins can affect the bone building process and the snout may progressively become twisted. Affected pigs will also show retarded growth. *P. multocida* toxins can also damage the nasal epithelium and cilia causing inhaled air to reach the respiratory organs without being filtered or warmed, which in turn increases the risk for other respiratory infections.

LEGISLATION

Atrophic rhinitis is a notifiable disease according to SJVFS 2013:23.

SURVEILLANCE

The purpose of the control programme is to declare herds selling breeding stock free from infection with toxigenic *P.*

multocida, and thereby decrease the incidence of AR in all herds. Nucleus and multiplying herds are actively controlled for the presence of toxigenic *P. multocida* at least once a year and every time there is clinical suspicion of AR. Eradication of *P. multocida* is not realistic since it is an ubiquitous bacterium that can affect all mammals. However, anytime AR is suspected in a herd, tests should be performed for the presence of toxigenic *P. multocida*. If toxigenic *P. multocida* is detected, the health declaration is withdrawn and restrictions on the sale of pigs are put in place until the herd is sanitised and declared free from the disease. Diagnostic tools developed by DAKO (Copenhagen, Denmark) and evaluated at SVA during the late 1980s and early 1990s offered the possibility to combat AR in an effective way. Nasal swabs are cultured on a special media overnight. The entire microbial growth is harvested and diluted in water and the presence of the *P. multocida* toxin is assessed by an ELISA system.

RESULTS AND DISCUSSION

Atrophic rhinitis used to be a common disease, but the disease is now very rare due to efforts made in the early 1990s and the control programme that was initiated in 1995. The latest Swedish herd was diagnosed with AR in 2005 (Table 2). In 2009, *P. multocida* was detected in 10 out of 34 imported Norwegian boars in quarantine. These boars were isolated and found negative for *P. multocida* at re-sampling before moved to a boar station as intended.

Table 2: The total number of samples and the outcome of nasal swabs analysed for *P. multocida* 2005-2017. The samples have been collected in all nucleus and multiplying herds, as well as in production herds suspected for AR.

Year	Samples	Positive samples	Diagnosed herds
2005	2,413	29	2
2006	1,836	2	0
2007	1,878	1	0
2008	462	0	0
2009	1,724	10	1
2010	1,523	0	0
2011	1,323	0	0
2012	1,431	0	0
2013	1,027	0	0
2014	1,050	0	0
2015	844	0	0
2016	976	0	0
2017	1,294	0	0

Aujeszky's disease



Blood samples from hunted wild boars are used for active surveillance of exposure to Aujeszky's disease virus. In 2017, 136 animals were investigated, with negative result. Photo: Torsten Mörner

BACKGROUND

Aujeszky's disease (AD) is caused by a herpes virus with the capacity to infect several species, but pigs are the natural hosts. The disease is of importance for pig production worldwide although it is controlled in many countries, at least in the domestic pig population. AD is widespread in the wild boar populations in Europe and wild boars are reported to develop clinical signs of disease and could act as reservoirs, but their role in transmitting the disease is not well known. Other species, including cattle, sheep, goats, dogs and cats, develop clinical signs but are not of importance for the transmission of the disease, but rather considered as dead-end hosts. A few cases of human infection have been reported but AD is not considered a zoonotic disease.

Sweden has been officially free from AD since 1996 (Commission Decision 96/725/EU with amendments). This status was achieved following a national, government-supported control programme, that was introduced in 1991 and operated by Farm & Animal Health. Farm & Animal Health is also responsible for the ongoing active surveillance programme financed by the Swedish Board of Agriculture.

DISEASE

The clinical presentation of AD is different depending on the age of the infected animal. The most severe clinical signs develop in newborn or very young piglets in which infection leads to neurological signs and nearly 100% mortality, whereas adult pigs show only mild respiratory signs and inappetence. In addition to the mild clinical signs, pregnant sows can abort as a consequence of the infection. Species other than pigs develop neurological signs including severe itch ("mad itch") and die within 1-2 days.

LEGISLATION

The disease is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and is thereby notifiable on clinical suspicion for all veterinarians and farmers. Sweden has been granted certain additional guarantees regarding AD by the European Commission, in order to protect the Swedish pig health status (Decision 2008/185/EC).

SURVEILLANCE

The purpose of the surveillance is to document continued freedom from the disease. Samples are analysed for antibodies against the AD virus using a blocking ELISA (Svanovir™, PRV-gB-Ab ELISA, Svanova) and in the case

of clinical suspicion also for virus or viral genome. All analyses are performed at the National Veterinary Institute.

Passive surveillance

As AD is notifiable on clinical suspicion for both veterinarians and farmers, cases with clinical signs consistent with AD will be investigated following notification to the Swedish Board of Agriculture. The investigation includes sampling of sick or dead animals and examination of the herd for presence of clinical signs and analyses of production results. The farm is placed under restrictions during the investigation.

Active surveillance

In 2017, the samples used for active surveillance of AD, were collected in the abattoir sampling component of the surveillance for porcine respiratory and reproductive syndrome virus (PRRSV), carried out by Farm & Animal Health. This programme is designed using a between-herd design prevalence of 0.5%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 5 years. The number of samples needed is calculated yearly taking the outcome of the surveillance in the previous years into account. For 2017 the calculated number of samples needed for PRRS from the abattoir sampling was 2400 (3 samples per holding from 800 holdings). All these samples were also used for AD. See chapter on PRRS for details on sampling and the target population.

In addition to the surveillance of AD in domestic pigs there is also an active surveillance of AD in wild boar, see chapter Infectious diseases in wild boars.

RESULTS

Passive surveillance

During 2017, no clinical suspicions of AD were investigated.

Active surveillance

In 2017, 2,625 samples, corresponding to 3 samples per herd at 875 sampling occasions, were analysed within the active surveillance programme. Each herd was, as a rule, sampled 1-2 times during the year. All samples were negative for antibodies to the AD virus.

DISCUSSION

The purpose of the surveillance is to document freedom from the disease and to contribute to the maintenance of this situation by detection of an introduction of the disease before it is widely spread in the swine population. The design of the active surveillance has been changed several times since 2007. Since 2011, the AD surveillance is based solely on abattoir sampling in the PRRS surveillance programme. The effects on probability of freedom and sensitivity of the surveillance of these changes have not been evaluated. However, since the risk of introduction is considered lower for AD than for PRRS the result of the surveillance indicates that the probability of freedom of AD is high (Table 3).

Table 3: Number of samples and sampling population included in the active surveillance of Aujeszky's disease 2007-2017.

Year	Sampling population	Number of samples
2007	Boars and sows at slaughter	4,529
2008	Boars and sows at slaughter	3,612
2009	Boars and sows at slaughter	776
2009	Fatteners at slaughter	2,712
2010	Field sampling of nucleus herds, multiplying herds and sow pools	1,070
2010	Abattoir sampling	4,371
2011	Abattoir sampling	2,308
2012	Abattoir sampling	2,152
2013	Abattoir sampling	1,548
2014	Abattoir sampling	2,028
2015	Abattoir sampling	2,383
2016	Abattoir sampling	2,418
2017	Abattoir sampling	2,625

Bluetongue

BACKGROUND

Bluetongue is a vector borne disease of ruminants and camelids caused by any of 27 serotypes of bluetongue virus (BTV). The virus is transmitted by haematophagous midges (*Culicoides* spp).

Until 1998, bluetongue had not been detected in any European country but since then, outbreaks of several serotypes have frequently been detected in the Mediterranean countries. In August 2006, BTV-8 appeared in the Netherlands. During 2006 and 2007 this outbreak spread to a large number of countries in Northern and Western Europe. In 2008, further cases were reported and vaccination campaigns were launched in most of EU as soon as inactivated vaccines became available. In September 2008, the first case of BTV-8 infection in Sweden was confirmed. A vaccination campaign and intensive surveillance activities were initiated nationally, with focus on the southern part of the country. Following the detection of infected animals in new areas, the zones were adjusted accordingly. Vaccination and surveillance activities continued in 2009. In the first quarter of 2009 transplacental infection was detected in three newborn calves, all three cases originating from infections of their dams in autumn 2008.

In December 2010, after extensive surveillance, Sweden was declared free from BTV-8. After that, surveillance according to Commission Regulation (EC) No 1266/2007, with amendments, has been carried out annually.

DISEASE

BTV causes clinical disease in ruminants, mainly in sheep. The different serotypes appear to vary in their ability to cause clinical signs in different animal species and also in the severity of clinical signs in the same species. The signs include fever, lesions in the mucous membranes of the mouth and nostrils, inflammation of the coronary band, swollen head and oedema in various body tissues.

LEGISLATION

The control, monitoring, surveillance and restriction of movements of certain animals of susceptible species are governed by Regulation 1266/2007 with amendments. Bluetongue is a notifiable disease and is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments).

SURVEILLANCE

All diagnostic testing, as outlined below, was performed at the National Veterinary Institute with the purpose of demonstrating sustained freedom from BTV in Swedish cattle. Serum samples were analysed with a competitive ELISA (ID Screen Bluetongue Competition ELISA) and milk samples were analysed with an indirect ELISA (ID Screen Bluetongue Milk). Organs and blood were analysed with real-time pan-PCR detecting 24 serotypes.

A positive case is defined as an animal giving rise to a

positive PCR-product or an unvaccinated animal without remaining maternal antibodies giving a significant antibody titre.

Passive surveillance

Suspicious based on clinical signs must be reported to the Swedish Board of Agriculture and will be subsequently investigated.

Active surveillance

Vectors

Vector surveillance was initiated in 2007 in order to document the activity of relevant *Culicoides* spp. throughout the different seasons of the year. The programme was discontinued in 2011 after Sweden was declared free from BTV-8.

Animals

In the 2017 bluetongue surveillance, approximately 1,330 animals from 133 dairy herds were selected for testing. The number of holdings to test were distributed among the state district veterinarians in accordance with the cattle density in each county. The district veterinarians selected the test-herds based on convenience sampling criteria. Ten animals from each holding were selected for testing by the sampling veterinarian according to the following inclusion criteria: lactating, unvaccinated and having grazed (been exposed to the vector) during the last season. The number of tested herds was sufficient to detect 2% prevalence with 95% confidence. The sampling took place after the vector season, from December 2017 until February 2018 and samples were analysed with the milk ELISA routinely used.

In addition to the field testing, serological testing for bluetongue prior to import and export, and at breeding centres was performed.

RESULTS

Two clinically suspect cases were investigated and tested during 2017, and found negative. The outcome of all other testing performed in 2017 was also negative.

DISCUSSION

In summary, no clinical suspicions of bluetongue were confirmed nor was there any indication of viral circulation during 2017, confirming the continued sustained freedom from BTV in Sweden.

Competent vectors are present in Sweden and may spread the infection. Reintroduction of the virus to Sweden may occur by infected animals, infected vectors or other yet unidentified means.

At present, there are no indications of BTV-8 circulation in neighbouring countries. However in 2015, France reported that BTV-8, of the Northern European strain from 2007, had re-emerged in the central parts of the country. Since September 2015 several thousands of cases (animal

found positive for BTV with real time PCR) have been reported by France. Most of these cases are animals found positive within active surveillance activities. During the vector season of 2016, 59 out of in total 1,740 confirmed cases were animals with clinical signs of BTV. During the vector season of 2017, the United Kingdom (UK) and Switzerland reported outbreaks of BTV-8. The outbreak in the UK refers to one shipment with cattle imported from France in which 7 out of 32 animals were found positive for BTV-8 with real time PCR. The animals did not express any clinical signs. In Switzerland, two outbreaks, each involving one animal, was located close to the French border and presumed to be caused by vector migration.

During 2017, BTV-4 was detected in France, involving several outbreaks on the island of Corsica and subsequent spread to mainland France via movement of live animals.

During 2012, BTV-14 was detected in cattle in Estonia, Latvia, Lithuania, Poland and Russia. Sequencing was performed and indicated that the positive cases were derived from a common source and suggested significant spread of the virus in the field. The strain was identified as a BTV-14 reference or vaccine strain, possibly indicating the use of a live BTV-14 vaccine.

The detection of BTV-8 in France in 2015 after several years of silence, and the numerous cases detected during 2017, again demonstrates that BTV may spread and become established in livestock populations in Europe. Moreover,

as the prevalence of seropositive animals decline, the population will again become susceptible to BTV-8. Therefore, new introductions of this serotype, or any remaining foci in previously infected countries, could pose a threat. Likewise, new serotypes could emerge in the Mediterranean region or start circulating worldwide, underlining how the situation can rapidly change.

REFERENCES

Ågren, E.C., Burgin, L., Sternberg Lewerin, S., Gloster, J., Elvander, M., 2010. Possible means of introduction of bluetongue virus serotype 8 (BTV-8) to Sweden in August 2008 - comparison of results from two models for atmospheric transport of the *Culicoides* vector. *Veterinary Record* 167:484-488.

Sternberg Lewerin, S., Hallgren, G., Mieziowska, K., Treiberg Berndtsson, L., Chirico, J., Elvander, M., 2010. Infection with bluetongue serotype 8 in Sweden 2008. *Veterinary Record* 167:165-170.

Nielsen S. A., Nielsen B. O., Chirico J., 2009. Monitoring of biting midges (Diptera: Ceratopogonidae: *Culicoides* Latreille) on farms in Sweden during the emergence of the 2008 epidemic of bluetongue. *Parasitology Research* 106:1197-1203.

Bovine spongiform encephalopathy

BACKGROUND

Classical bovine spongiform encephalopathy (BSE) belongs to a group of diseases called transmissible spongiform encephalopathies (TSE). It was first described in cattle in the UK in 1986 and from there the disease spread to a large number of European countries as well as countries outside Europe. The current theory about the causative agent is the protein-only hypothesis. This theory assumes that misfolded prions (small proteins) induce the same misfolded structure in normal proteins in the body of the host, resulting in accumulation of prions and cellular damage without involvement of any microorganism. Classical BSE primarily spread through contaminated meat and bone meal (MBM), i.e. MBM containing parts of animals infected with BSE. However, the primary source of the epidemic was never established.

In 1996, the disease became a public health concern, after the detection of a new variant of Creutzfeldt-Jacob Disease in humans (vCJD), likely to be linked to classical BSE in cattle. This resulted in actions taken to prevent transmission to humans through removal of specified risk material (such as brain and spinal cord) from cattle at slaughter, restrictions related to feed to avoid recycling of infectious material to ruminants through infected MBM and an intensified surveillance which started in 2001 after rapid diagnostic tests became available.

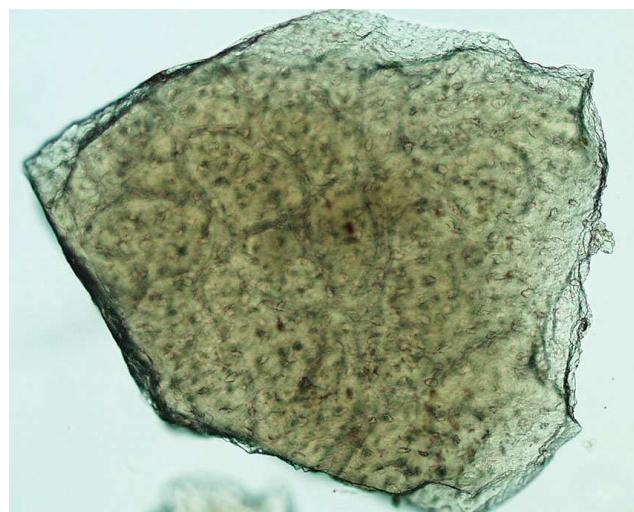
Atypical strains of BSE, which show diagnostic dissimilarities with classical BSE, have been described. These atypical BSE cases probably occur spontaneously and possible links to classical BSE and potential zoonotic aspects are being discussed.

Sweden has historically had a low risk of introduction of classical BSE and a low risk of recirculation of the disease if it had been introduced, due to an early ban on the use of fallen stock in production of feed for livestock and limited imports. This has been assessed by the Scientific Steering Committee, by the European Food Safety Authority (EFSA), and later by the OIE Scientific Commission and expressed in terms of the Geographical Bovine spongiform encephalopathy Risk (GBR). Sweden is currently, recognised as having a negligible risk for classical BSE, as a result of a resolution adopted by the OIE International Committee.

One case of BSE has been detected in cattle in Sweden. This was in 2006 in a beef cow born in 1994. This case was confirmed to be atypical BSE of the H-type, i.e. not classical BSE.

DISEASE

The incubation period is long, from two years up to several years. Clinical signs are related to the neurological system and include altered behaviour and sensation as well as affected movement and posture. The clinical state can last for weeks or months. The disease is progressive and always fatal.



Samples of feed and imported raw material for feed production are analysed for the presence of processed animal protein (PAP). The image shows a bone fragment of from a terrestrial vertebrate, which is characteristic of the presence of PAP. Photo: SVA

LEGISLATION

Surveillance and control of BSE is regulated through the Regulation (EC) No 999/2001 of the European Parliament and of the Council of 22 May 2001. The surveillance design is in accordance with Annex III and Sweden applies derogation for remote areas with low cattle density (Commission Decision 2008/908), where there is no collection of fallen stock. The cattle population in these areas does not exceed 10% of the bovine population in Sweden. On the national level, the sampling is regulated by SJVFS 2010:9, last amended through SJVFS 2013:3. BSE is a notifiable disease under the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments). Feed controls are regulated through Regulation (EC) 152/2009.

SURVEILLANCE

Feed

In order to investigate compliance with the feed bans, samples of feed and imported raw material for feed production are collected at feed mills, points of retail and at the farm level and analysed for the presence of processed animal protein (PAP) using microscopy. This is part of the official controls and the Swedish Board of Agriculture and the County Administrative Boards are responsible.

Animals

The Swedish Board of Agriculture is responsible for the surveillance programme. It is carried out in cooperation with the National Veterinary Institute, which is the National Reference Laboratory (Regulation (EC) 999/2001). Samples are analysed at the National Veterinary Institute.

Passive surveillance

All suspicions of BSE (bovine animals not responding to treatment, with clinical signs that are consistent with a BSE

diagnosis) must be reported to the authorities. The obligation to report applies to animal owners, veterinarians and everyone else who is responsible for the animals. Samples are analysed with Bio-Rad TeSeE short assay protocol (SAP) in combination with Bio-Rad TeSeE Western Blot.

Active surveillance

The following categories were sampled in the active surveillance:

- Cattle of Swedish origin, above 48 months of age, that have remarks at antemortem inspection before slaughter or are emergency slaughtered.
- Cattle of other than Swedish origin above 24 months of age that have remarks at antemortem inspection before slaughter or are emergency slaughtered.
- All healthy slaughtered cattle above 30 months of age that originate in a country other than Sweden, which does not have negligible risk for BSE.
- All fallen stock (animals dead or killed on farm but not slaughtered for human consumption) above 48 months of age that originate from Sweden. For cattle that originate from a country other than Sweden which does not have a negligible risk for BSE, the age limit for sampling fallen stock is 24 months. The fallen stock are sampled by employees at the rendering plants or by veterinarians or veterinary assistants at necropsy.

All samples were examined with Bio-Rad TeSeE SAP. In case of positive or inconclusive results the material was prepared and examined with Bio-Rad TeSeE Western Blot.

RESULTS

Feed

In 2017, 25 feed samples were taken at feed mills and one from retail; 14 of these were from feed (12 were cattle feed) and 12 from raw materials for feed production. All of these samples were negative. No samples were collected in primary production during 2017.

Animals

Passive surveillance

In 2017, two bovines were examined due to clinical suspicion, both with negative results.

Active surveillance

In 2017, 8,317 samples were examined for BSE. All samples were negative. Of these samples 8,182 were from fallen

stock, 17 samples were from animals with remarks at antemortem inspection before slaughter and 172 samples were from emergency slaughtered animals.

DISCUSSION

No positive BSE cases were detected in Sweden in 2017. Preventive measures have been in place for many years and the fact that no cases were detected supports that these measures have been effective. The low number of clinical suspicions may be an indication of a lower degree of awareness among farmers and veterinarians compared to 10-15 years ago. Reports of prion transmission studies, including several passages in different species, have shown that prion-strains do not always remain stable through these passages. The source of the large epidemic of classical BSE has not been determined and atypical cases cannot be excluded as the source. Thus, the atypical cases may be a potential source of a new epidemic. As the number of cases of classical BSE is decreasing within the European Union, surveillance is decreasing and suggestions have been made to once again allow the use of MBM in feed within the EU. However, strict separation and bans of these feeding practices must be kept in place to avoid any possibility of recirculation of BSE, if the disease agent were to enter the system again. Recent international reports of a few cases of classical BSE in young animals born long after implementation of the strict feed ban either indicates problems with the ban or there are other causes of classical BSE that we do not yet understand.

REFERENCES

- Gavier-Widén D, Nöremark M, Langeveld JP, Stack M, Biacabe AG, Vulin J, Chaplin M, Richt JA, Jacobs J, Acín C, Monleón E, Renström L, Klingeborn B, Baron TG. Bovine spongiform encephalopathy in Sweden: an H-type variant., *J Vet Diagn Invest.* 2008 Jan;20(1):2-10.
- Capobianco R et al. (2007) *PLoS Pathog.* Conversion of the BASE prion strain into the BSE strain: the origin of BSE? Mar;3(3):e31.
- EFSA Scientific Report on the Assessment of the Geographical BSE-Risk (GBR) of Sweden. Adopted July 2004 (Question No EFSAQ-2003-083). Last updated 8 September 2004. Publication Date 20 August 2004 http://www.efsa.europa.eu/en/science/tse_assessments/gbr_assessments/572.html

Bovine viral diarrhoea



Surveillance of dairy herds for BVD is performed by sampling bulk milk in conjunction with milk quality testing and analysing the milk for antibodies. In this way, dairy herds can be investigated for many different diseases in a cost-efficient manner, without conducting any herd visits. The bulk-milk collection system is administered by Växa Sverige. It was originally developed for EBL surveillance, with support from public funding. Photo: Maria Adlerborn

BACKGROUND

Bovine viral diarrhoea (BVD) is caused by bovine viral diarrhoea virus (BVDV), which is classified in the genus Pestivirus and the family Flaviviridae. Cattle are the primary host of BVDV, but most even-toed ungulates are likely to be susceptible to the disease. Cattle that are persistently infected serve as a natural reservoir for the virus. The virus may spread between animals via direct or indirect routes. A voluntary surveillance and control programme with the objective to eradicate BVD without vaccination was launched in 1993. The programme is managed by Växa Sverige while the government and the farmers share the costs for sampling and testing. Since June 2001, there is also a compulsory control programme requiring all cattle herds to be tested for BVDV on a regular basis. Since 2014, Sweden is considered free from BVD. In 2016, two herds were antibody positive but were considered to be non-infected after investigation.

DISEASE

BVDV may induce disease of varying severity, duration and clinical signs after an incubation period of 6-12 days. Fever, depression, respiratory distress, diarrhoea are typical signs of acute BVD. In pregnant cattle, infection may result in reproductive failure such as abortion, stillbirth or the birth of calves that are persistently infected with the virus. A more uncommon form of BVD is mucosal disease, that may occur

in an acute or chronic form in persistently infected animals.

LEGISLATION

BVD is a notifiable disease according to SJVFS 2013:23. The voluntary control is regulated through SJVFS 1993:42 and the compulsory control in SJVFS 2002:31.

SURVEILLANCE

Herds are individually risk categorised based on the number of herds they have purchased from and sold to during the preceding 12-month period.

Surveillance of dairy herds is performed by sampling bulk milk in conjunction with milk quality testing. The laboratory gets an order from Växa Sverige about which herds to sample. All samples are marked using bar code labels. Surveillance of beef herds is performed by blood sampling at slaughter. Field testing can also be carried out as a backup component if herds to be tested cannot be accessed through the abattoir or through sampling of bulk milk. The scheme is designed to detect the presence of infection at a herd design prevalence of 0.2%, with 99% confidence. The within-herd design prevalence is set to 30%. In case of re-appearance of BVD, herds that are infected will be screened, and persistently infected virus carriers identified and removed. Details on numbers of samples and herds tested 2017 are given in Tables 4 and 5.

Diagnostic testing is performed at the National Veterinary Institute. For screening, an indirect antibody ELISA (Svanovir® BVDV-Ab ELISA) is used on serum, milk and bulk milk samples. Presence of virus is analyzed by an in-house IPX (immunoperoxidase) or PCR tests.

RESULTS

Numbers of antibody positive bulk milk, slaughter, and field samples tested in 2017 are given in Table 4. As shown in Table 5, two herds (both beef herds) were antibody positive during the year. These herds were investigated and considered to be non-infected. In 2017, no newly infected herds were identified and no virus positive animals were born.

DISCUSSION

All herds in Sweden were affiliated to the voluntary or compulsory programmes during 2017. At the end of the year, no herd was diagnosed to have an ongoing BVDV-infection. A newly infected herd has not been detected since 2011, and the last virus positive animal was born in an infected dairy herd in 2012. Since 2014, Sweden is considered free from BVDV. Continued surveillance is necessary to maintain confidence in freedom from the disease.

REFERENCES

Växa Sverige, Statistics for 2017.

Table 4: Total numbers of samples with different contents of BVDV antibodies tested in 2017.

Sample type	Class/Finding	Herds	Animals
Bulk milk	0-1 ^A	2,388	-
Bulk milk	2-3 ^A	0	-
Blood sample at slaughter	Negative	-	11,402
Blood sample at slaughter	Positive	-	2
Field sample	Negative	-	347
Field sample	Positive	-	0

^A Class 0-1 = no or very low levels of antibodies; Class 2-3 = moderate or high levels of antibodies.

Table 5: Dairy and beef herd results from testing of BVDV antibodies in bulk milk or blood samples in 2017 divided by herd level risk

Herd level risk ^A	Herd numbers (N)	Production type	
		Dairy	Beef
<i>Low risk</i>	N of herds	2,456	7,009
	N of herds tested	963	1,891
	N positive	0	0
<i>Medium risk</i>	N of herds	1,270	1,626
	N of herds tested	1,156	947
	N positive	0	1
<i>High risk</i>	N of herds	331	1260
	N of herds tested	278	331
	N positive	0	1

^A Based on the number of herds they have purchased from and sold to during the preceding 12 month period

Brucellosis

BACKGROUND

Brucellosis is caused by a zoonotic, gram-negative bacterium belonging to the genus *Brucella*. Most human cases are caused by four species, each having a preferred animal host. *Brucella melitensis* occurs mainly in sheep and goats, *Brucella abortus* in cattle *Brucella suis* in pigs and *Brucella canis* in dogs. The infection is transmitted by contact with placenta, foetus, foetal fluids and vaginal discharges from infected animals and may also be found in milk, urine, semen and faeces. *In utero* infections occur, however, venereal transmission seems to be uncommon. Humans are usually infected through contact with infected animals or contaminated animal products, such as cheese made of unpasteurised milk.

Brucellosis was eradicated from the Swedish cattle population during the first half of the last century. The last Swedish bovine case was recorded in 1957. Brucellosis in humans has been a notifiable disease in Sweden since 2004. Between 4 and 19 human cases have been reported annually. Most of these patients have acquired the infection outside Sweden or via consumption of products from countries where brucellosis is endemic.

DISEASE

Animals

In animals, brucellosis mainly causes reproductive disorders such as abortion, orchitis and epididymitis. Arthritis is occasionally seen in both sexes. Systemic signs and deaths are rare, except in the foetus or newborn. The period between infection and abortion or other reproductive signs is variable. Infected asymptomatic females may shed the organism in milk and uterine discharges.

Humans

B. melitensis is considered to be the most severe human pathogen in the genus. Brucellosis in humans is commonly characterised by fever periods that wax and wane (undulant fever) with headache, malaise and fatigue. Untreated brucellosis can continue for months and progress to meningitis, cardiac infections, bone and joint infections. If left untreated the mortality rate is around 2%.

LEGISLATION

Animals

Brucellosis in food-producing animals is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). Vaccination is prohibited and notification of suspect cases is mandatory. Sweden's bovine brucellosis free status has been officially stated in EU legislation since 1994, Decision 2003/467/EC. Ovine brucellosis is covered by Directive 91/68/EEC. Sweden was declared officially free from brucellosis in sheep and goats in 1995 by Decision 94/972/EC.

Current surveillance standards for bovine and ovine brucellosis are given in the EU legislation, Directive

64/432/EEC and Directive 91/68/EEC, respectively.

Brucellosis in non-food-producing animals is not included in the Swedish Act of Epizootic diseases but is still notifiable.

Humans

Brucellosis has been a notifiable disease since 2004 according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

The purpose of the surveillance activities is to document freedom from bovine and ovine brucellosis in Sweden in accordance with the EU legislation, and also to document freedom from the disease in the Swedish pig population. The Swedish Board of Agriculture finances the surveillance, which is planned and executed by the National Veterinary Institute. Since the start of the screenings, no samples have been confirmed positive. All diagnostic testing is performed at the National Veterinary Institute. Bovine samples (serum and milk) are tested with an ELISA, and porcine, ovine and caprine samples (serum) are tested with the Rose Bengal Test (RBT). In case of positive reactions in the ELISA or RBT, serum samples are confirmed with a Complement Fixation Test (CFT). For positive bovine milk samples, serum samples are requested for re-testing with the ELISA.

Diagnostic tests for animals with clinical signs suggesting brucellosis or animals that are to be exported/imported will often be tested with the same diagnostic tests as used in the Swedish surveillance programme. Samples from animals (foetuses) included in the passive post mortem surveillance programme are cultured. For rare species, CFT is most commonly used and Rapid Slide Agglutination Test (RSAT) is the most common test for dogs. A positive case is defined as an animal from which *Brucella* spp. has been isolated, or in some cases an animal with a confirmed positive serological reaction.

Humans

Diagnosis of human cases is made by detection of *Brucella* species in blood, bone marrow, bronchoalveolar lavage, biopsy, pleural effusion or urine or, commonly for non-acute infections, by detection of antibodies in blood. Clinical samples from acute infections are tested by direct real-time PCR in parallel by culture. Positive colonies are investigated by microscopy, MALDI-TOF and repeated PCR.

Passive surveillance

Animals

Suspicious based on clinical signs in food producing animals must be reported to the Swedish Board of Agriculture and will be subsequently investigated. In addition, culture for *Brucella* spp. is included in the enhanced passive surveillance of aborted foetuses of ruminants and pigs (Page 116).

Brucellosis in dogs is not included in the Swedish Act of Epizootic diseases and the zoonotic potential of *B. canis* is considered to be significantly smaller than that of *B. abortus*, *B. melitensis* or *B. suis*. Nevertheless, confirmed cases of infection with *B. canis* are notifiable and cases have also been investigated and put under restrictions by the Swedish Board of Agriculture.

Humans

Surveillance in humans is passive.

Active surveillance

Animals

Screening for *B. abortus* has been conducted regularly in Sweden since 1988, for *B. melitensis* since 1995 and for *B. suis* since 1996.

Ongoing serological testing of all susceptible species prior to export, and in bulls and boars at semen collection centres, adds to the active disease surveillance of *Brucella* spp.

Surveillance for brucellosis in cattle

This sampling is, since 2010, conducted every third year and was thus not performed in 2017. From 1997 and onwards, approximately 3,000 samples (bulk milk and/or serum samples) have been tested each year for antibodies against *B. abortus*. Samples are selected by systematic random sampling every 6th serum and every 8th milk sample evenly distributed throughout the sampling period from samples collected in the surveillance programmes for bovine viral diarrhoea and enzootic bovine leucosis.

Surveillance for brucellosis in sheep and goats

Serum samples were tested for antibodies against *B. melitensis*. The sheep serum samples were collected within the surveillance programme for Maedi/Visna and the goat serum samples were collected within the Caprine Arthritis Encephalitis programme. The samples were selected by systematic random sample by collecting the first 5 samples submitted from each herd in these surveillance programmes.

The ovine and caprine surveillance of 2017 was designed with a between-herd design prevalence of 0.2%, a within-herd prevalence of 40% and a risk of introduction of 1 in 25 years. Sample size is calculated on a yearly basis to reach a probability of freedom of 95% at the end of the year. To reach this target, 2,000 samples (5 samples per herd from 400 herds per year) is required.

Surveillance for brucellosis in pigs

From 1996 until 2008 approximately 3,000 serum samples from pigs have been tested for antibodies against *B. suis* each year. Beginning in 2009, serum samples are tested every second year, and accordingly, this sampling was performed in 2017.

RESULTS

Passive surveillance

Animals

During 2017, no clinical suspicions of brucellosis were seen in any food-producing animal species.

Within the surveillance of aborted fetuses, 22 bovine, 20 ovine, two caprine, one water buffalo and six pig fetuses were examined for *Brucella* spp. All samples were negative.

Humans

For many years, no domestic cases were reported and Sweden is therefore considered free from brucellosis. However, since 2010 there has been approximately one domestic case reported annually. Predominantly these cases have, or were suspected to have, consumed unpasteurized milk products from endemic countries. During the time period, one congenital and one laboratory acquired *Brucella* infection were also reported.

In 2017, 15 cases were reported. The most common country of infection was Iraq, which represented 10 of the cases. In addition, the only case without a travel history to endemic countries also reported to have consumed unpasteurised milk products from Iraq.

Active surveillance

Animals

During 2017, 2,000 ovine and caprine serum samples from 376 individual holdings were analysed for *B. melitensis* and 750 pig serum samples were analysed for *B. suis* within the active surveillance programme. The pig samples originated from 750 sampling occasions and each herd was as a rule sampled 1-2 times during the year.

One sheep in one herd tested positive in the ovine surveillance. There were some clinical signs in this herd but no epidemiological links suggesting possible routes of introduction. Serological samples from all twelve animals in the herd were tested for *B. melitensis*, all with negative results and altogether infection was ruled out.

All samples from the serological testing prior to export and from bulls at semen collection centres were also negative.

DISCUSSION

In summary, *Brucella* infection was not detected in cattle, sheep, goats or pigs during 2017. The long standing and extensive serological screenings performed without finding any infection and the very low number of human cases, only occasionally domestically acquired, confirms that *Brucella* is not present in Swedish food-producing animals. The enhanced passive surveillance in aborted fetuses from food-producing animals is an important part of the surveillance system.

An unknown number of stray dogs from countries where *B. canis* is endemic are brought into Sweden every year. It is important to be aware of the risk this group of dogs represents, for *Brucella* infection as well as for other diseases. Imported non-stray dogs, or dogs mated abroad are seen as a risk factor for introduction of *B. canis* into Sweden as well. During the past six years five dogs have tested positive for *B. canis* using bacterial culture and/or serology. All these dogs were imported or had close contact with imported dogs.

Campylobacteriosis



A national outbreak of human campylobacteriosis in 2016-2017 was temporally associated with an increase in the prevalence of *Campylobacter* in broiler flocks from one large abattoir. Subtyping of isolates from humans, animals and chicken meat confirmed the temporal association. Photo: Désirée Jansson

BACKGROUND

Thermophilic *Campylobacter* spp. are gram negative curved rods, and are the most common cause of human bacterial gastroenteritis in many countries. *Campylobacter* was first isolated from human diarrhoea in 1972, although spiral bacteria had earlier been seen microscopically in human stool samples. Most human infections are caused by *C. jejuni*, followed by *C. coli* and a few by other *Campylobacter* species.

Birds are considered the principal reservoir although *Campylobacter* can colonise the intestinal tract of many other animal species. The bacteria are excreted in faeces. *Campylobacter* spp. are fragile organisms but are able to survive in water for longer periods. The infectious dose for humans is low. A seasonal peak in the summer months is observed in most European countries. Most human infections are considered sporadic, which makes identification of the source of infection difficult in the absence of molecular typing. Risk factors for infection include consumption or handling of undercooked contaminated meat products (especially poultry), consuming contaminated unpasteurised milk and other dairy products, drinking from contaminated water supplies, travelling abroad and contact with farm animals and pets.

During the last two decades, the incidence of human campylobacteriosis has varied between 67 and 110 cases per 100,000 inhabitants (Figure 5). Of these, approximately 20-60% have been reported as domestic. In recent years, the proportion of domestic cases has increased.

DISEASE

Animals

Asymptomatic carriage of thermophilic *Campylobacter* is common in several animal species, including poultry, cattle, pigs, sheep and dogs. The prevalence is higher in younger animals.

Humans

Campylobacteriosis is an acute, usually self-limiting enteric disease that resolves within a week. In some individuals, the symptoms may last longer. The symptoms are mild to severe: diarrhoea, fever, abdominal pain, nausea and malaise. The infection can be complicated by reactive arthritis, irritable bowel syndrome as well as the neurological disorder Guillain-Barré syndrome.

LEGISLATION

Animals

Findings of thermophilic *Campylobacter* spp. in meat-producing poultry are notifiable in Sweden, according to SJVFS 2012:24. In addition, *Campylobacter fetus* subsp. *venerealis*, which causes bovine genital campylobacteriosis, is notifiable.

Food

Detection of *Campylobacter* spp. in food is not notifiable.

Humans

Infection with *Campylobacter* is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

A monitoring programme for broiler chicken has been operated by the Swedish Poultry Meat Association since 1991. The programme is co-financed by the Swedish Board of Agriculture (SJVFS 2015:17, K152). The goal of the programme is an overall annual *Campylobacter* prevalence of less than 10% of the batches of slaughter chicken. Prior to 2017, the goal was 5%. In 2017, the guidelines of the programme were reviewed.

The programme covers 99% of the broilers slaughtered in Sweden. Since 2006, sampling is performed by collecting intact caeca from 10 birds from each slaughter batch at the major abattoirs. When thinning is applied, samples are taken from both batches. The caeca are pooled into one composite sample per batch. Samples are analysed according to ISO 10272 part 1.

In 2017, all *Campylobacter* isolates collected in the monitoring programme during two periods of 2.5 weeks, starting week-8 and week-31, were subjected to whole genome sequencing. The time frames were selected to precede the collection of human domestic isolates.

Food

No official surveillance programme exists. Sampling may be performed by national and local authorities as part of extended official controls, or as targeted projects. In 2017, 300 samples of fresh chicken meat were taken at retail. These samples were taken and analysed by the National Food Agency during spring (March and May) and late summer (August).

Humans

A trace back investigation is performed for all domestic cases of campylobacteriosis. Since 2017, the Public Health Agency of Sweden requests isolates from all domestic cases reported during week 11 (low season) and week 34 (high season) for whole genome sequencing. The periods for collection were chosen to reflect the diversity in different seasons. The aims of the typing are to assess the diversity of domestic strains and identify clusters.

RESULTS

Animals

In 2017, thermophilic *Campylobacter* spp. were detected in 474 (10.7%) of the 4,419 conventionally produced broiler chicken batches tested at slaughter (Figure 6), which is less than the year before. However, the monthly prevalence of *Campylobacter* in chicken slaughter batches varied between 1.4% and 18.6% with the highest prevalence in February. The prevalence during the first six months of the year was higher than during the previous years. *Campylobacter* prevalence varied between the abattoirs. The largest

Swedish chicken abattoir, which produces approximately 50% of the national supply, had problems with contamination of *Campylobacter* and thus an unusually high prevalence.

Typing by whole genome sequencing was performed on all isolates collected in one period in late winter/early spring (48 isolates) and in one period in the summer (59 isolates). During the first period, more than 90% of the isolates were of the same strain and originated from one abattoir. Typing performed on isolates collected during the summer revealed a much higher diversity of strains. However, the dominating strain from the first period still represented 25% of the isolates analysed in the second period.

Food

In spring and late summer, *Campylobacter* was detected in 43% and 50% of the samples, respectively. In spring 2017, most findings (69%) of *Campylobacter* were from samples originating from the largest Swedish chicken abattoir, whereas most *Campylobacter* positive samples in late summer originated from organic chicken (88%).

In addition, 276 samples were also collected by local authorities. These were mostly taken as part of a survey (201 of 276). *Campylobacter* were detected in 3 of all 276 samples. One of the three positive samples in which *Campylobacter* was detected, was taken as part of an investigation of a complaint or a suspected food poisoning, while two positive samples were taken for another reasons. The positive samples were from broiler meat.

Humans

A total of 10,608 cases of campylobacteriosis were reported in 2017. Of the reported cases, 58% (6,023 cases) were domestic. The incidence in domestic cases decreased by 14% from the year before to 59.5/100,000 inhabitants, which is lower than in 2016 but higher than recent years. Seen over a longer period there is an increasing trend in the domestic incidence.

Among the domestic cases in 2017, the median age was 46 years with a spread from about 0 to 98 years. Like 2016, the domestic incidence was highest in adults above the age of 20, and there were more men (54%) than women reported with campylobacteriosis. The incidence was higher among men in all age groups.

Of the 4,358 cases infected abroad, Spain was the most common country of infection (931 cases), followed by Thailand (629 cases) and Greece (248 cases). In contrast to the increasing trend in the domestic incidence, the incidence in travel related infections does not show a statistically significant change over time. However, the analysis was done using population size as an exposure and did not account for differences in travel between years.

During August 2016 to June 2017 an outbreak of campylobacteriosis was occurring in Sweden. This outbreak was the largest in Sweden so far and was estimated to have caused approximately 5,000 notified cases.

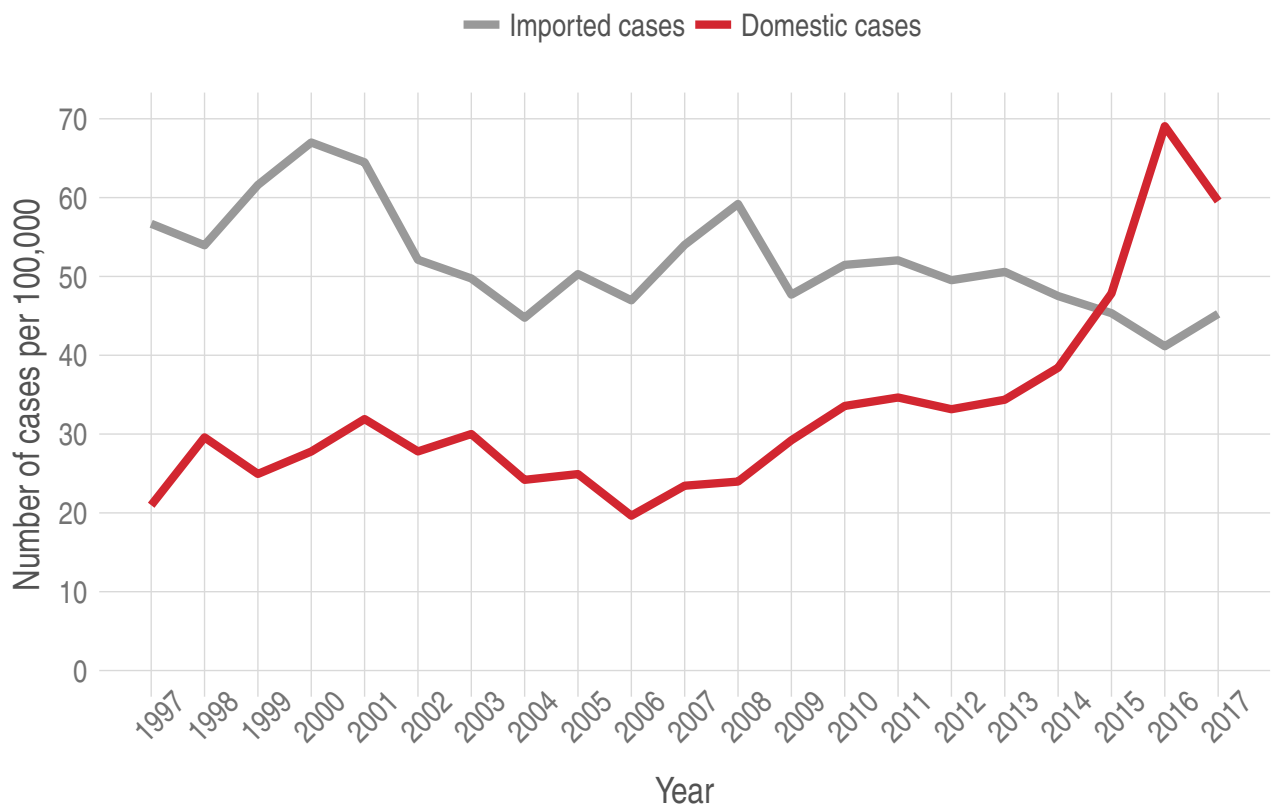


Figure 5: Notified incidence (per 100,000 inhabitants) of human cases of campylobacteriosis in Sweden, 1997-2016. Imported cases are those where the patient has reported travel to another country during the incubation period prior to clinical presentation. Domestic cases are patients that have not recently travelled outside Sweden.

In 2017, *Campylobacter* was included in the microbial surveillance programme of the Public Health Agency. In the active surveillance conducted in March (week 11), more than 80% of the isolates belonged to the outbreak strain. The outbreak strain was still identified in August (week 34) and constituted the largest cluster.

DISCUSSION

During the last fifteen years, the number of reported human domestic cases of campylobacteriosis has increased. Although most campylobacteriosis cases are considered sporadic, outbreaks do occur. This was observed in 2012, when stored human isolates were subtyped together with strains from suspected sources and matches were discovered. The subtyping showed to be a useful tool in the outbreak identifications. Moreover, the large increase in human cases in the winter months during the last three years, and its link to poultry, shows that national outbreaks of campylobacteriosis do occur. The exceptional increase in domestic cases in 2016-2017 was temporally associated with an increase in the prevalence of *Campylobacter* in broiler flocks from one abattoir. Subtyping of isolates from humans, animals and chicken meat has confirmed the temporal association.

In 2017, the annual prevalence of *Campylobacter* in broiler chicken batches was lower than the year before (Figure 6). However, during the first six months of the year, the largest Swedish chicken abattoir had problems with *Campylobacter* contamination. This abattoir covers approximately

50% of the national market supply of chicken meat. *Campylobacter* prevalence varies considerably between abattoirs, with only a few findings in some abattoirs and high prevalences at others. Chicken production has increased in Sweden and the industry has started to apply practices that has increased the prevalence of *Campylobacter* infected broiler flocks.

The increase in domestic cases was due to a corresponding increase in the proportion of *Campylobacter* infected poultry flocks from one domestic abattoir. This could, in turn, be explained by an incorrect installation of a new washing equipment for transport cages in combination with the practice of thinning as well as shorter empty periods between rounds of flocks. After the error with the washing equipment was discovered, it also took a long time to reduce the infection pressure at the broiler farms. The outbreak strain was found in human samples, in chicken caecal samples and in chicken meat samples, from this specific abattoir, collected from different stores.

In 2017, the guidelines for the surveillance programme were renewed. Reducing *Campylobacter* prevalence at the farm level decreases the risk of human infection. Over the years, applying strict biosecurity measures has decreased the number of *Campylobacter* positive broiler slaughter batches in Sweden. However, there has been a marked change in the production system and more effort is needed to decrease the number of infected broiler flocks.

Broiler carcasses are easily contaminated at slaughter

which necessitates that consumers apply good hygiene practices. Strict hygiene in the kitchen is essential to avoid cross-contamination between contaminated raw meat and food that will not be heated such as raw vegetables.

In 2013, a national strategy plan for *Campylobacter* was published in cooperation between the Swedish Board of Agriculture, National Food Agency, Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute to decrease human incidence of campylobacteriosis. Several measures to control the infection were proposed in the strategy document, which is now scheduled for revision in 2018. As the *Campylobacter* outbreak caused by domestically produced chicken was challenging to control, the Swedish authorities asked Finnish experts to evaluate the actions taken. The recommendations of the experts will be considered in the revision of the national *Campylobacter* strategy.

REFERENCES

Folkhälsomyndigheten. Mikrobiologisk övervakning av campylobacter. 2018, <https://www.folkhalsomyndigheten.se/mikrobiologi-laboratorieanalyser/mikrobiella-och-immunologiska-overvakningsprogram/overvakning-av-campylobacter/>.

Hansson I., Nyman A., Lahti E., Gustafsson P., Olsson Engvall E., Associations between *Campylobacter* levels on

chicken skin, underlying muscle, caecum and packaged fillets, *Food Microbiol.*, 2015, 178-181.

Hansson I, Vågsholm I, Svensson L, Olsson Engvall E. Correlations between *Campylobacter* spp. prevalence in the environment and broiler flocks. *J Appl Microbiol.* 2007; 103:640-9.

Harvala H, Rosendal T, Lahti E, Olsson Engvall E, Brytting M, Wallensten A, Lindberg A. Epidemiology of *Campylobacter jejuni* infections in Sweden, November 2011-October 2012: is the severity of infection associated with *C. jejuni* sequence type? *Infect. Ecol. Epidemiol.* 2016; 6:31079. doi: 10.3402/iee.v6.31079.

Lindqvist R, Lindblad M. Quantitative risk assessment of thermophilic *Campylobacter* spp. and cross-contamination during handling of raw broiler chickens evaluating strategies at the producer level to reduce human campylobacteriosis in Sweden. *Int J Food Microbiol.* 2008; 121:41-52.

Newell, DG, Elvers KT, Dopfer D, Hansson I, Jones P, James S, Gittins J, Stern NJ, Davies R, Connerton I, Pearson D, Salvat G, Allen VM.

Biosecurity-based interventions and strategies to reduce *Campylobacter* spp. on poultry farms. *Appl Environ Microbiol* 77(24): 8605-8614n.

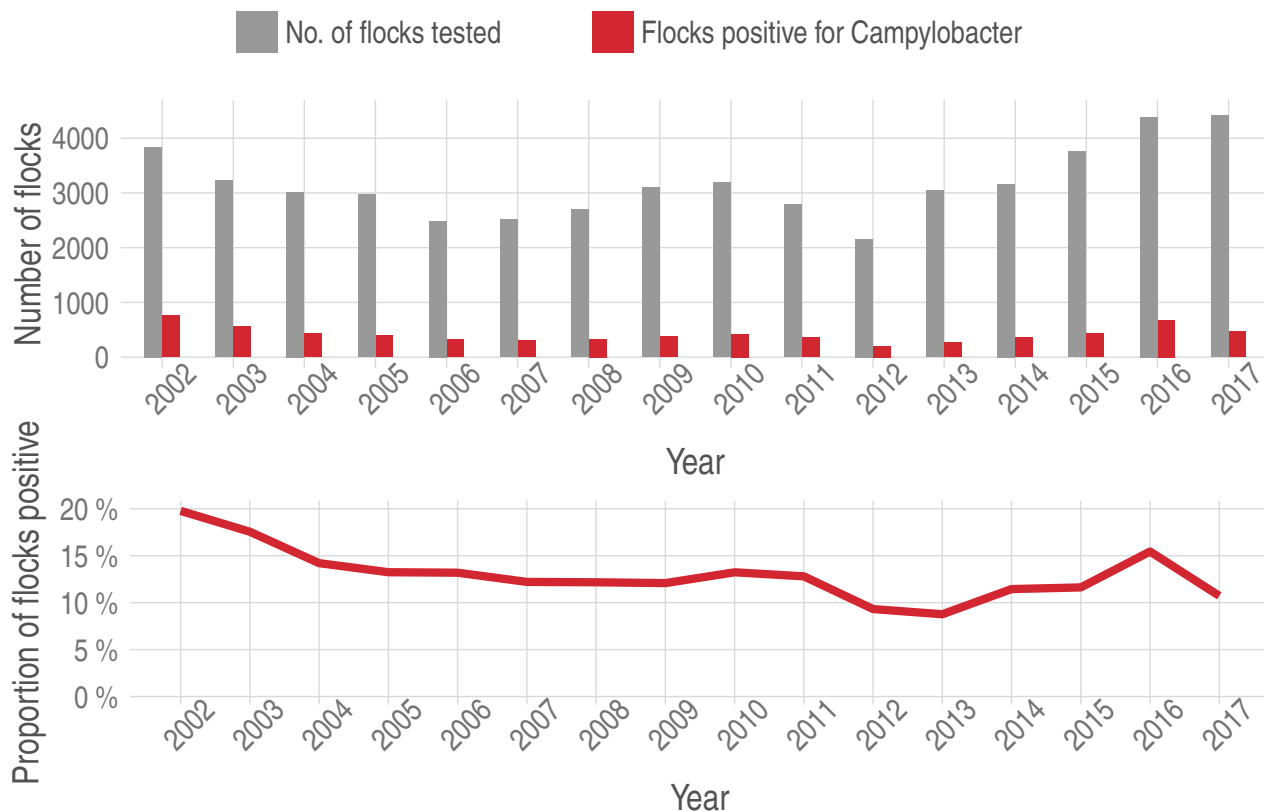


Figure 6: Prevalence of *Campylobacter* in broiler flocks in 2002-2016.

Chronic wasting disease

BACKGROUND

Chronic wasting disease (CWD) is a transmissible spongiform encephalopathy (TSE) affecting cervid species. The disease was first described in Colorado in 1967 and in 1978 identified as a transmissible spongiform encephalopathy (TSE). The disease has spread, and is now confirmed present in at least 22 states in the USA, and in two Canadian provinces (CDC, 2018). Through export of live cervids, CWD has also spread to South Korea.

Until 2016, CWD had not been reported in Europe. But in spring of 2016, the first case in Europe was detected in wild reindeer in the region of Nordfjella in Norway (Benestad *et al*, 2016). As a consequence of the finding, surveillance in Norway was intensified and this has so far (April 2018) resulted in the detection of the disease in three moose close to the Swedish border (in Selbu and Lierne), one red deer (in Gjemnes) and detection of 17 further cases in the reindeer flock of Nordfjella. The cases in reindeer show similarities with the cases found in North America, whilst the cases in moose and red deer have been shown to differ from the cases in reindeer. What this means in terms of differences in e.g. the disease transmission pattern is still unknown. The origin of the outbreaks has not been confirmed.

In March 2018, the first case of CWD in Finland was reported. It was a fifteen-year old moose that was found dead in Kuhmo in the eastern parts of Finland. The case showed similarities with the cases in moose and red deer in Norway.

Wildlife, including cervid animals, cross the border between Sweden and Norway. Some semidomesticated reindeer also cross the border between the countries. In Sweden, reindeer herding is an essential part of the Sami culture; there are no wild reindeer and only Sami people have the rights of reindeer husbandry. Moose and roedeer live in the wild (with few exceptions) and many people are involved in hunting of these species. The farmed cervid species in Sweden are mainly fallow deer and red deer, as well as a low number of moose.

Due to similarities with BSE, which is linked to variant Creutzfeldt Jacobs disease in humans, and the known fact that many transmissible spongiform encephalopathies experimentally can be transmitted between several different species, there has been a suspicion that Chronic Wasting Disease may be a zoonotic disease. Currently, there is not enough data to exclude that CWD could be zoonotic, however, the risk is deemed to be very low (VKM 2016 and 2017, Wadell 2017). In areas where CWD is endemic, people are recommended not to consume animals displaying clinical signs consistent with CWD or animals with positive test results for CWD.

HISTORY

The disease has so far (April 2018) not been detected in Sweden. However, with exception of an EU-regulated active

surveillance in 2007-2010, and a retrospective study examining 270 frozen brains from cervids sent for necropsy between 2008 to first part of 2016, surveillance has only been passive, i.e. based on reporting of animals displaying clinical signs. Since the disease has not been known to occur in Europe, the awareness of the disease in the field has been low and as a consequence very few animals have been examined.

DISEASE

The incubation period is long, over a year. The disease spreads through direct contact between animals but also through body excretions which can contaminate the environment. The predominant clinical signs are behavioural changes, change of locomotion and loss of body condition. The disease is fatal.

The currently accepted theory of TSEs is that they are transmitted through small proteins, prions with abnormal structural conformation. These prions induce a structural transformation of normal prion-proteins in the body of the recipient. Thus, the disease is not caused by parasites, bacteria, fungi or viruses, but by proteins. The full details of these processes are not yet understood. Prions accumulate in body tissues, especially the brain where damage can be observed when studying tissue in a microscope. Although TSEs exist in other ruminant species, i.e. bovine spongiform encephalopathy (BSE) in cattle and Scrapie in sheep and goats, there are essential differences when it comes to spread of disease and distribution of prions in the body. Spontaneous cases of TSEs seem to occur both in human and animals.

LEGISLATION

CWD is a notifiable disease under the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments) and there is a scheme to compensate farmers for losses due to eradication measures. CWD is also regulated through the Commission Regulation (EU) 2017/1972 of 30 October 2017 amending Annexes I and II to Regulation (EC) No 999/2001 of the European Parliament and of the Council as regards a surveillance programme for chronic wasting disease in cervids in Estonia, Finland, Latvia, Lithuania, Poland and Sweden and repealing Commission Decision 2007/182/EC.

SURVEILLANCE

As mentioned above, CWD is a notifiable disease. However, since the disease has not been known to be present in Europe prior to 2016, the awareness of the disease has been low and very few suspect cases have been reported. In response to the detection of CWD in Norway, information was sent to stakeholder organisations encouraging them to be observant and notify animals displaying clinical signs of CWD. To further raise the awareness of CWD amongst concerned parties, a workshop was organised by SVA in October 2017. Media has also shown a growing interest in CWD during 2017.

General sampling of all adult cervids sent for necropsy

to SVA started during summer 2016. In response to the additional finding of a CWD positive moose in Norway close to the Swedish border a limited active surveillance was conducted in the county of Jämtland where samples were collected during the moose hunting period. Brainstem and lymph node samples were analysed with Bio-Rad TeSeE short assay protocol (SAP) at the National Veterinary Institute which is the National Reference Laboratory (Regulation (EC) 999/2001) for TSEs.

RESULTS

One investigation following clinical suspicion of CWD (in a moose) was carried out in 2017, with negative result. In addition, 239 cervids (191 moose, 13 roe deer, 6 red deer, 8 fallow deer and 21 reindeer) were examined for CWD at SVA during 2017, all with negative results. Around 60 of the moose were examined as a result of the active surveillance in the county of Jämtland.

DISCUSSION

The number of animals examined so far has been limited and not well represented geographically. The current CWD status of the country is therefore largely unknown. As a next step, large scale surveillance, ensuring geographic coverage, is needed. A surveillance programme, as regulated in Commission Regulation (EU) 2017/1972, will be conducted during the years 2018 to 2020.

If the disease is present or introduced into the country, it could have large consequences for reindeer, wild cervid

populations and farmed cervids. Consequently, the disease could also have large consequences for people involved in activities related to, or making their living from, these species.

The experience from North America is that CWD is very difficult to eradicate, and to have a chance, early detection is needed while the prevalence is still low.

REFERENCES

Centers for Disease Control and Prevention, <https://www.cdc.gov/prions/cwd/occurrence.html> (accessed 2018-03-26)

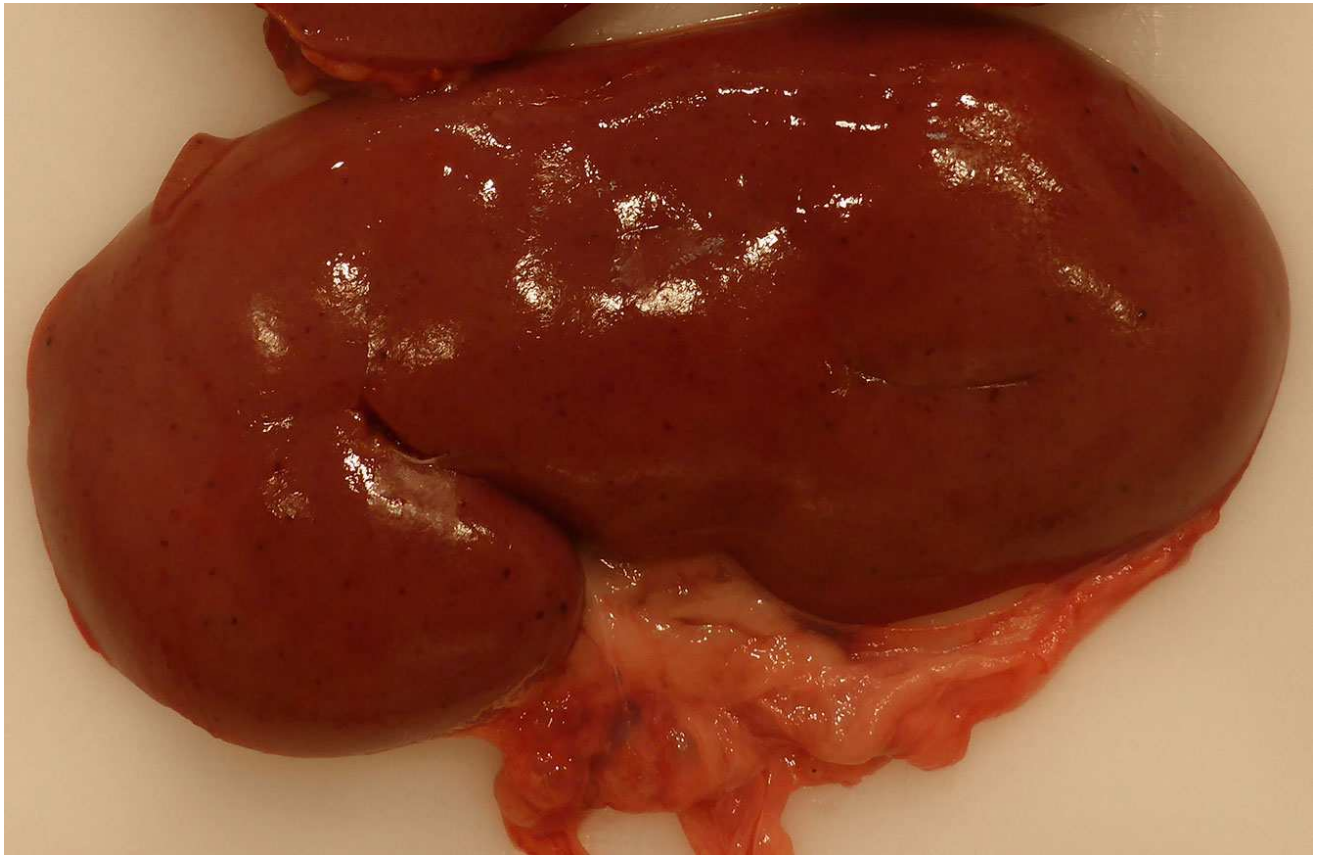
Benestad SL, Mitchell G, Simmons M, Ytrehus B, Vikøren T., First case of chronic wasting disease in Europe in a Norwegian free-ranging reindeer. *Vet Res.* 2016 Sep 15;47(1):88. doi: 10.1186/s13567-016-0375-4.

VKM (2016). CWD in Norway. Opinion of the Panel on biological hazards, ISBN: 978-82-8259-216-1, Oslo, Norway.

VKM (2017). CWD – update statement. Opinion of the Panel on biological hazards, ISBN: 978-82-8259-283-3, Oslo, Norway.

Waddell L, Greig J, Mascarenhas M, Otten A, Corrin T, Hierlihy K., Current evidence on the transmissibility of chronic wasting disease prions to humans-A systematic review. *Transbound Emerg Dis.* 2017 Jan 30. doi: 10.1111/tbed.12612.

Classical swine fever



The acute form of the classical swine fever includes clinical signs such as high fever ($<42^{\circ}\text{C}$), shivering, weak hind legs, purple discolouration of the skin and diarrhoea. At post mortem, multiple and disseminated petechiae (small bleedings) in the kidney are a common finding. Photo: Emil Wikström

BACKGROUND

Classical swine fever (CSF) is a disease of pigs caused by a pestivirus closely related to bovine virus diarrhoea virus and border disease virus. The acute clinical form of CSF cannot be distinguished from the clinical manifestation of African swine fever (ASF), although these two viruses are not related. CSF is considered one of the most important and devastating pig diseases worldwide. During 1997-98 an extensive outbreak occurred in the Netherlands, Germany, Belgium and Spain. Since then, outbreaks in Europe have been confined to more limited geographic regions although the outbreaks in Lithuania 2009 and 2011 involved very large farms and are thus considered extensive. In 2012 and 2014, CSF was reported in domestic pigs in Latvia and was still present in the wild boar population there during 2015. Ukraine also reported CSF in wild boar in 2015 and CSFV is also present in Russia as well as in Asia and South America. CSF has not been diagnosed in Sweden since 1944 and Sweden received official status as a historically CSF free country issued by OIE in February 2015.

Classical swine fever is a highly contagious disease that is transmitted by direct and indirect contact between animals. Feeding pigs swill contaminated with CSFV is considered the main route of spreading the disease to new areas.

Because of this, swill feeding of pigs is prohibited in the European Union.

DISEASE

CSF appears in different clinical forms; acute, chronic and a mild form with reproductive disorders as the main clinical manifestation. The incubation period is 2-14 days and the acute form of the disease includes high fever ($<42^{\circ}\text{C}$), shivering, weak hind legs, purple discolouring of the skin and diarrhoea. Chronically infected animals exhibit a more diffuse clinical picture with intermittent fever, anorexia and stunted growth. In the mild form, abortion is the main clinical sign.

LEGISLATION

CSF is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and the control of the disease is regulated in detail through Council Directive 2001/89/EC with amendments.

SURVEILLANCE

The purpose of the surveillance programme is to document freedom from CSF in the Swedish pig population and to contribute to the maintenance of this situation by early detection of an introduction. The National Veterinary Institute

is responsible for surveillance design, sample analysis and reporting to the Swedish Board of Agriculture. Serological analyses for CSF, PCR analyses for the presence of CSF viral genome and CSFV culturing are performed at the National Veterinary Institute. CSF serology is done using a commercial kit (IDEXX® HerdChek CSFV Antibody Test Kit) and in case of positive ELISA results, a confirming serum neutralisation (SN) test for detection of antibodies against CSFV is performed.

Passive surveillance

Because CSF is notifiable on clinical suspicion for both veterinarians and farmers, cases with clinical signs consistent with CSF will be investigated following a notification to the Swedish Board of Agriculture. The investigation includes restrictions on the farm during investigation, sampling of sick or dead animals and examination of the herd for presence of clinical signs and analyses of production results. Due to the similarity of clinical signs, samples are analysed for both CSF and ASF. This strategy is strongly recommended by the EU.

In addition, analyses for the CSFV genome with PCR are included in the enhanced passive surveillance of aborted foetuses (Page 116).

Active surveillance

Samples collected for the abattoir sampling part of the surveillance carried out by the Farm & Animal Health for porcine reproductive and respiratory syndrome (PRRS) were used for the active surveillance (See chapter on PRRS for details on sampling and population). The surveillance was designed using a design prevalence of 0.5% between herd, 40% within herd, and a risk of introduction of 1 in 25 years. The number of samples needed to achieve a probability of freedom of >99% is calculated yearly taking the surveillance results of previous years into account. For 2017, the number of samples needed was 2,000. Typically, all three samples from each holding from the abattoir sampling for PRRS were used. Temporarily, two samples per holding were analysed for CSF depending on the sample flow in the PRRS surveillance.

In addition to the surveillance of CSF in domestic pigs there is also active surveillance of CSF in wild boar (Page 106)

RESULTS

Passive surveillance

Three investigations following clinical suspicion of CSF were carried out during 2017, two in domestic pigs and one in wild boar. The clinical manifestations included sudden deaths, neurological signs and circulatory disorders including organ hemorrhages and purple discoloration of the skin. Following further investigations, including sampling, the herds and the wild boar could be declared negative for CSF (the investigations also included testing for African swine fever).

Within the surveillance of aborted foetuses, 6 foetuses from 4 herds were examined for the CSF viral genome and all samples were negative.

Active surveillance

Serum samples from 1,992 pigs were analysed and in none of them antibodies to CSFV could be found. Taking the surveillance outcome from 2016 into account, the probability of freedom based on the summarised surveillance during 2017, was >99%.

DISCUSSION

The results from the passive and active surveillance for CSF in Sweden during 2017 add to the documentation of freedom from this infection in the Swedish commercial pig population. During recent years the Swedish pig industry has undergone heavy structural changes leading to a rapidly declining number of herds and extensive changes in the market and in the habits of farmers. The active surveillance, in terms of planning design and number of samples, is therefore evaluated yearly and adjusted accordingly if needed.

Although the situation regarding CSF in the EU has successively improved in recent years, occasional outbreaks in domestic pigs in countries close to Sweden and the extensive movement of products and people, including labour in the animal production sector, emphasises the need for both passive and active surveillance for CSF.

Coccidiosis and clostridiosis

BACKGROUND

Coccidiosis and clostridiosis are intestinal diseases that commonly affect broiler chickens worldwide. Both diseases are major causes of economic losses and reduced welfare.

DISEASE

Coccidiosis is caused by microscopic parasites (genus *Eimeria*) that invade the intestinal epithelium. *Eimeria spp.* are ubiquitous, resilient and host specific parasites that are easily transmitted between birds by the faecal-oral route, especially when birds are kept on litter at a high stocking density. The severity of the intestinal lesions is influenced by parasite and host factors, such as parasite species, infectious dose, host age and level of immunity. Generally, young broiler chickens are highly susceptible.

Clostridiosis is a multifactorial disease and the pathogenesis is not well understood. Clostridiosis is associated with proliferation of the bacterium *Clostridium perfringens* type A, which together with management factors and loss of mucosal integrity cause lesions in the intestines (necrotic enteritis) and liver (cholangiohepatitis).

Clinical signs of coccidiosis and clostridiosis range from clinical disease with significantly increased mortality rates to mild or subclinical forms, which are associated with reduced weight gain and impaired feed conversion. Clostridiosis is also a cause of condemnation at slaughter due to liver lesions. Both diseases may be prevented by in-feed ionophorous anticoccidials.

LEGISLATION

The health control programme for coccidiosis and clostridiosis in broilers is regulated in Swedish legislation (SJVFS 1998:131) and is administered by the Swedish Poultry Meat Association.

SURVEILLANCE

The purpose of the surveillance is to document that the anticoccidials efficiently protect broilers from disease. The longterm goal is to replace anticoccidials by other preventive measures such as vaccines.

Intestinal lesion scoring

Field control of anticoccidial efficacy is performed by a lesion scoring method in broiler chickens from 20 selected farms originating from regions served by different feed mills. The flock selection is performed by the Swedish Poultry Meat Association. From each selected farm, intestinal lesion scoring (scale 0-4) is completed on 5 birds at 2 occasions during the year when the birds are between 22-24

days of age. If the mean total lesion score of an individual flock exceeds a certain level (2.5), an analysis of the feed for the concentration of anticoccidial is performed and an on-farm investigation of management and general health status is carried out.

Condemnation due to liver lesions

The occurrence of hepatic lesions is registered at the abattoir, and if more than 0.5% of the birds in a flock are affected, samples are sent for histological examination to the National Veterinary Institute. Data on the level of condemnations due to liver lesions are compiled on a quarterly basis, from all abattoirs.

RESULTS AND DISCUSSION

In 2017, 11 broiler flocks were investigated, and no lesion scores above 2.5 were identified.

Samples for histological examination of the liver were submitted from abattoirs originating from 58 broiler flocks with > 0.5% condemnation due to liver lesions. Lesions consistent with clostridiosis (i.e. cholangiohepatitis) were observed in all flocks.

It was concluded that there is currently no indication of reduced efficacy of anticoccidials in Sweden, despite the increasing occurrence of hepatic lesions at the abattoirs. No longterm trends towards reduced anticoccidial efficacy or increased prevalence of coccidiosis were observed.

During 2017, the Animal Health Board who is responsible for this programme has reviewed and assessed this control programme and proposed essential changes in the programme from 2018 as follows:

- The cutoff for submitting samples for histological examination, based on liver lesion-associated condemnation rates, will be increased from 0.5 to 2%.
- On-farm investigations will be initiated when condemnation due to liver lesions has exceeded 1% on more than two occasions. It is anticipated that in-depth investigations, focusing on possible causes of clostridiosis-associated liver lesions, will be carried out on 3-5 farms per year.
- Intestinal lesions will be removed as an indicator, since it is no longer recorded in the abattoirs.

REFERENCES

Johnson J, Reid WM (1970). Anticoccidial drugs: lesion scoring techniques in battery and floor-pen experiments with chickens. *Exp. Parasitol* 28, 30-36.

Echinococcosis

BACKGROUND

Echinococcosis is a common name for different diseases in humans caused by tapeworms belonging to the genus *Echinococcus*. Although the genus contains several species, only the species of *E. granulosus* and *multilocularis* exist in Europe. The life cycles of these parasites are completely different but both require two hosts: a definitive and an intermediate host. Humans are dead-end hosts of these parasites and may become infected by accidental ingestion of the eggs.

Alveolar echinococcosis

BACKGROUND

Echinococcus multilocularis is endemic in large parts of Europe and has a reported increasing geographical range. Although a rare disease in humans, alveolar echinococcosis is of considerable public health concern due to its high mortality if untreated as well as high treatment costs. The definitive hosts of this parasite are mainly foxes, but raccoon dogs, dogs, coyotes and wolves can also act as definitive hosts. Rodents, mainly voles, serve as intermediate hosts. Foxes contract *E. multilocularis* by eating infected rodents.

HISTORY

Prior to 2010, *E. multilocularis* had not been detected, and no case of alveolar echinococcosis had been reported in Sweden. As a response to finding *E. multilocularis* in foxes in Denmark, an active monitoring programme of the red fox (*Vulpes vulpes*) was implemented in Sweden in 2000. From 2000 to 2009, a total of 2,962 red foxes, 68 raccoon dogs (*Nyctereutes procyonoides*) and 35 wolves (*Canis lupus*) were examined for *E. multilocularis*, all with negative results. Samples from the majority of foxes ($n=2,675$) were examined by ELISA (CoproAntigen ELISA) at the Institute for Parasitology, Zurich University, for the presence of the *E. multilocularis* coproantigen. The remaining samples and those that were ELISA positive, were examined using the sedimentation and counting technique (SCT) ($n=726$). All samples from raccoon dogs and wolves were examined by SCT.

During 2010, 304 foxes were examined for *E. multilocularis*. A total of 103 were tested by SCT and 201 by egg PCR. One fox, shot in south-west Sweden (Västra Götaland) and analysed in 2011 was found to be positive.

During the spring of 2011, a national surveillance programme was implemented where 2,985 hunter-shot foxes were analysed with the segmental sedimentation and counting technique (SSCT). Three foxes were found positive: one in Västra Götaland, one in Södermanland and one in Dalarna County. In addition, 119 faecal samples from hunting dogs collected in the region of the first positive finding were analysed with egg PCR and all were negative. In the same area 236 rodents were necropsied and all potential lesions examined by an in-house PCR without any positive finding.

To obtain a better prevalence estimate in a known infected area, fox scats were collected, by a systematic sampling procedure, from a circular area with a diameter of 25 km surrounding a positive finding in Södermanland county. The samples were collected in 2011 and analysed in 2012, using semi-automated magnetic capture probe based DNA extraction and real-time PCR method (MC-PCR). Six out of 790 (0.8%) faecal samples were positive.

A second national screening was initiated in 2012 and continued in 2013 and 2014. In all, a total of 2,779 fox scat samples were analysed and three positive fox scats were identified, one from Gnesta, one from Katrineholm (both in the county of Södermanland) and one from the county of Västra Götaland.

From the five known infected areas (including Kronoberg county which was identified as an infected area in 2014), hunters were asked to submit 30 foxes from each circular area with a diameter of 40 km. The aim was to follow up the positive findings, and to collect parasites from any positive cases, for further subtyping. Sampling was initiated in 2012. Sampling was finalized in 2016. In Västra Götaland two foxes were positive, in Södermanland three foxes from Katrineholm and one from Gnesta were positive, whereas no foxes from Dalarna or Kronoberg were positive.

Within the Emiro research project (<http://www.emiro.org/>), finalized in 2016, and the FoMA Zoonosis monitoring programme (<http://www.slu.se/en/environment>) at the Swedish University of Agricultural Sciences (SLU), the parasite was found for the first time in an intermediate host; voles caught in Södermanlands county in 2013 (Gnesta/Nyköping). One out of 187 *Microtus agrestis* and eight out of 439 *Arvicola amphibius* were positive. Presence of protozoa were confirmed in the infected *Microtus agrestis* and in three out of eight *Arvicola amphibius*. No lesions were found in *Myodes glareolus* ($n=655$) and *Apodemus* spp. ($n=285$). Within this project, a new infected area was identified in 2014; Växjö region in Kronoberg county.

In 2012, alveolar echinococcosis was diagnosed in humans in Sweden for the first time. There were two human cases with clinical symptoms and both were considered to have been infected abroad. No human cases were diagnosed in 2013 to 2015. In 2016, one case was reported.

DISEASE

Animals

In the definitive animal host, the infection is asymptomatic. The main intermediate hosts, rodents, will usually die from the infection if not captured by a predator.

Humans

In humans, alveolar echinococcosis may develop into a serious, potentially fatal disease characterised by infiltrative tumour-like lesions in the affected organ. The incubation period for developing alveolar echinococcosis in humans is assumed to be between 5 and 15 years. Because of the long incubation period, the disease is most frequently seen in adults. The most common site of localisation is the liver but other organs can also be affected. Symptoms depend on the site and size of the lesion.

LEGISLATION

Animals

Detection of the parasite is notifiable according to Swedish legislation (SJVFS 2013:23). Before 2012, all imported dogs and cats (except from certain countries) were required to be de-wormed with praziquantel before entering Sweden as a preventive measure. Because *E. multilocularis* has been detected in Sweden, there is presently no legal requirement to deworm pets entering the country. However, as the prevalence of the parasite in foxes is very low in Sweden compared to many European countries, dog owners are still encouraged to deworm their dogs prior to entry to Sweden.

Humans

Infection with *Echinococcus spp.* has been notifiable since 2004 according to the Communicable Disease Act (SFS 2004:168) with the amendments of SFS 2013:634. However, notification at the species level is not required. If cases of *E. multilocularis* occur in humans, the data will be presented in the annual report at the website of the Public Health Agency of Sweden (<http://www.folkhalsomyndigheten.se>). Before 2004, *Echinococcus spp.* was reported on a voluntary basis by the laboratories.

SURVEILLANCE

Animals

As *E. multilocularis* does not cause clinical signs in the definitive host, surveillance in these species must be active. All free-living wolves submitted to necropsy at the National Veterinary Institute were tested with semi-automated magnetic capture probe-based DNA extraction and real-time PCR test (MC-PCR).

Humans

Surveillance in humans is passive.

RESULTS

Animals

During 2017, 60 wolves (*Canis lupus lupus*) and seven wolf/domestic dog hybrids, one raccoon dog (*Nyctereutes procyonoides*) and one dog were tested with the MC-PCR and all were negative.

Humans

In 2017, there were four cases of alveolar echinococcosis reported. They were all considered to have acquired their infection abroad, either in the respective country of origin or while traveling.

DISCUSSION

E. multilocularis is considered to be endemic albeit at a very low prevalence in Sweden. It is not known how and when the parasite was introduced into the country. The national screening finalised in 2014, can be used as a baseline estimate of the national prevalence, against which the future trend can be assessed. It is well known that the prevalence of this parasite varies geographically. Regional screenings have previously shown a prevalence of more than 1% in a part of Södermanlands county and within the Emiro research project and FoMA Zoonosis monitoring programme 18 of 80 (20%) of fox scats were found to be positive in one of four investigated small areas. However, the true geographical distribution is unknown. No positive cases have been found north of Dalarna County. At present, a total of five areas have been found infected.

E. multilocularis was found for the first time in an intermediate host in 2014, within the Emiro research project. This finding increases our knowledge about in which biotypes the life cycle of the parasite can be completed. It was suggested that the absence of *Microtus arvalis* in Sweden may be a contributing factor to the low prevalence of the parasite. However, in small restricted areas, prevalence has been reported to be higher and more research is needed to clarify which intermediate host(s) are most important.

Based on the studies that exist today, the risk that humans will become infected in Sweden is considered negligible.

REFERENCES

- Isaksson, M., Hagström, A., Armua-Fernandez, M., Wahlström, H., Ågren, E., Miller, A., Holmberg, A., Lukacs, M., Casulli, A., Deplazes, P., Juremalm, M. (2014). A semi-automated magnetic capture probe based DNA extraction and real-time PCR method applied in the Swedish surveillance of *Echinococcus multilocularis* in red fox (*Vulpes vulpes*) faecal samples. *Parasites & vectors* 7, 583.
- Miller, A. The role of rodents in the transmission of *Echinococcus multilocularis* and other tapeworms in a low endemic area. Doctoral Thesis 2016. Faculty of Veterinary Medicine and Animal Sciences, Swedish University of Agricultural Sciences, Uppsala, Sweden.
- Wahlström, H., Comin, A., Isaksson, M., Deplazes, P. (2016). Detection of *Echinococcus multilocularis* by MC-PCR: evaluation of diagnostic sensitivity and specificity without gold standard. *Infect Ecol Epidemiol* 6: 30173.
- Wahlström H, Lindberg A, Lindh J, Wallensten A, Lindqvist R, et al. (2012) Investigations and actions taken during 2011 due to the first finding of *Echinococcus multilocularis* in Sweden. *Eurosurveillance* 17(28).

Cystic echinococcosis

BACKGROUND

Cystic echinococcosis is caused by *Echinococcus granulosus*. Domestic dogs and wolves are the most frequent main hosts. Eggs of the parasite are excreted in faeces into the environment where they can infect intermediate hosts such as cattle, horses and wild ruminants. The eggs develop into the larval stage (hydatid cyst) mainly in the liver and occasionally in other organs of the intermediate host. The main hosts get the infection when consuming organs containing larval cysts.

History

Echinococcosis was quite common in reindeer in the northern parts of Scandinavia in the first half of the 20th century. In the 1990's, single cases of *E. granulosus* were detected in moose and reindeer in Sweden.

DISEASE

Animals

In animals, the infection is usually asymptomatic.

Humans

In humans, the main site for cystic echinococcosis is the liver. However, the lungs, brain or other tissues may also be involved. Infected patients may remain asymptomatic for years or permanently. Clinical signs of disease depend on the number of cysts, their size, localisation and pressure exerted on surrounding organs or tissues. The incubation period for developing cystic echinococcosis ranges from one to several years.

LEGISLATION

Animals

Detection of the parasite is notifiable in all animals according to (SJVFS 2013:23).

Humans

Echinococcosis has been notifiable according to the Communicable Disease Act since 2004 (SFS 2004:168) with the amendments of SFS 2013:634. However, notification on species level is not required. If cases of *E. granulosus* occur in humans, the data will be presented in the annual report at the website of the Public Health Agency of Sweden (<http://www.folkhalsomyndigheten.se>). Before 2004 *Echinococcus* spp. was voluntarily reported by the laboratories.

SURVEILLANCE

Animals

All animals are inspected for cysts during routine meat inspection. Semi-domesticated reindeer are inspected at slaughter, but not all free-ranging hunted cervids are inspected. If cysts are noted in liver or lung, samples would in some, but not all cases, be sent to the National Veterinary Institute for diagnosis.

Humans

Surveillance in humans is passive.

RESULTS

Animals

During the slaughter season of 2016-2017, 58,740 reindeer were slaughtered and inspected. The statistics for the 2017-2018 season are not yet available. *E. granulosus* was not detected in any animals in 2017.

Humans

In 2017, 31 cases of cystic echinococcosis were reported. Annually around 15-30 cases are reported in Sweden. In 2017, the reported cases ranged in age from 18 to 83 years (median 38 years). Thirteen cases were women and 18 were men. They were all considered to have been infected abroad in areas where the parasite is endemic. The most frequently specified country of infection was Iraq with 7 cases.

DISCUSSION

E. granulosus has not been detected in Sweden in animals since the late 1990s, when it was reported in two reindeer in the northernmost regions of Sweden, bordering Norway and Finland. The parasite is prevalent in several European countries. In Finland it has been detected in wildlife (wolves, moose and reindeer). In other European countries it is identified mainly in a cycle between dogs and farm animals.

In humans, cystic echinococcosis is a rare disease seen in immigrants or other people who have resided in endemic countries. In Sweden, no domestically acquired human cases have been reported since the infection became notifiable. In Finland, on the other hand, pulmonary cystic echinococcosis (*Echinococcus canadensis*) was confirmed in 2015 in an eight year old child from the eastern parts of the country with no history of travelling abroad. The infection was presumably transmitted by hunting dogs.

Enzootic bovine leucosis

BACKGROUND

Enzootic bovine leucosis (EBL) is caused by bovine leukaemia virus, which is an oncovirus in the family Retroviridae. The viral infection is transmitted by infected lymphocytes via contact with contaminated biological material from an infected animal. Sweden was declared officially free from EBL by the European Union (EU) in January 2001 (former Decision 2001/28/EC, currently Decision 2003/467/EC last amended by Decision 2005/764/EC). Before this, a voluntary control programme had started in 1990 and a mandatory eradication programme had been running since the autumn of 1995.

DISEASE

EBL is characterized by multiple cases of multicentric lymphosarcoma in adult cattle within a herd after an incubation period of 4-5 years. The tumours can develop rapidly in many sites, which may cause variable clinical signs depending on the site. Persistent lymphocytosis, without clinical signs, develops earlier but rarely before 2 years of age.

LEGISLATION

EBL is included in the Swedish legislation for notifiable diseases (SJVFS 2013:23). Current surveillance standards are given in EU legislation, Directive 64/432/EEC.

SURVEILLANCE

The purpose of the surveillance is to document freedom from EBL in accordance with Directive 64/432/EEC. Växa Sverige (former Swedish Dairy Association) is responsible for this surveillance, which is financed by the Swedish Board of Agriculture.

From 2010 onwards, surveillance in dairy herds has been performed by random sampling. The between-herd design prevalence is 0.2% and the within-herd design prevalence 15%, with a 99% confidence, given known freedom of infection the previous year. To achieve this, approximately 1,500 herds need to be randomly sampled per year. Bulk milk samples are collected within the quality control programmes of the dairies. The surveillance in beef herds is performed with an aim to random sample 1-3 animals per herd in 2,000 herds every year. Serum is collected from slaughtered cattle above 2 years of age originating from sampled herds. Details on numbers of herds and animals tested in 2017 are given in Table 6.

Diagnostic testing is performed at the National Veterinary Institute. Both milk and sera are analyzed using an antibody ELISA (Svanovir® BLV GP-51 ELISA).

RESULTS

No positive samples were found in 2017.

DISCUSSION

Sweden was declared free from EBL in 2001 (Commission Decision 2001/28 EC), and has had a very stable disease-free situation since then. In 2012 one slaughtered animal above 2 years of age was positive for EBL. All animals over 6 months in the herd from which the positive animal originated were tested for EBL in spring 2013 and all samples were negative. The herd was thereafter cleared from suspicions of EBL infection.

REFERENCES

Växa Sverige, Statistics for 2017.

Table 6: Total numbers of herds and animals tested for EBL antibodies in 2017.

Herd type (sample type)	Herds	Animals
Dairy herds (1 bulk milk sample per herd)	1,247	-
Beef herds (blood from 1-3 animals per herd)	1,633	3,939

Footrot



A control programme with the aim to eliminate footrot from affected sheep flocks and to provide certification of freedom from footrot for the sheep trade has been in place in Sweden since 2009. The programme is implemented by Farm & Animal Health. Photo: Ulrika König

BACKGROUND

Footrot is a globally distributed contagious disease in sheep and goats. The causative agent is *Dichelobacter nodosus* (*D. nodosus*). The disease is characterised by inter-digital dermatitis, and predisposing factors are humid and warm weather conditions. The severity of footrot can vary by the strain of *D. nodosus* and the environmental conditions.

The first case of footrot in Swedish sheep was identified in 2004. Data on all affected flocks within the programme have been recorded since 2004. A study on the prevalence in slaughter lambs was performed in 2009 and a voluntary

control programme for footrot (“Klövkontrollen”) was established by Farm & Animal Health in 2009.

DISEASE

The clinical signs of the disease are typically foot lesions, and lameness due to the painful lesions. However, lameness is not a consistent clinical sign in all affected sheep. Footrot varies greatly in severity from inflammation of the interdigital skin to complete underrunning of hoof horn.

LEGISLATION

Footrot is a notifiable disease (SJVFS 2013:23).

SURVEILLANCE

The aim of the control programme is to eliminate footrot from affected sheep flocks and to provide certification of freedom from footrot for the sheep trade. Another important part of the programme is training of veterinarians and non-veterinary staff to perform clinical inspection and footrot scoring. The feet of sheep are inspected by veterinarians and farmers on an annual basis. The inspections are performed during August 15 to October 15, when the risk of footrot is highest due to the weather conditions. If no signs of footrot are detected, the flock is certified free from footrot (F-status). However, if signs of footrot are documented the following measures are taken: foot baths, moving of animals to clean pasture and culling of chronically infected sheep. Flocks with a history of footrot can be certified as free, at the earliest ten months after the last signs of infection.

Diagnostic testing of samples from interdigital skin is performed at the National Veterinary Institute. The development of additional diagnostic tools is also linked to the control programme. Recent improvements to the programme include testing of strains for virulence and pooling of samples (results published 2017). A total of 382 sheep flocks are affiliated to the control programme.

For all newly affiliated flocks and for all affiliated-to-be flocks with clinical signs suspecting footrot, a real-time PCR is used for detecting *D. nodosus* and determining strain virulence.

RESULTS

During 2017, 6 new flocks were detected with footrot (Figure 7). In 1 of the 6 flocks, virulent strains of *D. nodosus* were detected. In the programme, 376 flocks were certified free from footrot (F-status). Most of the Swedish *D. nodosus*

strains are benign, and the virulent type is uncommon.

DISCUSSION

The awareness of disease control has been enhanced in the sheep farming community, and their agreement on a trade ban between certified and non-certified flocks has been essential to the programme's success. Good collaboration between authorities, the sheep farming community and individual sheep farmers has resulted in a cost-effective control programme. The new real-time PCR can discriminate between benign and virulent strains. This typing might make it possible in the future to limit mandatory notification to virulent strains of footrot.

REFERENCES

Frosth, S., König, U., Nyman, A.K., and Aspán, A. Sample pooling for real-time PCR detection and virulence determination of the footrot pathogen *Dichelobacter nodosus*. *Veterinary Research Communications*, 2017, 41(3), 189-193

Frosth S, König U, Nyman AK, Pringle M, Aspán A. Characterisation of *Dichelobacter nodosus* and detection of *Fusobacterium necrophorum* and *Treponema* spp. in sheep with different clinical manifestations of footrot. *Vet Microbiol* 2015, 179(1-2), 82-90.

Frosth S, Slettemeås JS, Jørgensen HJ, Angen O, Aspán A: Development and comparison of a real-time PCR assay for detection of *Dichelobacter nodosus* with culturing and conventional PCR: harmonisation between three laboratories. *Acta Veterinaria Scandinavica* 2012, 54:6

König U, Nyman A-K J, de Verdier K: Prevalence of footrot in Swedish slaughter lambs. *Acta Veterinaria Scandinavica* 2011, 53:27.

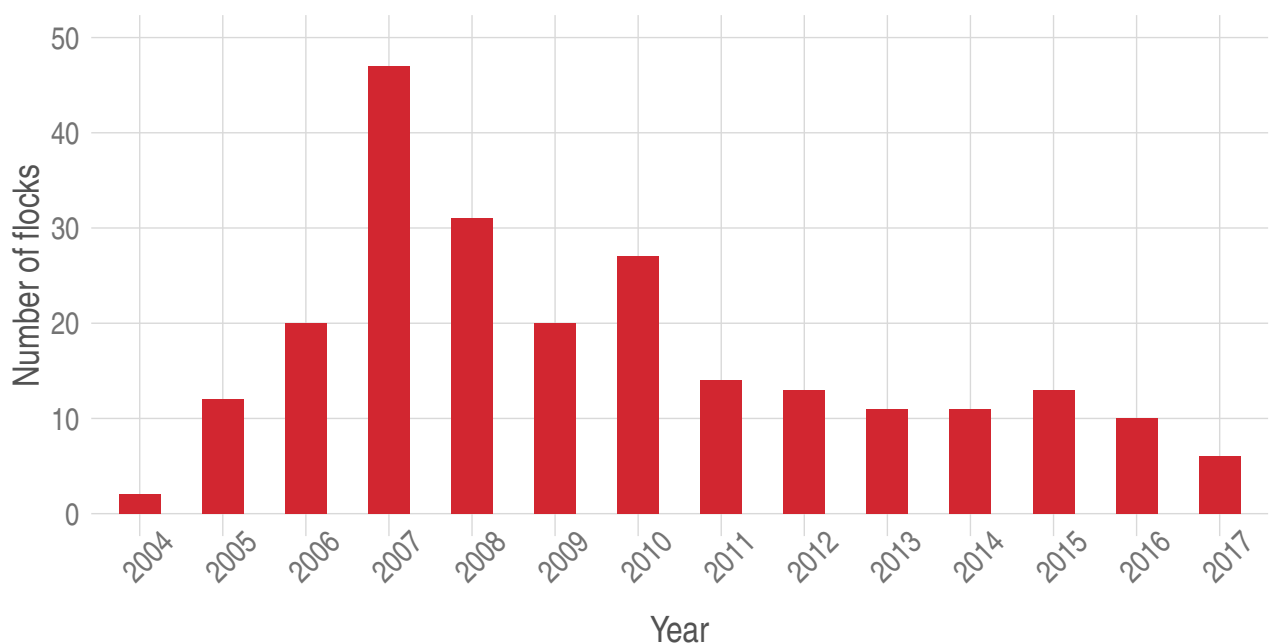


Figure 7: Number of sheep flocks detected with footrot 2004-2017

Infectious bovine rhinotracheitis

BACKGROUND

Infectious bovine rhinotracheitis (IBR) is caused by Bovine herpes virus 1. The same virus can affect different organ systems causing respiratory, abortive, genital or conjunctival disease. Transmission is mainly by aerosol for the respiratory form and by venereal transmission for the genital form.

Examination of Swedish bulk milk samples during the early nineties showed the presence of a small number of seropositive herds. No signs of clinical disease were present in these herds. An eradication programme was initiated in 1994 and the last seropositive animal was found in 1995.

DISEASE

The incubation period of IBR is 3-21 days, but the virus can be silently present in the host animal and be reactivated by stress or immunosuppression. The clinical picture varies by subtype of the virus but also with the environmental and management factors. Several manifestations of the disease can be present during the same outbreak in the same herd. However, the clinical signs are typically concentrated either to the respiratory tract, reproductive organs or the eyes.

LEGISLATION

The Swedish IBR eradication programme was approved in 1994 (Decision 73/94/ COL and Decision 95/71/EC). Sweden was allowed additional guarantees by the EU to reduce the chance of IBR introduction in 1995 (Decision 95/109/EC) and was officially declared free from IBR in 1998 (former Decision 98/362/ EC, current Decision 2004/558/ EC). Since 2004, all neighbouring Nordic countries have additional guarantees from the EU relating to this disease (Decision 74/94/ COL and Decision 95/71/EC). IBR is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). Vaccination is prohibited and notification of clinical suspicion is mandatory.

SURVEILLANCE

All diagnostic testing was performed at the National Veterinary Institute. Milk and sera were analysed for the presence of antibodies using an indirect ELISA (SVANOVIR™ IBRab, Svanova®). A blocking-ELISA IBR/BHV-1 gB Ab ELISA kit (IDEXX) was used for confirmatory testing. Semen and organ samples were tested with a real time PCR (Wang et al, 2007). A positive case is defined as an animal with a positive PCR result or a confirmed positive serological reaction for IBR.

Passive surveillance

Suspicious based on clinical signs must be reported to the Swedish Board of Agriculture and will be subsequently investigated.

Active surveillance

The purpose of the surveillance is to document freedom from IBR. The Swedish Board of Agriculture is responsible for the surveillance, which is implemented by Växa Sverige (the former Swedish Dairy Association). Within the surveillance programme, dairy herds are tested by bulk milk samples and in farms with more than 60 cows, pooled milk samples from individual cows are used. The sampling is conducted twice a year within the Växa Sverige's quality control programme and synchronised with the programmes for bovine viral diarrhoea and enzootic bovine leucosis. The surveillance also includes serum samples from beef cattle. The sample size for dairy herds is calculated based on a herd design prevalence of 0.2% and a confidence level of 99%, and for beef cattle on a herd design prevalence of 0.2%, an animal design prevalence of 10% (beef cattle) and a confidence level of 99%.

In addition to the official active surveillance programme, bulls are tested within health schemes at semen collection centres and all cattle (and other potentially susceptible ruminants) are tested before export and import.

RESULTS

Within the active surveillance, 3,427 bulk milk samples and 5,629 serum samples from beef cattle were examined. 270 cattle, 162 reindeer, 48 alpaca, 8 moose, 1 roe deer, 1 camel and 4 European bison were tested as part of health schemes, prior to export, or for research purposes. All samples were tested negative. No herds were investigated due to clinical suspicions of IBR.

DISCUSSION

In summary no herd or individual animal was diagnosed with IBR infection during 2017. This supports Sweden's IBR free status.

REFERENCES

Wang et al., 2007. Validation of a real-time PCR assay for the detection of bovine herpesvirus 1 in bovine semen. *J Virol Methods* 144, 1-2, pp 103-108. doi.org/10.1016/j.jviromet.2007.04.002

Influenza

BACKGROUND

Influenza type A is a viral disease affecting both birds and mammals, including humans. The causative agent is an RNA-virus of the family *Orthomyxoviridae* with a marked ability to change over time. New strains are created both through accumulation of point mutations ('antigenic drift') and through genetic reassortment (antigenic shift). Influenza type A viruses are classified into different subtypes based on the surface glycoproteins: hemagglutinin (H) and neuraminidase (N).

The main mode of transmission of influenza type A virus is by aerosols containing virus from the airways of infected individuals of the same species. Occasionally influenza type A virus can be transmitted from one species to another, like in the case of avian influenza infecting humans, but typically, each host species has its own influenza type A viruses.

Avian Influenza

BACKGROUND

Avian influenza (AI) viruses are divided into different antigenic subtypes based on the combination of two surface glycoprotein (HxNy). Currently, 18 HA and 11 NA variants have been identified. Except for the H17N10 and H18N11, which have only been found in bats, all other possible combinations can be found in the aquatic wild bird reservoir. The disease is highly contagious and is spread both directly and indirectly. Wild birds are reservoirs for low pathogenic viruses (LPAIV) including subtypes H5 and H7, which upon transmission and further adaptation to poultry may mutate and become highly pathogenic (HPAIV).

The detection of highly pathogenic avian influenza (HPAI) H5N1 in Hong Kong in the middle of 1990s, with the ability to cause disease in humans, highlighted the potential threat of avian influenza to human and animal health.

In May 2005, an outbreak of H5N1 led to the death of over 6,000 migratory waterfowl in Qinghai Lake in western China. This was the first sustained major outbreak with H5N1 viruses within wild bird populations since 1997. Subsequently, H5N1 outbreaks in wild birds or in poultry were reported in Siberia (July 2005), Mongolia and Kazakhstan (August 2005), Romania, Croatia, and Turkey (October 2005). Wild bird infections with or without poultry disease were also noted in several other countries in Europe including Sweden, in 2006. The outbreak of HPAIV-H5N1 in Sweden led to deaths among several species of wild birds, one infected farmed mallard in a game bird holding and a mink.

In early 2014, highly pathogenic avian influenza A(H5N8) viruses belonging to clade 2.3.4.4 of the Gs/Gd-like lineage were detected in wild birds and poultry first in the Republic of Korea, China, Japan and Russian Federation. By autumn the same year, the group A (Buan-like) virus of clade 2.3.4.4 was detected in commercial poultry in Canada and later in December, strains of HPAI were also detected in wild birds and poultry in the United States of America (USA). By the middle of 2015, over 50 million poultry were dead or culled because of the outbreak with the estimated economy-wide losses of 3.3 billion dollars. In November 2014, almost simultaneously A(H5N8) Buan-like viruses were also detected in The Netherlands, Germany, Italy, the United Kingdom and Northern Ireland and in Hungary. In

2014-2015, outbreaks in Europe were limited to a few commercial poultry holdings and only sporadic cases in wild birds. The last reported detection during the 2014/2015 European outbreaks was two mute swans in Sweden in February 2015.

In May 2016, a new H5N8 subtype belonging to clade 2.3.4.4 group B (Gochang-like) viruses were detected in wild migratory birds in the Tyva Republic, southern Russia. This was the starting point of a new intercontinental wave of transmission by H5 viruses within the Gs/GD/96-lineage causing multiple outbreaks of disease in poultry and wild birds across Europe, Asia and Africa and was by far the most severe in terms of the number of countries affected.

On 27 October 2016, an infected wild swan with HPAI virus A(H5N8) was reported from Hungary. On 4 November, Hungary reported the first outbreak of HPAI H5N8 in poultry. The virus spread rapidly across central Europe with multiple notifications in wild birds, poultry and captive birds.

In November 2016, H5N8 virus was detected in a dead common goldeneye (*Bucephala clangula*) in Skåne county in the southern part of Sweden. Shortly after, a high-biosecurity establishment of laying hens also in Skåne became infected, and the 210,000 animals had to be destroyed. Further cases with H5N8 viruses were found subsequently during 2017, as described in this chapter.

Disease Animals

Morbidity in birds infected with HPAIV may be as high as 100%, but depends on the species affected, co-infections, virulence of the virus and other factors. In general, gallinaceous birds, including turkeys and chickens, suffer a more severe disease than waterfowl such as ducks and geese, which may exhibit only minor or no clinical disease. LPAIV infections most often cause asymptomatic infections or mild respiratory disease. HPAIV infections cause variable clinical signs such as cyanosis, respiratory distress, diarrhoea, nervous signs, depression, decreased food and water intake and decreased egg production with altered egg quality. Sometimes the only clinical sign is the sudden death of a large numbers of birds.

Humans

Since 2003, more than 859 human cases of HPAI H5N1 infection have been identified worldwide with a death rate of 53%. According to the WHO, most of the positive cases have been diagnosed in Egypt, Indonesia and Vietnam. A decrease of cases was noted during the last years, three cases were determined in Egypt and one case in Indonesia during 2017. The majority of human cases of H5N1 infection have been associated with direct or indirect contact with infected live or dead poultry.

More than 1,560 laboratory-confirmed cases of human infection with LPAI H7N9 viruses, including 39% deaths, have been reported since 2013. The first wave in spring 2013 (weeks 7-2013 to 40-2013) resulted in 135 cases, the second wave (weeks 41-2013 to 40-2014) led to 320 cases, the third wave (weeks 41-2014 to 40-2015) caused 223 cases, the fourth wave (weeks 41-2015 to 40-2016) caused 120 cases, the fifth wave (weeks 41-2016 to 40-2017) resulted in 766 cases, and the sixth wave which started on week 40-2017 has resulted in one case as of 31 December 2017. An increase of human cases of H7N9 has been noted during the fifth winter season. During this wave, the number of human cases is higher than in previous waves and accounts for 49% of the human cases reported so far. This increased number is most likely due to increased environmental contamination in live bird markets and increased circulation of the virus among poultry. In February 2017, a new A(H7N9) virus with mutations in the haemagglutinin gene indicating high pathogenicity in poultry was detected in three patients, as well as in environmental and poultry samples. During the fifth wave, 28 human cases with HPAI A(H7N9) virus were reported in China.

Since 1998, 43 laboratory-confirmed cases of human infection with LPAI H9N2 virus, including one death, have been reported globally. Cases occurred in China (36), Egypt (4) and Bangladesh (3). During 2017 were six cases of H9N2 reported from China.

A total of 19 laboratory-confirmed cases of human infection with HPAI H5N6 virus, including 6 deaths, have been detected in China since 2014. During 2017 were two cases H5N6 reported from China. Controlling the disease in domestic animals is the first step in decreasing the risk to humans.

LEGISLATION

Animals

Highly pathogenic avian influenza of all subtypes as well as LPAI of H5 and H7 subtypes are included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and cases are notifiable upon suspicion. If AI is suspected or confirmed on a farm, measures will be taken to combat the disease and to prevent further spread according to Council Directive 2005/94/EC.

Humans

All laboratory confirmed cases of influenza are notifiable according to SFS 2015:587, and H5N1 infection is noti-

fiable according to the Communicable Disease Act (SFS 2004:168).

SURVEILLANCE

The Swedish Avian Influenza surveillance programme in poultry and wild birds 2017 is based on Council directive 2005/94/EC and Commission decision 2010/367/EU.

Surveillance programmes have been carried out annually in all member states since 2002 to determine the prevalence of avian influenza viruses, in particular the subtypes H5 and H7. The aim of the surveillance in poultry is to detect infections of avian influenza virus subtype H5 and H7 in different species of poultry. Surveillance of wild birds contributes to the knowledge of the threats from wildlife to domestic animal health and serves as an early warning system for avian influenza threat to domestic poultry flocks. From 2006-2010 there was active surveillance of 2,000-4,500 wild birds annually. Since 2011, the surveillance has been conducted on dead birds submitted for necropsy only.

Poultry

In 2017, sampling was performed in kept game birds (mallard ducks and pheasants), layers, breeders, small-scale broiler production, turkeys, geese, ducks, and ratites. Ten blood samples from each holding were collected except for holdings with geese, ducks or mallards where 20 samples from each flock were collected. In flocks with fewer individuals than the above mentioned sample size, all individuals where sampled. In total, 2,187 blood samples were taken. Table 7 gives an overview of all poultry flocks sampled in 2008 to 2017. In addition to the surveillance programme, samples were taken on clinical suspicion of avian influenza. On clinical suspicion of AI or Newcastle disease, laboratory analyses for both diseases are generally performed.

The surveillance programme for 2017 was based on representative sampling and the serological analyses were performed at the National Veterinary Institute. All poultry samples were collected at slaughter, except breeders and game birds. Blood samples from these categories of birds were collected at their holdings. Breeders were sampled late in their production period. Samples were analysed using an ELISA (IDEXX Influenza A Ab Test). Positive results were confirmed with haemagglutination inhibition tests (for subtypes H5, H7 and H5N8) in accordance to the OIE guidelines.

Wild birds

The surveillance in wild birds is passive and based on birds found dead or diseased and submitted for post mortem examination. The geographical distribution of wild birds examined for avian influenza is shown in figure 8. Swab samples (both cloacal and tracheal) taken from these birds were analysed for the detection of avian influenza viral genome by using an M-gene qRT-PCR. Samples found positive for the matrix gene were further analyzed by qRT-PCR specific for the haemagglutinin gene of H5 and H7 and virus pathotyping by amplicon sequencing.

Humans

Every year during the influenza surveillance season 1,500-2,000 samples are collected from sentinel patients with influenza-like illness. These samples are analysed for influenza A and B. If influenza A is detected, further subtyping is performed into A(H1N1)pdm09 and A/H3N2. If influenza A positive samples cannot be subtyped further characterisation is performed to rule out zoonotic influenza A. A further 200-300 of the influenza positive samples from the diagnostic laboratory are subtyped/characterised. The Public Health Agency of Sweden, also performs a specific PCR for H5N1, H5N6 and H7N9 if requested.

RESULTS

Poultry

In 2017, antibodies against influenza virus subtype H5 or H7 was not detected in any poultry holding sampled within the active surveillance programme (Table 7).

Avian Influenza was investigated following 28 clinical suspicions in poultry or captive birds. Clinical signs as suspicion arose included; increased mortality, production losses and/or eggshell abnormalities. Twenty-two of the suspicions were in commercial flocks (one in broiler, eight in pullets, one in game birds (mallards) and 13 in layer flocks). Six of the suspicions were in small hobby flocks with hens or mixed species. All suspicions were investigated by PCR on swab and/or organ samples. One layer farm, two small hobby flocks and a small bird exhibition in a public park were confirmed as HPAI H5N8; the other 24 suspicions were PCR-negative for influenza. In the AI positive cases the symptoms raising the suspicions were increased mortality.

Wild birds

Autumn migrations of wild birds have been implicated in the incursion of HPAIV into Europe in 2005, 2014 and 2016. Wild birds play a key role in the long-distance spread, introduction into new areas or countries and further local amplification and spread of HPAIV. For 2017 the bird migration seemed to be later than usual, probably due to warmer weather.

In 2017, the HP H5N8 epizootic from 2016 continued with positive findings in wild birds over the winter months with a peak in February and the last finding for the season in March. Cases were found in wild birds along the south and eastern coast of Sweden, including the islands of Öland and Gotland.

Within the passive surveillance programme, 452 wild birds of 69 different species were sampled of which 97 individual birds were waterfowl or shorebirds. Thirty-nine wild birds were PCR-positive for HPAI H5N8 (22 water fowl, 15 bird of prey and 2 corvids), all during the period January – March. One northern hawk-owl (*Surnia ulula*) was positive for avian influenza but not for the notifiable H5 or H7 type. All other birds were negative for Influenza A virus.

Humans

No cases of zoonotic influenza were identified among the samples characterised during 2017 in Sweden.

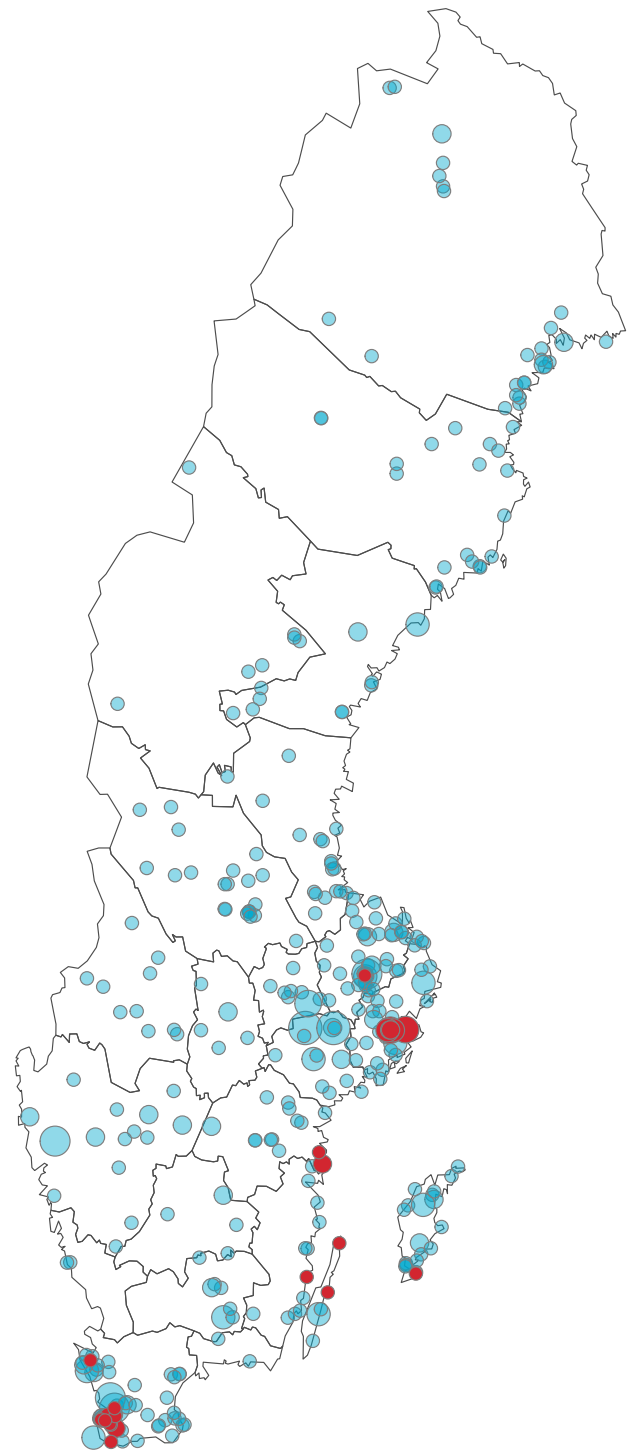


Figure 8: Geographical location of the wild birds analysed for avian influenza in 2017. Point sizes are scaled by the number of birds sampled at a given location. A total of 39 birds were identified positive for influenza H5N8 in 2017. ©EuroGeographics for the administrative boundaries

DISCUSSION

The first large outbreak of HPAI in wild birds was reported from China in May 2005. Thereafter wild birds infected with HPAI have been detected in Europe. HPAI may cause disease and death in wild birds, though there seem to be a host-species dependent susceptibility. Wild birds, especially waterfowl, may be infected with LPAI without the presence of clinical symptoms. Considering the capacity of the virus to mutate and become highly pathogenic (HPAI), wild birds may pose a potential risk to poultry since they may host and introduce LPAI into poultry flocks, where the virus may circulate, mutate and become HPAI.

A recent development in the evolution of HPAI H5N1 virus is the emergence of HPAI H5N8 virus. A HPAI H5N8 virus with genes from viruses of the influenza A(H5N1) A/Goose/Guangdong/1/1996 lineage was first detected in birds on live bird markets in China in 2010. This HPAI H5N8 virus is a reassortant virus with the HA gene segment of HPAI H5N1 virus and other gene segments of multiple other AI viruses circulating in eastern China, and is categorized in the new HPAI H5 virus clade 2.3.4.4 (WHO 2015).

This virus caused a large AI outbreak in poultry in South Korea in the winter of 2013/2014, and subsequently spread to Japan, North America, and Europe, causing AI outbreaks there between autumn 2014 and spring 2015. The H5N8 viruses involved in the 2014/2015 outbreaks in Europe and North America belonged to group A(Buan-like) viruses of clade 2.3.4.4, while the current 2016/2017 outbreaks in Europe belongs to group B(Gochang-Like) in clade 2.3.4.4. Since the first detection of H5N8 clade 2.3.4.4 group B-Gochang-like viruses at the Ubsu-Nur Lake in May 2016, closely related viruses continued to spread throughout the

autumn, winter and spring of 2016–2017, eventually affecting more than 50 countries in Asia, the Middle East, Western, Eastern and Southern Africa and Europe by the June 2017. Countries in the European Union reported a total of 874 outbreaks of HPAI in poultry or captive birds in 24 countries and 1,146 reports by 19 countries on findings in wild birds. In winter and spring of 2017 H5N8 virus detection continued to occur among wild and domestic birds across the south and eastern coast of Sweden.

Wild birds have played an important role in the arrival and subsequent spread of the H5N8 in 2016-2017. During this period one commercial farm, two small hobby flocks and a small bird exhibition in a public park were confirmed as HPAI H5N8. All of the cases in domestic birds occurred in areas in close proximity to wetlands and had a wild birds outbreak reported in close proximity to affected farm.

The ongoing event further signifies the need for awareness and improved biosecurity in poultry holdings to prevent the introduction of the virus from wild birds.

Influenza viruses are unpredictable and changes by mutation or reassortment occur. This might enable the virus to become more transmissible among humans. Monitoring of human infections with these viruses is also critically important to assess their pandemic potential.

REFERENCES

- European Commission, ADNS
OIE - WAHID database.
WHO 2015 www.who.int/influenza/gisrs_laboratory/h5_nomenclature_clade2344/en/
WHO Feb. 2018 www.who.int/influenza/vaccines/virus/201802_zoonotic_vaccinevirusupdate.pdf?ua=1

Table 7: Number of flocks of different poultry categories sampled in 2008-2017.

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Laying hens ^A	65	61	62	61	52	44	58	68	62	68
Free range laying hens ^A	-	-	-	30	27	16	23	23	30	43
Turkeys	23	17	21	22	19	26	16	18	18	16
Ducks	8	3	4	6	3	1	3	3	4	1
Geese	30	13	11	20	20	13	9	9	7	5
Broilers ^B	28	27	24	39	34	26	12	22	33	23
Ratites	10	6	4	5	3	2	3	3	3	2
Breeding hens (parents)	42	33	34	36	36	36	32	31	34	35
Breeding turkeys (parents)	2	4	3	3	3	3	2	3	3	3
Game birds (mallards)	6	6	7	9	7	7	5	6	7	2
Game birds (pheasants)	23	20	17	15	16	16	12	13	9	13
Backyard flocks(geese, ducks)	0	6	0	0	0	0	0	0	0	0

^A Until 2011 sampling of all laying hens were reported under the same category regardless of housing system. From 2011, free-range (organic) laying hens are reported separately while the category 'laying hens' includes hens in furnished cages and indoor litter-based housing systems.

^B Small-scale production.

Swine influenza



Swine influenza has occasionally infected pigs by transmission from humans. In 2017, influenza A virus was detected in 2 herds. Complete genome sequencing and phylogenetic analysis of the obtained sequences indicated zoonotic transmission of the virus from humans to pigs. Photo: Anna Söllén

BACKGROUND

Swine influenza (SI) has a worldwide distribution and causes an acute upper respiratory disease characterised by fever, lethargy, anorexia, weight loss and laboured breathing in pigs. The most commonly occurring subtypes of swine influenza virus (SIV) worldwide are H1N1, H1N2 and H3N2. Of these, the H1N1 SIV was reported to infect pigs in North America already in 1918. In 2009, a new triple reassortant type of influenza H1N1, partly of porcine origin, began circulating among people. In a number of countries including Sweden, this virus has occasionally infected pigs by transmission from humans. This reassortant H1N1 virus became known as influenza A(H1N1)pdm09.

Animals

Influenza H1N1 was isolated from Swedish pigs for the first time in 1982. The clinical signs were severe in the previously naïve pig population, but waned over time. Since 1982, H1N1 virus has been considered endemic in Sweden. Influenza H3N2 is also present in the Swedish pig population. Antibodies to H3N2 were first detected in 1999, but the clinical signs were not as evident as when H1N1 was introduced. Actually, antibodies to H3N2 were first detected

in a screening of apparently healthy animals, and it is therefore less clear when this subtype was introduced. However, H3N2 has since 1999 occasionally been correlated with severe respiratory disease in pigs.

Another swine influenza A type (H1N2) that spread through Europe, was diagnosed for the first time in Sweden in a large multisite unit with respiratory disease in growers during the winter of 2009. Since the first report of the detection of pandemic influenza A(H1N1)pdm09 in early May 2009 in pigs in Canada, H1N1pdm09 has been isolated from pigs throughout the world including several European countries including Germany, Italy, Denmark, Norway, Iceland and Finland. This virus is well adapted to humans and clinical signs of disease in pigs were sparse. In 2013, a new variant of this influenza virus was identified in Swedish pigs where the HA gene revealed high nucleotide identity with contemporary human pH1 strains, suggesting that a recent human to pig transmission was the most likely route of infection in the pigs. The isolate expressed a human pandemic H1N1-pdm09 like HA and a H3N2 SIV-like NA that was closely related to Avian like H1N2 SIV NA from isolates collected in Sweden since 2009. The internal genes were entirely of pandemic H1N1-pdm09 origin which is well adapted to humans. Although the pH1N2 subtype influenza

A virus was exclusively prevalent in the Swedish pig population in 2014, the clinical signs of the disease were minor, as later also seen in other countries.

There has not been a regular monitoring of influenza in pigs in Sweden, but serological screenings were performed in 1999, 2002, 2006 and 2010. On each occasion, 1,000 porcine sera were analysed for H1N1, H3N2 and H1N2. The screening in 2006 also included analyses for antibodies to H5 and H7. During the past five years, 10-15 herds have been sampled annually with special focus on influenza; in these herds influenza virus has been demonstrated in 3-5 herds per year (Table 8).

Infection with influenza virus can produce clinical respiratory disease including dyspnoea, sometimes with nasal discharge and coughing, accompanied by fever, inappetence and lethargy. The disease can affect pigs of varying ages and the severity of clinical signs varies from severe respiratory disease to subclinical infection. The morbidity of affected herds is generally high but mortality is low.

Humans

Globally, 5-10 human cases of influenza virus infections with influenza from pigs are reported yearly. Since 2005, 434 humans have become infected with A(H3N2)v in USA and Canada. In 2016, 18 cases of human infection with A(H3N2)v virus were detected in North America and in 2017, 63 cases were reported from USA. Since 2005, 13 humans have become infected with A(H1N2)v in USA. During 2017, there were two cases of A(H1N2)v diagnosed in USA. In total three laboratory confirmed human cases of A(H1N1)v were determined in Italy, Switzerland and USA during 2017. Human infection with swine influenza has been associated with agricultural fairs where people are in close contact with potentially infected pig populations.

LEGISLATION

All laboratory confirmed influenza is notifiable according to SFS 2015:587.

SURVEILLANCE

Animals

Passive surveillance

During the period from 2009 to 2015, samples from pig herds with respiratory signs consistent with influenza were collected and analysed for presence of the pandemic influenza A (H1N1)pdm09 virus using a polymerase chain reaction (PCR) method. From each affected herd, 5-10 nasal swab samples were collected and analysed first for swine influenza A and if positive, samples were further analysed for pandemic influenza A(H1N1)pdm09. These samples were also investigated for other influenza A types.

Active surveillance

The surveillance in 2010 included 1,008 pig sera collected at slaughter. These sera were randomly selected from the porcine reproductive and respiratory syndrome control programme and included a maximum of 4 sera per herd and

sampling occasion. These sera were tested for antibodies to swine influenza types H1N1, H1N2 and H3N2 using haemagglutination inhibition tests (HI). Titres of $\geq 1:64$ were interpreted as significant levels of serum antibodies. For the recently demonstrated influenza H1N2-virus, two HI-tests were carried out, one using a traditional strain and one based on the strain isolated in Sweden (the 9706-strain).

In 2015, the National Veterinary Institute (SVA) and the Public Health Agency of Sweden initiated a study on the transmission of human and swine influenza among farmers, veterinarians and pigs. In collaboration with the industry, ten field veterinarians were asked to select pig farms that were representative of the pig production systems in Sweden and that were owned by producers interested in participating in the study. All workers on the pig farms with a daily contact with pigs, pig farmers and their families were asked to collect nasal swabs from themselves every third week and whenever they had influenza-like symptoms. Concurrently, samples were collected from the pigs at these farms. Participants were asked to complete a health questionnaire about the type of symptoms, duration of illness, and possible exposures to infected pigs. The participants were also asked if they had been vaccinated against seasonal influenza A viruses.

Starting from the last week of January 2015, participating farms were visited every third week for 6 consecutive visits by the field veterinarian. A total of 15 nasal swab samples from pigs were collected at each farm during each visit. During the visit, the age of the pigs and any respiratory clinical signs (absence or presence of sneezing, coughing and nasal secretion) among the sampled individuals was recorded.

The nasal swabs and submission sheets from animals and humans were shipped overnight to SVA or the Public Health Agency, respectively.

Nasal swab samples were initially screened for influenza A virus by real-time reverse transcription PCR (rRT-PCR) selective for the matrix gene. Samples positive by rRT-PCR were further analysed for determination of subtype, including the influenza A(H1N1)pdm09 virus using rRT-PCR specific for hemagglutinin gene of influenza A(H1N1)pdm09 virus. The hemagglutinin and neuraminidase fragments from all positive pig and human isolates were sequenced by the Sanger sequencing method.

Humans

In Sweden, 1,500-2,000 samples are collected annually from patients with influenza like illness during the influenza season in a sentinel surveillance system for influenza. These samples are analysed at the Public Health Agency of Sweden for influenza A and B. If influenza A is detected, further subtyping is performed into A(H1N1)pdm09 and A(H3N2). If Influenza A positive samples cannot be subtyped, further characterisation is performed to rule out zoonotic influenza A. A further 200-300 influenza positive samples from the diagnostic laboratory are subtyped/characterised.

RESULTS

Animals

Passive surveillance

Samples from 9 herds with respiratory signs were analysed for swine influenza virus in 2017 (Jan 1st to Dec 31st, 2017). In two of these herds, influenza A virus was detected. The pandemic A(H1N1)pdm09 virus was demonstrated in both herds. Complete genome sequencing and phylogenetic analysis of the obtained sequences of the virus isolated from one of these herds revealed a close relationship between the swine A(H1N1)pdm09 virus and the concomitant human A(H1N1)pdm09 viruses circulating in 2017 indicating zoonotic transmission of the virus from human to pigs.

Active surveillance

No active surveillance was performed in 2017.

The surveillance in 2010 revealed low frequencies of pigs with significant levels of antibodies to swine influenza types H1N1, H1N2 and H3N2 using HI tests (Table 8). It is, however, notable that the prevalence of pigs with significant levels of antibodies to H1N2 increased somewhat when the analysis was based on the recent Swedish isolate of the strain.

No pigs with clinical disease were observed during the 6 visits to 10 farms as part of the study on the transmission of human and swine influenza among farmers, veterinaries and pigs. Out of ten participating farms, four farms had at least one positive result during this period and two farms were tested positive on at least two occasions. In total, 825 swabs collected from pigs and 330 swabs collected from humans were analysed for the presence of influenza A viruses. Of these, 19 samples (2%) were positive for influenza A viruses with rRT-PCR.

Humans

No cases of zoonotic influenza were identified among the characterised samples during 2017 in Sweden.

DISCUSSION

The results indicate presence, but no large impact, of swine influenza in the Swedish pig population. In the serological screening carried out in 2010, the incidence of influenza H1N1 and H3N2 was low. The prevalence of pigs with significant levels of serum antibodies was lower during 2010 than 2006. Also the prevalence of pigs with significant levels of serum antibodies to H1N2 was low, regardless of the origin of viral strain used for the analysis. The reactions defined as low, indicate unspecific reactions rather than true antibodies to the influenza strains analysed for. Still, the difference in results depending on H1N2-viral strain used for analysing, illustrates the necessity to include relevant influenza strains (Table 8) in the testing protocol.

In last five years two new influenza A viruses were detected in the Swedish pig population. Both of these viruses were the result of multiple reassortments between avian or/and human and swine influenza A viruses. Influenza A viruses are unpredictable and changes (mutations or reassortment) might be induced. This could enable the virus to be more transmissible among humans. The veterinary medical importance and the public health significance of influenza A virus in pigs should not be underestimated. Monitoring of human infections caused by these viruses is critically important to assess their pandemic potential.

REFERENCES

Kiss, I., A. Bálint, G. Metrevelli, E. Emmoth, F. Widén, S. Bélaç and P. Wallgren (2010). Swine influenza isolated in 1983, 2002 and 2009 in Sweden exemplify different lineages. *Acta Vet Scand.* 52:65.

Wallgren, P, Paulsson, M. Gerth Löfstedt, M. (2009). Ny influensastam, H1N2, påvisad hos gris i Sverige (Influenza H1N2 demonstrated in Swedish pigs). *Svensk VetTidn.* 61 (14) 11-17.

Table 8: Reactors from the serological surveys performed in 2006 and 2010. The table shows the prevalence of significant seroreactors to the three porcine adapted strains of influenza present in the country. The table also shows the prevalences with low reaction in the HI tests. Note the difference in prevalences depending on strain used for antibody detection for H1N2 in 2010.

Seropositive samples	H1N1	H3N2	H1N2-standard	H1N2 new (9706strain)
Significant levels of antibodies ($\geq 1:64$)				
2006 (n=999)	33.0%	6.7%	0.6%	-
2010 (n=1,008)	0.6%	3.7%	0.1%	0.9%
Low levels of antibodies ($\leq 1:32$)				
2006 (n=999)	15.1%	18.8%	7.0%	-
2010 (n=1,008)	2.3%	9.6%	1.3%	5.1%

Leptospirosis

BACKGROUND

Several species of the spirochetal bacterium *Leptospira* can cause leptospirosis. All mammals including humans, are susceptible to one or several *Leptospira* serovars. Leptospirosis occurs worldwide but the dominant serovars vary by region. Cattle are considered the reservoir for *L. Hardjo* and pigs for *L. Pomona*. Between 1994 and 2006 sampling and testing for antibodies to *L. Hardjo* and *L. Pomona* in cattle and pigs, respectively, was performed each year and after 2006 every third year.

Leptospira may be transmitted directly between animals or indirectly in the environment. The bacteria do not multiply outside the host, but may survive for long periods in the environment.

DISEASE

Animals

L. Hardjo is one of several pathogenic serovars and is associated with disease in cattle, sheep, goats and horses. Infections may be acute or chronic; asymptomatic, mild or severe. Acute disease is more often seen in calves. Disease in adults may go unnoticed, because the early clinical signs of fever and depression are often transient and mild. Infected herds may have problems with abortions, decreased fertility and decreased milk yield as well as increased mortality in calves. The clinical signs in sheep and goats are similar to those in cattle. Sheep and cattle can act as reservoir hosts because the disease may be asymptomatic. *Leptospira* infections in pigs may also be asymptomatic or may give rise to reproductive failure. In piglets, fever, gastrointestinal disorders and jaundice may be present. The clinical presentations in dogs infected with *Leptospira* range from subclinical to severe clinical illness affecting the kidneys and liver. Clinical manifestations in dogs include fever and acute liver or kidney affection.

Humans

Leptospirosis in humans ranges from asymptomatic or mild influenza-like illness to a severe infection with renal and hepatic failure, pulmonary distress and death.

LEGISLATION

Animals

Since 2004, leptospirosis is a notifiable disease in Sweden (SJVFS 2013:23), in all animal species concerned.

Humans

Leptospirosis in humans is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

Passive surveillance in animals involves mandatory case reporting of laboratory confirmed cases. Surveillance in dogs is passive only.

The active surveillance in cattle is focused on *L. Hardjo* and is based on serum and bulk milk samples selected by systematic random sampling from the surveillance programme for bovine viral diarrhoea virus (BVDV) and evenly distributed throughout the sampling period. See chapter on BVDV for details on sampling and population. The surveillance was designed using a between-herd design prevalence of 0.2%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 50 years.

In domestic pigs, the active surveillance is based on samples collected for the abattoir sampling part of the surveillance carried out by Farm & Animal Health for porcine reproductive and respiratory syndrome (PRRS). See chapter on PRRS for details on sampling and population. The surveillance is focused on *L. Pomona* and the surveillance was designed using a between-herd design prevalence of 0.5%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 25 years. Active surveillance in cattle and pigs is at present performed every third year. Animals sampled for export and in breeding centres adds to the active surveillance.

The serological analyses are performed at the National Veterinary Institute. The diagnostic test used for *L. Hardjo* is an indirect ELISA (Prio-CHECK *L. Hardjo*, Antibody detection ELISA, Lelystad, Holland) for both blood and bulk milk samples. Positive blood samples are further tested with MAT (Microscopic agglutination test) with results reported as positive at 1:100 or above. For positive or doubtful ELISA results on bulk milk samples, an investigation is carried out in the herd and additional individual samples are taken. Antibodies against *L. Pomona* are analysed using the microscopic agglutination test (MAT) with results reported as positive at 1:100 or above.

Humans

The surveillance in humans is passive.

RESULTS

Animals

In 2017, 36 cases of *Leptospira* infection were reported in dogs and one in a horse.

No active surveillance was performed in cattle and pigs. See previous reports for surveillance results from 2016 and earlier.

Humans

In 2017, four cases of leptospirosis were reported. Three of the cases had acquired their infections in Asia. Cases infected outside Sweden have often acquired their infections during leisure activities in contact with water. One case was most likely infected in Sweden, but the source of infection could not be determined. In 2017, all the cases were adults and three out of four were men.

DISCUSSION

Leptospirosis occurs worldwide, but the predominant serovars vary by geographic region. The disease is associated with reproductive losses in cattle and significant economic costs worldwide. Certain *Leptospira* serovars are present in Sweden. Occasional cases of pigs serologically positive to *Leptospira* spp (other than *L. Pomona*) are diagnosed in Sweden, mostly to an indigenous serovar of *L. Sejroe*, *L. Bratislava* and *L. Ichterohaemorrhagiae*. An even lower prevalence to the indigenous strain of *L. Sejroe* in cattle has been recorded.

Swedish cattle and the commercial pig population are considered free from *L. Hardjo* and *L. Pomona* based on only negative results from the surveillance system since 1994. Since 2006, the surveillance programme in cattle and pigs is no longer performed on a yearly basis as the serological screening of *Leptospira* is considered of less importance compared to screening programmes of other contagious animal diseases. Also, human infections are mainly travel-associated. The Swedish Board of Agriculture can decide

to initiate an epidemiological investigation in case of clinical disease consistent with leptospirosis in animals.

The number of reported *Leptospira* cases in dogs is higher 2017 compared to previous years and, although not further investigated, this could be indicative of an increase in the incidence. The sources of infection have not been investigated in these cases, but rodent contact could be one possible source.

REFERENCES

Lindahl E, Boqvist S, Artursson K, Magnusson U, 2011. A field-study on *Leptospira* seroprevalence in dairy cows in four geographical areas in Sweden. *Acta Veterinaria Scandinavica* 53(1), 53.

Boqvist S, Eliasson-Selling L, Bergström K, Magnusson U, 2012. The association between rainfall and seropositivity to *Leptospira* in outdoor reared pigs. *The Veterinary Journal* 193(1), 135-9.

Listeriosis

BACKGROUND

The genus *Listeria* contains several species but *Listeria monocytogenes* is the only zoonotic species and was first described in 1926. Previously, sporadic cases of listeriosis were reported, often in employees in contact with diseased animals but since the 1980s outbreaks of listeriosis have been traced to food products.

Listeria bacteria are widely distributed in the environment, such as in soil, silage and water. They can survive for long periods in the environment and tolerate disinfection and also grow at refrigeration temperatures, in vacuum packed food and in modified atmospheres. *L. monocytogenes* is often found as an environmental contaminant in food premises. These properties make elimination of *L. monocytogenes* difficult. The main sources of human listeriosis are contaminated food products, such as smoked or gravad vacuum-packaged fish products, meat products and soft cheeses or other ready-to-eat foods with a long shelf-life. *L. monocytogenes* is destroyed by heating (pasteurisation and cooking). The infection can also be transmitted from infected animals to humans or via person-to-person contact.

The environment and animals serve as important reservoirs of the pathogen. The main sources of listeriosis for animals are feed or environment. To prevent listeriosis in ruminants it is essential to feed animals with a silage of good quality (low pH and without contamination with soil) as the less acidic pH enhances multiplication of *L. monocytogenes*.

In Sweden, during the last ten years approximately 50-120 human cases have been reported annually. Outbreaks have been associated with vacuum-packaged fish (1995-1996, 2013-15), with cheese made of unpasteurized goat's milk (2001), cold cuts (2013-2014) and with frozen corn (2016-2017). During 2017 the incidence of listeriosis increased compared to the year before and the overall picture is an increasing trend of cases of listeriosis in Sweden (Figure 9).

Animals

L. monocytogenes can infect a wide range of animal species, both domestic and wild. Animals may be asymptomatic carriers and shed the organism but especially sheep may develop clinical disease, such as neurological symptoms, abortions, mastitis or septicaemia.

Humans

Listeriosis can be manifested either as a milder noninvasive form or as a severe invasive disease. The non-invasive form is mainly febrile gastroenteritis. The severe form most often occurs in immunocompromised persons, newborns, pregnant women and elderly people. Symptoms of invasive listeriosis are septicaemia, meningitis and meningoencephalitis. For those with severe infection, the mortality rate is high (20-40%). The infection can lead to miscarriage, premature

delivery or neonatal death. The incubation period of listeriosis varies from 3-70 days, with an average incubation of 21 days.

LEGISLATION

Animals

Listeriosis is a notifiable disease in animals according to SJVFS 2013:23.

Food

Criteria for *L. monocytogenes* in foods are specified in the EU-regulation on microbiological criteria (EC 2073/2005). Food business operators shall ensure that foodstuffs are in compliance with the regulation. Different criteria apply to ready-to-eat (RTE) foods in which growth of *L. monocytogenes* can occur and in RTE foods in which growth of *L. monocytogenes* will not occur during their shelf-life.

Humans

The invasive form of listeriosis has been a notifiable disease in Sweden since 1960. It is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2014:1549).

SURVEILLANCE

Animals

Surveillance in animals is passive. Notifications are based on clinical cases and laboratory analyses. The diagnosis can be based on histological findings at necropsy or by detection of the organism by cultivation methods using enrichment in selective broth followed by culture on selective and non-selective agar. Identification is made by biochemical methods. The Swedish Board of Agriculture can decide on epidemiological investigations if needed.

Food

No official control programme exists, but sampling can be conducted as part of official controls completed by national and local authorities, mainly at retail level but also at production units. Sampling performed by the industry is normally not reported to the authorities. Analysis is based on cultivation methods according to EN/ISO 11290-1 and 11290-2 or NMKL 136 or other methods available at accredited laboratories. The ISO-standard was revised and published in 2017. Laboratories need to adapt their processes to the new standard within a three-year period.

Humans

The surveillance in humans is passive. Isolates from human cases are sent to the Public Health Agency of Sweden for typing using whole genome sequencing (WGS) to verify molecular serotype and for cluster detection. As a conventional nomenclature tool, not only the serotype but also the Multi Locus Sequence Typing (MLST) type, ie. ST-type, is defined by WGS.

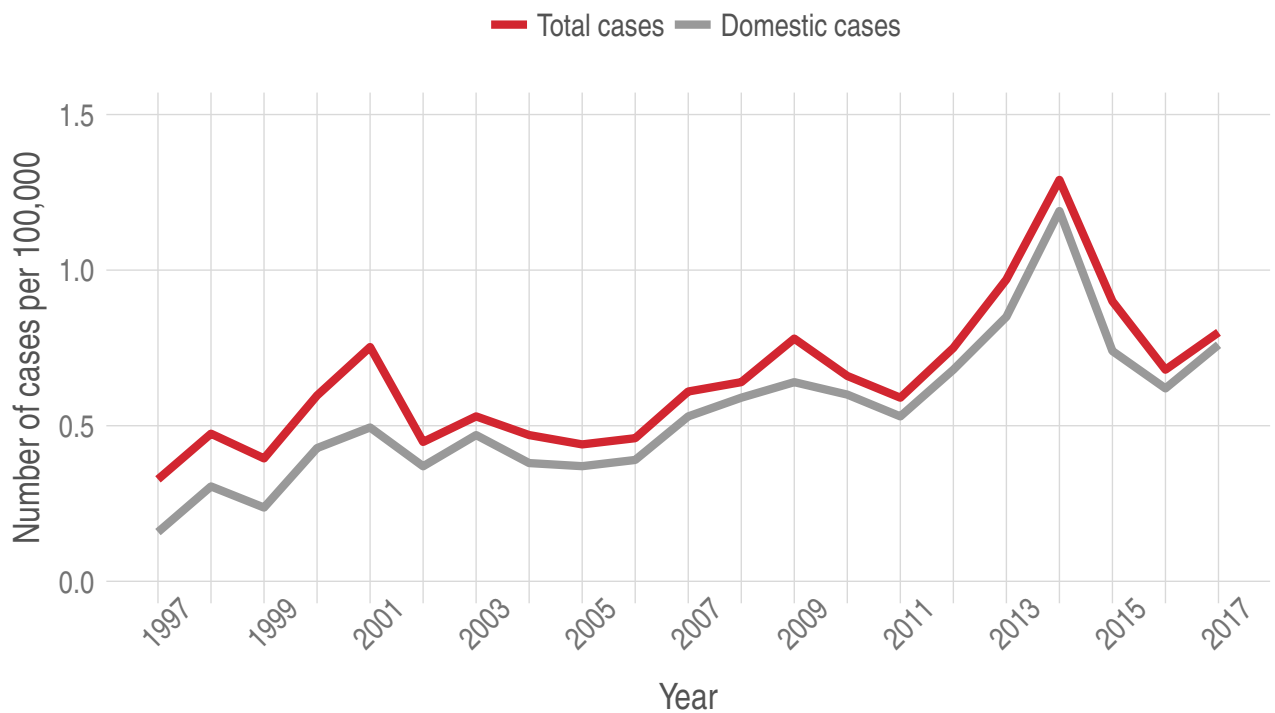


Figure 9: Notified incidence (per 100,000 inhabitants) of human cases of listeriosis in Sweden 1997-2017.

RESULTS

Animals

In 2017, listeriosis was reported in 22 sheep, three cattle, one goat and one forest reindeer.

Food

Results from official sampling by local authorities at food enterprises showed that 491 samples from various food products were analysed. Out of them, 208 samples were taken as part of a project. There were 110 samples that were analysed both qualitatively and quantitatively. *L. monocytogenes* was detected in 13 of the 491 samples. Of these 13 samples there were two samples from raw fish, three samples from meat from pig, and two samples from cheese made from unspecified milk.

Humans

In 2017, 81 cases of listeriosis were reported (incidence 0.8 cases per 100,000 inhabitants). (Figure 9). This was an increase in number of cases compared to the year before when 68 cases were notified. The majority of the cases reported with listeriosis belong to the older age groups. In 2017, the median age was 75 years and 68% were people over 70 years. As previous years, the highest incidence was found in the age group over 80 years (6.2 cases per 100,000 inhabitants). Of the reported cases, 56% were women. In total 35% of the reported cases died within one month from diagnosis.

Listeriosis is most often a domestic infection. During 2017, 77 cases (95%) were reported with Sweden as country of infection. Three cases were reported as infected abroad and one case had missing information about country of infection.

In 2017, all but five (94%) of the human isolates were

sent in to the Public Health Agency of Sweden for typing. The most common molecular serotypes were IIa (68%), IVb (24%), IIb (5%) and IIc (3%). In addition to serotypes, sequence types (ST) are also identified through WGS. Different ST can belong to the same serotype and during 2017 the most common ST were ST-37 and ST-451 belonging to serotype IIa and ST-6 belonging to serotype IVb. Through molecular comparison within the same ST, cluster of identical isolates can be identified and also be associated with a suspected source of infection. Identical isolates within the same ST have been identified during several years. This might indicate that some of these strains have been established in production facilities and occasionally contaminate food products causing illness in patients.

During 2017, a cluster of serotype IVb ST-6 was identified belonging to a European outbreak of listeriosis. The cluster included six cases between May 2016 and December 2017. All six cases were over 70 years. In total 28 cases in 2015-2017 from five different countries are included in the outbreak which was identified through WGS. Investigations showed that frozen corn, produced in Hungary and packaged in Poland, was the suspected source of infection. In Sweden, the outbreak strain could be identified in frozen corn from a large retailer and all suspected batches were recalled from the market. The outbreak is ongoing and additional cases have been detected in 2018.

In addition to the outbreak, a single case with serotype IIa ST155 could be associated with a soft cheese produced at a local farm.

DISCUSSION

During 2017, the incidence of listeriosis increased compared to the year before and the overall picture is an increasing

trend of listeriosis since 1983. (Figure 9). The same trend has been observed in other European countries. The reasons for the increase remain unclear but are most likely related to a combination of factors such as an ageing population, a widespread use of immunosuppression medications and consumer preference changes to more ready-to-eat foods. The European Centre for Disease Prevention and Control (ECDC) collaborate with the member states to strengthen the molecular surveillance to be able to detect cross-border clusters and outbreaks of *L. monocytogenes*. This collaboration, also including the European Food Safety Authority (EFSA), was essential in the investigation of the European outbreak associated with frozen corn. Through subtyping of isolates from both humans and food it was possible to link cases from different countries to the suspected food product.

The case-fatality rate of listeriosis is high. Approximately one third of the patients die within three months. Since most of the patients suffer from severe underlying diseases the impact of listeriosis is difficult to estimate. The microbiological criteria for *L. monocytogenes*, set in 2005, determine the standard the industry has to achieve for their products to be considered safe for consumers.

Continued surveillance of *L. monocytogenes* in humans and in food and food processing environments will be essential for understanding the sources for human infection and providing tools to prevent infections. For identification of possible links between human cases and food products, subtyping of isolates is essential.

REFERENCES

Lopez-Valladares G, Tham W, Parihar VS, Helmersson S, Andersson B, Ivarsson S, Johansson C, Ringberg H, Tjernberg I, Henriques-Normark B, Danielsson-Tham ML. Human isolates of *Listeria monocytogenes* in Sweden during

half a century (1958-2010). *Epidemiol Infect.* 2014 Nov; 142(11):2251-60

Thisted Lambertz S, Ivarsson S, Lopez-Valladares G, Sidstedt M, Lindqvist R. Subtyping of *Listeria monocytogenes* isolates recovered from retail ready-to-eat foods, processing plants and listeriosis patients in Sweden 2010. *Int J Food Microbiol.* 2013

Thisted Lambertz S, Nilsson C, Brådenmark A, Sylvén S, Johansson A, Jansson L-M and Lindblad M. Prevalence and level of *Listeria monocytogenes* in ready-to-eat foods in Sweden 2010 2012;160:24-31.

Parihar VS, Lopez-Valladares G, Danielsson-Tham ML, Peiris I, Helmersson S, Unemo M, Andersson B, Arneborn M, Bannerman E, Barbuddhe S, Bille J, Hajdu L, Jacquet C, Johansson C, Löfdahl M, Möllerberg G, Ringberg H, Rocourt J, Tjernberg I, Ursing J, Henriques-Normark B, Tham W. Characterization of human invasive isolates of *Listeria monocytogenes* in Sweden 1986-2007. *Foodborne Pathogens and Dis.* 2008;5:6.

Carrique-Mas J, Hökeberg I, Andersson Y, Arneborn M, Tham W, Danielsson-Tham ML, Osterman B, Leffler M, Steen M, Eriksson E, Hedin G, Giesecke J. Febrile gastroenteritis after eating on-farm manufactured fresh cheese - an outbreak of listeriosis? *Epidemiol Infect.* 2003;130(1):79-86.

Maedi-visna



At the end of 2017, 4,062 flocks with 148,563 sheep were enrolled in the Swedish maedi-visna programme, administered by Farm & Animal Health. A total of 3,753 of these flocks were declared free from the disease. Photo: Karin Bernodt

BACKGROUND

Maedi-visna (MV) is a globally distributed contagious disease in sheep, first described in Iceland in 1939. The causative agent is a lentivirus in the Retrovirus family. Transmission between animals occurs most commonly via the oral route (mainly via milk), but may also occur via inhalation of infected aerosol droplets. The incubation period is long; often 4-5 years. The first case of MV in Swedish sheep was officially reported in 1974. Fifteen years later, the flock-level seroprevalence was 8.2% as demonstrated by sampling of randomly selected sheep at abattoirs. A voluntary control programme for MV was launched by Farm & Animal Health in 1993, and in 2005 an additional simplified version started, with single sampling of sheep and goats to identify diseased flocks and then in the next step enrol them into the control programme. The simplified version is not regulated within the Swedish legislation and does not require the same obligations from the farmers. The control programme and the simplified version of it are running in parallel.

Data from all sampled and controlled flocks have been recorded since 1993.

DISEASE

Only the maedi form of MV is occurring in Swedish sheep flocks; a progressive viral pneumonia. The disease typically remains latent in the flock for several years before appearing with clinical manifestations. In an advanced stage of the disease the typical clinical signs are severe emaciation and respiratory distress in older ewes. In highly infected flocks clinical signs can also appear in younger sheep. After the appearance of clinical signs the outcome is always fatal within weeks to months.

LEGISLATION

MV is a notifiable disease (SJVFS 2013:23). The control programme is regulated through SJVFS 1993:42 (Jordbruksverkets föreskrifter om organiserad hälsokontroll av husdjur (K 152).

SURVEILLANCE

The purpose of the control programme is to detect and eradicate MV from Swedish sheep flocks. Documentation of the MV status in the flocks is essential. By identifying infected flocks for disease control and taking measures, the spread of MV stops and eradication is possible. Prevention of introduction of MV into flocks is crucial.

The programme is based on serological testing of sheep at farm level. A flock specific Maedi status is achieved by repeated blood sampling and testing. Participating farmers sign an agreement that all sheep in the flock are individually identified and recorded. Purchase of sheep is only allowed from flocks with a similar or higher MV status.

Serological testing is performed on all sheep older than one year. Negative serology grants the flock an M1-status. A second sampling performed 12-16 months later grants an M2-status if all samples are negative for MV antibodies. This procedure is repeated 12-16 months later and a negative result grants an M3-status, which means that the flock is declared free from MV. The MV free status is maintained by an assurance of the animal keeper. An indirect control of the M3 status holdings is performed by testing of sheep from holdings entering the programme as these new animals are mainly bought from M3 status flocks. If antibodies are detected in a flock, either the whole herd is culled or other eradication measures including selective slaughter is performed, depending on the prevalence of positive sheep within the flock.

Goats and goat herds can also be enrolled in the MV programme.

The programme is based on serological examination of blood samples for antibodies against MV virus with an AGID-test (agar gel immunodiffusion) for which the antigen is purchased from the Animal and Plant Health Agency, Weybridge, UK. Samples with inconclusive or seropositive results are retested with an ELISA (Elitest MVV/ CAEV, Synbiotic), which is also used for flocks under partial eradication and for very small flocks with less than five sheep.

Post mortem examinations and histopathology are still important tools to detect MV. Diagnostic testing is performed at the National Veterinary Institute. Serum samples

collected in the MV-programme are also used for other active surveillance in sheep (eg. brucellosis and tuberculosis).

RESULTS

During 2017, approximately 12,000 samples from sheep (and a few goat) flocks were analysed in the MV control programme for antibodies against MV virus.

At the end of 2017, 4,062 flocks with 148,563 sheep were enrolled in the programme and 3,753 of these flocks were declared free from MV. For goats, 240 flocks with 2,453 goats were enrolled in the MV/CAE programme. This corresponds to about 50% of the Swedish sheep population, and about 25% of the goat population.

Within the simplified programme, 920 samples from 129 flocks were analysed.

In total during 2017, six flocks were considered positive of which five were goat flocks. Four were detected in the simplified programme.

DISCUSSION

It is now 25 years since the MV programme was launched. A series of measures have been taken in order to finalise the programme. A revision of the MV programme was made during 2013 by Farm & Animal Health and the National Veterinary Institute. Since July 2014, the programme was further refined to increase sampling in risk areas and higher risk flocks and reduce sampling in long term MV free and well documented flocks. Studies on the routes of introduction and appearance of MV in sheep flocks are desired to further understand how to conclude the programme, as well as investigations into the advantages and disadvantages of different diagnostic tests.

REFERENCES

Kampen AH, Mork J, Hopp P, Klevar S. The surveillance and control programme for maedi in Norway 2012. Surveillance and control programmes for terrestrial and aquatic animals in Norway. Annual report 2012. Oslo: Norwegian Veterinary Institute 2013

Lindqvist Å. Kontrollprogram hos maedi-visna hos får. Svensk veterinärtidning 1993, 11, 463-5

Nephropathia epidemica



The human incidence of nephropathia epidemica shows a considerable interannual variation coupled to the 3-4 year population cycle of the bank vole. A majority of the 158 cases reported in 2017 were from the four northernmost counties in Sweden. Photo: Ian Preston CC BY 2.0

BACKGROUND

Nephropathia epidemica (NE) is caused by Puumala virus, a member of the Hantavirus genus in the *Bunyaviridae* family. Hantaviruses are the cause of rodent-borne haemorrhagic fevers with renal syndrome (HFRS) and hantavirus pulmonary syndrome (HPS). Puumala virus is likely to be the most prevalent hantavirus in Europe. The virus is excreted in saliva, urine and faeces from its natural reservoir, the bank vole. Puumala virus can remain infectious in bank vole cage bedding for two weeks. Transmission to humans often occurs in an aerosolised form. Humans may be exposed to virus aerosols during occupational or recreational activities, such as working with hay, cleaning barns or summer cottages, cutting wood and entering buildings contaminated with rodent excretions.

Nephropathia epidemica was first described by two Swedish physicians, independently, in 1934. The linkage to the bank vole was suggested many years later. The virus was first isolated in 1982 in Puumala, a municipality in south-eastern Finland.

In Sweden, between 50 and 600 cases are reported each

season with a considerable interannual variation coupled to the 3-4 year population cycle of the bank vole. During the winter seasons 2006-2007 and 2007-2008 the number of notified cases rose to 1,400, where most of the cases occurred in 2007 (Figure 10). It is hypothesised that a parallel occurrence of a peak in the bank vole population and lack of snow cover in December 2006 caused bank voles to seek refuge in buildings and barns, hence increasing their contact with humans.

DISEASE

Animals

In the bank vole, the infection is understood to be subclinical.

Humans

The clinical picture is characterised by a sudden onset of high fever, headache, backache and abdominal pain. The symptoms range from sub-clinical to renal failure requiring intensive care and dialysis, but fatal cases are rare. The incubation period varies from 2 to 6 weeks.

LEGISLATION

Animals

Hantaviruses are not notifiable in animals.

Humans

Nephropathia epidemica has been notifiable since 1989 according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

There is no surveillance in animals.

Humans

The surveillance in humans is passive.

RESULTS

Humans

In 2017, 158 cases of NE were reported, which was an increase in comparison to the previous year (Figure 10). Most reported cases were in the age category between 50 and 69 years and the median age was 54 years. Consistent with previous years, more cases were reported in men (63%) than in women. The reason for this difference in incidence between age groups and sexes is not completely understood, but behaviour is most likely an important factor.

Most of the reported NE cases have acquired their infections in Sweden. In 2017, there were only two cases infected abroad, in Russia and in Norway respectively.

A majority of the cases (63%) were reported from the four northernmost counties in Sweden. In Västernorrland the incidence was highest (18.7 cases per 100,000 inhabitants) and in the counties of Jämtland, Norrbotten and Västerbotten there were 5.2-10.4 cases per 100,000 inhabitants. This regional pattern is consistent with previous years. There were not so many cases reported during the first half of 2017. The highest number of cases were reported in August and September respectively.

DISCUSSION

During recent years, fluctuations in the bank vole population have coincided with increases and decreases in the number of human cases of Puumala virus infections. The 3-4 year natural population cycle and variations in the climatic conditions impact the rodent populations.

REFERENCES

Evander, M and Ahlm, C. Milder winters in northern Scandinavia may contribute to larger outbreaks of haemorrhagic fever virus. *Global Health Action* 2009.

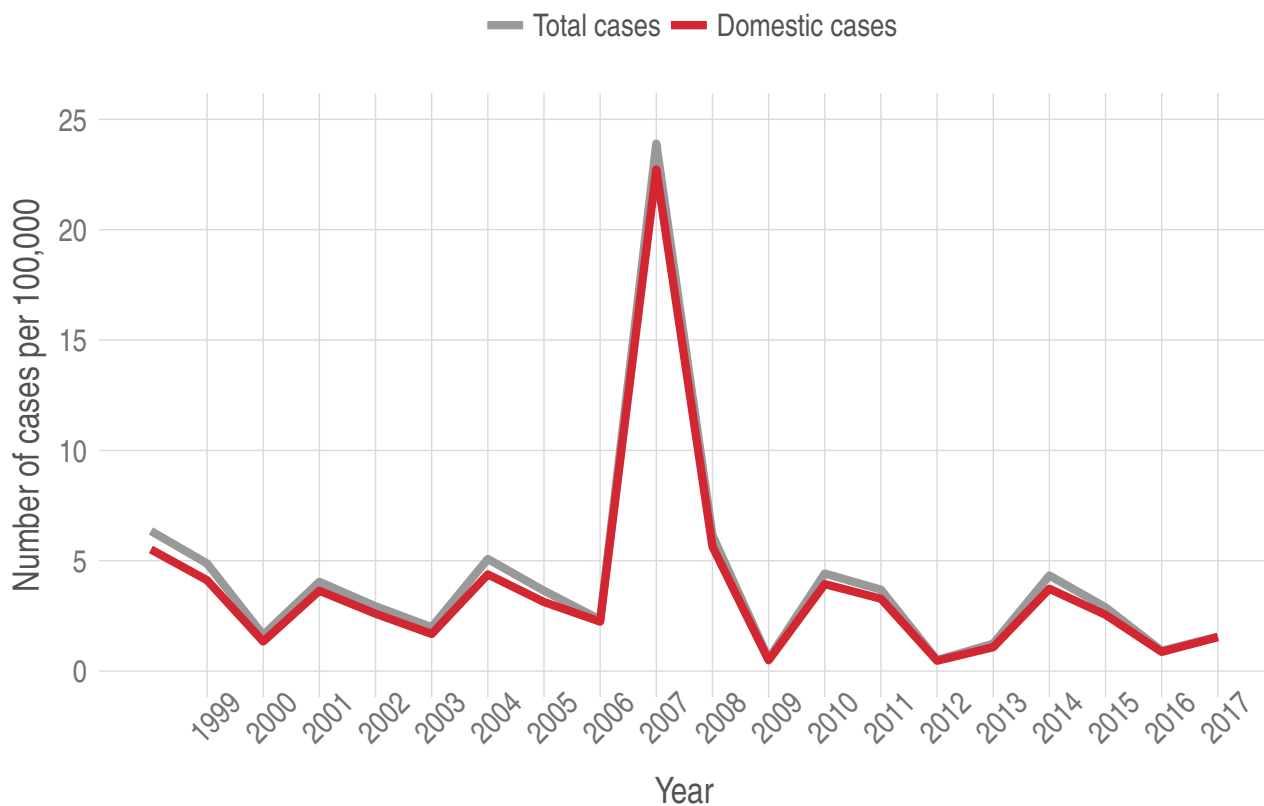


Figure 10: Notified incidence (per 100,000 inhabitants) of human Nephropathia epidemica in Sweden 1998-2017.

Paratuberculosis

BACKGROUND

Paratuberculosis is a common disease of ruminants in most parts of the world caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP). Sweden has a unique situation, where the prevalence of the disease is extremely low, or not present at all. Sporadic cases have previously occurred in beef cattle, all of them connected directly or indirectly to imported animals. The latest case was detected in 2005. Throughout the 20th century, detection of such cases has been followed by whole herd stamping-out, tracing and sanitation measures, with the goal to eradicate the disease and to prevent spread of infection.

Paratuberculosis has never been detected in dairy cattle, other ruminant species or wildlife in Sweden. The overall purpose of the surveillance and the voluntary control programme in beef herds is to document freedom from bovine paratuberculosis and to prevent possible spread by early detection of the infection.

In a study by Frössling and co-workers (2013), the probability of freedom and sensitivity of the surveillance system for MAP was estimated. Results showed that, at the end of 2008, there was a high probability that the Swedish cattle population was free from or had a very low prevalence of MAP.

Previous active surveillance

Tracings and several screenings in cattle were initiated after detection of a positive beef cow in 1993:

- Screening of 200 dairy herds in the years of 2000, 2003 and 2005.
- Since 2004 all ruminants above one year of age, submitted for necropsy, are sampled and cultured for MAP. Sampled animals also include exotic ruminants like buffalo and camelids.
- Screening of sheep herds during the years 1993- 2011, first with serology, then with faecal culture. The screening of sheep was discontinued in 2012.
- In 2007-2009 faecal culture screening of beef herds with animals imported during 1990-2005. In 2012, another screening of beef herds with animals imported during 2005-2011 was conducted.
- Risk-based screening of older cows at abattoirs in 2009-2010, including cows older than six years with signs of weight loss, resulted in 1,211 sampled cows.

In 2012-2013, a campaign to raise the awareness of the disease among farmers and veterinarians was initiated to improve the passive surveillance. Bovine practitioners were encouraged to look for and sample cows with low bodyweight, with or without diarrhoea. The 258 samples were analyzed by faecal PCR.

DISEASE

Paratuberculosis, also known as Johne's disease, is an intestinal infection in ruminants caused by *Mycobacterium avium* subsp. *paratuberculosis* (MAP). The bacteria is excreted in the faeces of an infected animal and the normal transmission route is faecal to oral. It causes chronic diarrhoea and emaciation resulting in suffering and death. If present, the disease causes great economic losses due to reduced milk production, reproductive losses and increased replacements of affected animals.

The incubation period is several years. In areas with endemic infection, clinical disease is most commonly seen at the age of 2-5 years. There is no reliable method to detect the infection in the individual animal during the incubation period.

The zoonotic potential of MAP is a recurring question and there are ongoing discussions about MAP as a possible contributing factor to the development of Crohn's disease in humans.

LEGISLATION

Paratuberculosis (Johne's disease) has been included in the Swedish Act of Epizootic diseases since 1952 (SFS 1999:657 with amendments). Vaccination is prohibited by law and notification of the infection is mandatory on clinical suspicion. Whole-herd slaughter with subsequent sanitation and tracing of animal trade is performed if MAP is detected in a herd.

SURVEILLANCE

Diagnostic tests

Cultures were pre-treated with HPC and double incubation. Samples were subsequently cultured on modified Löwenstein-Jensen medium supplemented with mycobactin and on Herrolds Egg Yolk medium for up to 4 months. Faecal samples from sheep were cultured for up to 6 months, on both modified L-J with mycobactin and modified Middlebrook 7H10 with mycobactin. Direct PCR on a new preparation from the stored samples was performed on samples that had mould overgrowth in the culture.

Samples collected because of clinical suspicion and individual faecal samples from the beef herd control programme are analysed with direct PCR.

All tests for detection of MAP bacteria are performed at the National Veterinary Institute

Passive surveillance

Notification, sampling and diagnostic testing are mandatory in animals of any ruminant species exhibiting clinical signs that lead to suspicion of paratuberculosis. Sampling includes faecal samples from live animals and post mortem samples from dead or culled animals. The latter consists of samples from the ileal wall, ileal contents and ileocaecal lymph nodes as well as any macroscopic lesions in the

intestines. Wildlife is sampled when MAP is suspected at necropsy.

Post mortem examinations

Sampling is performed on all ruminants above one year of age submitted for post mortem examinations as part of the enhanced passive surveillance for MAP. Samples are taken from the ileal wall, ileal contents and ileocaecal lymph nodes and submitted to the National Veterinary Institute.

Active surveillance

Control programme for surveillance in beef cattle

In the voluntary control programme, the target population is beef herds that sell animals for breeding. The programme is managed by Farm & Animal Health and financed by the Swedish Board of Agriculture. In total, at the end of 2017, the control programme for bovine paratuberculosis encompassed 449 herds, of which 423 are of the highest status. The control programme includes all main beef breeding herds and a smaller number of dairy herds selling calves to beef herds within the program.

In affiliated herds, individual faecal samples are collected annually for three consecutive years, from all cattle over two years of age and all purchased animals from one year of age. Affiliated herds are only allowed to trade with herds of the same status or higher to maintain their level within the programme. After three years of negative test results, the faecal sampling is replaced by necropsy of all euthanised or deceased cattle on the premises where paratuberculosis cannot be excluded as a cause of culling.

Health controls for export reasons

Twenty-three cattle were tested for export reasons, 16 by serology, 8 by PCR on semen and 1 by PCR on faeces. Some of the animals have been tested by more than one method or more than one time. Ten alpacas and 18 wisent (European bison) were tested by faecal PCR. The choice of analysis depends on the recipient country.

RESULTS

In 2017, four cattle were investigated by faecal PCR due to clinical suspicion of MAP. One sheep was included in the passive surveillance due to pathological changes detected at post mortem examination and tested by PCR. In addition, one bull had a serological reaction at sampling for semen export and was followed up by faecal PCR. All animals were tested by PCR with negative results. In 2017, 34 herds were sampled within the control programme for surveillance in beef herds, resulting in 1,130 individual samples (1,067 cattle from 30 herds, 60 sheep from 4 herds and 3 water buffalo from one herd).

Three hundred and forty-nine animals were sampled at post-mortem examination; 218 cattle, 114 sheep, 8 goats, 6 alpacas, 1 mufflon sheep and two moose. The mufflon and moose were kept at wildlife parks. No cases of MAP were detected in any of the examinations completed in 2017 (Tables 9, 10 and 11).

DISCUSSION

The prevalence of MAP in Swedish ruminants remains at a very low level, if present at all.

The screenings of beef herds with cattle imported from 1990-2011 was targeting the highest risk group of animals for MAP in Sweden; MAP has been detected in no other breeds or species than beef cattle and all cases have been traced back to imported animals with the latest case back in 2005.

Fallen stock is considered a risk category for MAP and therefore all ruminants older than one year of age, submitted for post mortem examination, are sampled for MAP and examined by culture. All herds affiliated with the control programme must send fallen stock for post mortem examination if paratuberculosis cannot be ruled out as a cause for death or culling. The post mortem sampling also includes other susceptible species, like sheep, goats and exotic ruminants. The exotic ruminants are sometimes imported, or kept in herds with other exotic ruminants imported from countries where MAP is prevalent.

A recent update of the evaluation of the paratuberculosis surveillance programme indicates that the surveillance sensitivity in the last years has decreased. This year work has been initiated to evaluate the possibility of utilising bulk milk samples to increase the surveillance in the dairy cattle population to improve the surveillance sensitivity.

REFERENCES

- Frössling, J, H. Wahlström, E. Ågren, A. Cameron, A. Lindberg, S. Sternberg-Lewerin. Surveillance system sensitivities and probability of freedom from *Mycobacterium avium* subsp *paratuberculosis* infection in Swedish cattle. Preventive Veterinary Medicine, Volume 108, Issue 1, 1 January 2013.
- Rockström, U. 2011. Slutrapport; Undersökning avseende paratuberkulos i nötkreatursbesättningar som varit sista besättning till djur, vilka importerats till Sverige under 1990 till 2005. Jordbruksverkets diariernr 33-4861/11.
- Sternberg Lewerin, S., E Ågren, J Frössling, G Bolske, A Holmstrom, A Lindberg, E Szanto, D Viske. Control of paratuberculosis in Sweden. In the proceedings of: 9th ICP, Japan, Nov 2007.

Table 9: Cattle sampled in 2017.

Surveillance in cattle	No. of sampled animals	No. of herds
Beef herd surveillance programme ^A	1,070	31
Cattle sampled at post mortem examinations	218	177
Cattle sampled for export	23	1

^A Including 3 water buffalo from one herd

Table 10: Sheep and goats sampled in 2017.

Surveillance in sheep and goats	No. of sampled sheep	No. of herds
Sheep sampled in cattle herds within the beef herd surveillance programme	60	4
Sheep sampled at post mortem examinations	114	98
Goats sampled at post mortem examinations	8	8

Table 11: Exotic ruminants sampled in 2017.

Surveillance in exotic ruminants	No. of sampled animals	No. of herds
Exotic and wild kept ruminants sampled at post mortem examination	9	8
Exotic and wild kept ruminants sampled for export ^A	28	3

^A 10 alpacas and 18 wisent.

Porcine reproductive and respiratory syndrome

BACKGROUND

Porcine reproductive and respiratory syndrome (PRRS) is caused by an enveloped RNA-virus belonging to the family Arteriviridae and the disease affects domestic pigs. PRRS is a highly contagious disease transmitted between pigs through both direct and indirect contact.

Seropositive feral pigs and wild boars have been described but there is no evidence of wild boar being a reservoir for PRRSV. The disease was first described in USA in 1987 and the virus was subsequently identified in 1991. Since then, PRRSV has spread and is endemic in most of the pig populations of the world. It is considered to be one of the most economically important viral diseases in swine production. In 2006, an atypical variant of PRRSV was reported from Asia. This variant causes more severe clinical signs and higher mortality than previously described genotypes of the virus.

In 1998, Farm & Animal Health launched a surveillance programme for PRRSV in which the Farm & Animal Health is responsible for the sampling and the National Veterinary Institute performs the analyses. The first case of PRRS in Sweden was confirmed in July 2007. Until then, Sweden was one of few countries that had declared themselves free of PRRSV. The outbreak was detected through the active surveillance programme. Since the disease was not widespread at the time of detection, a decision was made to control the outbreak through a modified stamping out procedure. The actions taken to eradicate the disease proved to be effective and following extensive surveillance during the fall of 2007, Sweden was declared free from the disease with a high probability in the beginning of 2008. Despite extensive investigation, the source of the outbreak could not be established.

After the outbreak in 2007, the surveillance programme was revised in order to enable even earlier detection of an introduction of PRRSV. Another revision of the programme was done in 2012 following extensive changes in the pig production in Sweden.

DISEASE

Infection with PRRSV causes varying clinical signs depending on the age of the infected animals. The incubation period is 2-7 days (usually 2-3 days) and in adult swine the clinical signs are usually mild, consisting of fever and inappetence for a few days. The devastating effect of PRRSV infection in this category of animals is that it causes reproductive failure including abortions, mummified foetuses, small litters and increased incidence of non-pregnant sows. In fattening pigs the infection mainly causes respiratory signs.

The atypical variant of PRRSV may cause high fever, discolouration of the skin and high mortality rates in all age groups.

LEGISLATION

The disease was included in the Swedish Act of Epizootic diseases in 1999 (SFS 1999:657 with amendments) and is consequently notifiable on suspicion. Notification will then lead to investigations.

SURVEILLANCE

The purpose of the surveillance is to document freedom from PRRSV and to detect introduction of the virus before it is widespread in the population. Both detection of viral genome and antibodies against PRRSV are used in the surveillance. All samples are analysed at the National Veterinary Institute. To detect antibodies against PRRSV, a commercial ELISA-method (IDEXX PRRS X3 Ab Test, Idexx Laboratories) is used and presence of the viral genome is analysed using an in-house PCR method (modified from Kleiboeker *et al*, 2005). Samples positive for PRRSV antibodies in the ELISA-test are analysed at the Danish Technical University using an immunoperoxidase monolayer assay (IPMA) for confirmation.

Passive surveillance

Because PRRS is notifiable on clinical suspicion for both veterinarians and farmers, cases with suspect clinical signs will be investigated following notification to the Swedish Board of Agriculture. The investigation includes sampling of sick or dead animals and examination of the herd for presence of clinical signs and analyses of production results. During the investigation the farm is placed under restrictions.

In addition, analyses for the PRRSV genome with PCR are included in the enhanced passive surveillance of aborted fetuses (See Page).

Active surveillance

The active surveillance programme revised 2012 and put into effect in 2013, comprises field sampling of all Swedish nucleus herds, multiplying herds and sow pools twice a year. In addition, randomly selected production herds are sampled continuously at slaughter. In nucleus herds, multiplying herds and sow pools eight samples per herd are taken on each sampling occasion, and at slaughter, three samples per herd are collected.

The revised programme was designed to take into consideration an increased risk of introduction, the changes in the structure of the pig production and to keep the probability of freedom of PRRS on the same level as after demonstration of freedom after the outbreak in 2007. To achieve this, the programme is designed using a between-herd design prevalence of 0.5%, a within-herd design prevalence of 40% and a risk of introduction of 1 in 5 years. The number of samples needed is calculated yearly taking the outcome of the surveillance in the previous years into account. For 2017, the calculated number of samples required was 2,400 from the abattoir sampling in addition to the field sampling described above.

RESULTS

Passive surveillance

Two investigations following clinical suspicion of PRRS were conducted during 2017. Respiratory disorder was the main clinical manifestation in both cases. The number of animals sampled and the methods chosen varied depending on the nature of the suspicion in terms of clinical manifestation and how widespread the clinical signs were in the herd. Following sampling and testing, both herds were declared negative for PRRSV.

Within the surveillance of aborted fetuses, 6 fetuses from 4 herds were examined for the PRRSV genome and all samples were negative.

Active surveillance

In 2017, 826 samples from 54 nucleus herds, multiplying herds and sow pools and 2,625 samples from the abattoir sampling were analysed. The samples from the abattoir sampling originated from 875 sampling occasions and each herd was, as a rule, sampled 1-2 times during the year. For comparison, the number of samples collected per year since the PRRSV outbreak is given in Table 12.

One investigation following a positive sample was performed. It included, in addition to further sampling, examination of the herd for clinical signs of PRRS and assessment of production results. No clinical signs of PRRS were detected and all additional samples were negative for PRRS antibodies and the investigation concluded the positive sample to be a singleton reactor and not due to infection with PRRS in the herd.

Taking the surveillance outcome from 2016 into account, the probability of freedom based on the surveillance during 2017, was >99%.

DISCUSSION

Before the outbreak of PRRS in 2007, the active surveillance programme was based on field sampling in all nucleus herds, multiplying herds, sow pools and 50 production herds once a year, usually clustered in time. This surveillance design had the drawback of being expensive, having a low sensitivity and a risk of poor timeliness. After the outbreak,

the surveillance was further developed employing continuous abattoir sampling and a more effective field sampling in nucleus herds, multiplying herds and sow pools to improve early detection of a PRRSV introduction and to increase the sensitivity of the surveillance. The evaluation of the programme in 2012 indicated that the probability of freedom and the sensitivity of surveillance were declining over time and the changes that were suggested aimed at breaking this trend. The main reason for the declining probability of freedom was the decreasing number of samples. During recent years, the Swedish pig industry has undergone substantial structural changes leading to a rapidly declining number of herds and extensive changes in the market and in the habits of farmers. These changes emphasise the need for continuous monitoring of surveillance performance over the year and a yearly evaluation of performance and design. The present design with continuous sampling and testing over the year in combination with the clinical surveillance, increase the probability of early detection compared to the strategy used before the outbreak.

REFERENCES

- U. Carlsson, *et al.* Emergence of Porcine Reproductive and Respiratory Syndrome in Detection, Response and Eradication. *Transboundary and Emerging diseases*. Published Online: Feb 20 2009 10:37AM DOI: 10.1111/j.1865-1682.2008.01065.
- Frössling J, *et al.* Probability of freedom from disease after the first detection and eradication of PRRS in Sweden: Scenario-tree modeling of the surveillance system. *Preventive Veterinary Medicine* 91(2-4),137-45
- Hultén C, 2012. Översyn av den aktiva övervakningen av porcine reproductive and respiratory syndrome (PRRS) i Sverige. SVA D-nr 2012/50 (In Swedish)
- Lindberg A, 2008. PRRS-översyn av övervakningsprogrammet. SVA D-nr 2008/429 (In Swedish)

Table 12: Number of samples and herds tested in the active PRRS surveillance 2008-2017 in relation to the number of registered swine herds

Year	Field sampling		Abattoir sampling		Total number of samples	Number of registered swine herds in Sweden ^A
	Number of samples	Corresponding number of sampled herds	Number of samples	Corresponding number of sampled herds ^B		
2009	1,106	69	2,712	904	3,818	2,027
2010	2,012	126	4,424	1,475	6,436	1,695
2011	1,240	78	2,308	770	3,548	1,515
2012	1,055	66	2,145	717	3,200	1,318
2013	1,024	64	1,548	516	2,572	1,281
2014	912	57	2,028	676	2,940	1,300
2015	824	52	2,382	521	3,206	1,228
2016	875	60	2,446	815	3,321	1,252
2017	826	54	2,625	875	3,451	1,082

^A Sources: Jordbruksverket, Statistikrapport 2018:01

^B Some herds were sampled more than once

Psittacosis

BACKGROUND

Psittacosis is caused by *Chlamydophila psittaci*, an intracellular bacterium. In 1879, psittacosis was described for the first time when an outbreak of pneumonia associated with exposure to tropical pet birds was detected among Swiss patients. The organism was identified in the 1930s. Since then, outbreaks have been described worldwide.

The main reservoir is birds and the organism is excreted in faeces and nasal discharges. Birds may become carriers of the organism and shed it intermittently for years without any clinical signs. People acquire the infection mainly via inhalation of contaminated dust or through contact with infected birds. In birds, the infection is transmitted via contact, by ectoparasites or contaminated equipment. *C. psittaci* may persist in dry faecal material for months.

Control of psittacosis is very difficult. As the organism exists in both domestic and wild birds, eradication is impossible.

DISEASE

Animals

Birds commonly develop clinical signs when stressed or when their immune system is suppressed. Clinical signs in birds range from an asymptomatic infection to conjunctivitis, sneezing, pneumonia and generalised infection. Adult birds recover from the infection but mortality can be up to 90% among young birds.

Humans

In humans, the symptoms often include fever, headache, rash, myalgia, chills and upper or lower respiratory tract infection. The disease is usually mild or moderate, but can be severe especially in untreated elderly persons. Most human cases are sporadic, many infections are probably not diagnosed. The incubation period is usually around 10 days but can vary from 1 to 4 weeks.

LEGISLATION

Animals

C. psittaci is notifiable in animals according to SJVFS 2013:23.

Humans

Psittacosis has been a notifiable disease since 1969 according to the Communicable Disease Act (SFS 2004:168) with the amendments of SFS 2013:634.

SURVEILLANCE

Animals

Surveillance in animals is passive. Notification is based on detection of the organism by PCR targeting all members of the *Chlamydiaceae* family, including both genera of *Chlamydia* and *Chlamydophila*. Species identification can be performed by sequencing the PCR fragment.

Humans

The surveillance in humans is passive. For laboratory verification of the infection serology and PCR are the methods used.

RESULTS

Animals

In 2017, six domestic birds from four different epidemiological units were tested for *C. psittaci*. All animals tested negative.

Humans

Psittacosis is mainly a domestic infection. Of the 43 cases reported during 2017 only 1 was infected abroad (in Spain). Of the 14 cases who were women the median age was 63. The median age for men was 71. A majority of the cases reported that they had been in contact with birds or bird droppings. For the remaining cases there were no obvious route of transmission. All cases except for two were reported from the south of Sweden.

DISCUSSION

At present, *C. psittaci* does not occur in Swedish poultry. The organism is occasionally reported in captive birds, but psittacosis is considered common in both captive birds and wild birds. Still, the few birds sampled over the year all tested negative for *C. psittaci*.

In the 1980s around 100 human cases were reported each year. However, during the last decade the number of reported cases has decreased considerably.

One of the reasons for the decrease in the number of cases is believed to be changes in diagnostic methods. The methods used today are more accurate and many of the early cases are believed to be incorrectly reported as psittacosis.

Another reason that may have contributed to the decrease were amendments in hygiene requirements for pet stores. One of the new requirements were that imported birds had to be treated with prophylactic antibiotics to prevent infections.

REFERENCES

Rehn M, Ringberg H, Runeheggen A, Herrmann B, Olsen B, Petersson AC, Hjertqvist M, Kühlmann-Berenzon S, Wallensten A, 2013. Unusual increase of psittacosis in southern Sweden linked to wild bird exposure, January to April 2013. Euro Surveill. 18 (19), 20478.

Blomqvist M, Christerson L, Waldenström J, Herrmann B, Olsen B. Chlamydia psittaci in Swedish wetland birds: a risk to zoonotic infection? Avian Dis. 2012; 56 (4):737-40.

Blomqvist M, Christerson L, Waldenström J, Lindberg P, Helander B, Gunnarsson G, Herrmann B, Olsen B. *Chlamydia psittaci* in birds of prey, Sweden. Infect Ecol Epidemiol. 2012; 2.

Q fever



Coxiella burnetii is shed in foetal and vaginal fluids, and consequently the pathogen can be transmitted in conjunction with calving and lambing. However, *C. burnetii* infection in sheep seems to be very rare in Sweden, whereas it is common in cattle. Photo: Bengt Ekberg

BACKGROUND

Q fever is a zoonotic disease caused by the bacterium *Coxiella burnetii*. Because of its tolerance to heat, dryness and many disinfectants, the organism is difficult to eradicate. Cattle, sheep and goats are considered to be the main reservoirs of the organism, but pets such as dogs and cats may also become infected. The agent is shed through several routes, such as milk, foetal and vaginal fluids, faeces, urine and semen. *C. burnetii* has also been isolated from ticks.

Transmission to humans is mainly considered to be through inhalation of contaminated aerosols and dust. Therefore, contact with dusty animal products and environments, such as wool, hay and bedding material may pose a risk. Also, consumption of unpasteurised milk may be a risk to susceptible individuals. In humans, immunosuppression, predisposing valvular heart disease and pregnancy may increase susceptibility to Q fever.

Larger outbreaks of Q fever, when reported, are principally associated with small ruminants, whereas cattle can be a source of sporadic cases. In many countries, Q fever is seen as an occupational hazard for professionals in contact with domestic ruminants and their environments, such as farmers, veterinarians and abattoir workers.

The presence of *C. burnetii* in domestic animal populations in Sweden has been known since the early 1990s. The bacterium was first isolated from a sheep placenta in a herd on the isle of Gotland. In 2008/2009, a national survey of dairy cattle herds showed that 8% of the herds were antibody positive in bulk milk. There were large regional differences with the highest prevalence on the isles of Gotland and Öland (59% and 35%, respectively). In 2010, national surveys of sheep and dairy goat herds showed a very low prevalence of antibodies; 0.6% (n=518 herds) and 1.7% (n=58 herds), respectively. In addition, goat bulk-milk was also analysed for the agent; *C. burnetii* was not detected. In 2011, 80 sheep farms were investigated by analysing vaginal swab samples from sheep taken in conjunction with lambing without detecting the agent in any of the samples. The results support that *C. burnetii* is a rare pathogen in the Swedish sheep and goat populations. In a survey of 99 Swedish moose during 2008-2010 no positive samples were found, indicating that *C. burnetii* is rare also in this wild species.

In humans, only two domestic cases were reported in the 1980s and 1990s. During the same period, a serological survey in humans identified 28% of sheep farmers and 13% of veterinarians to be antibody positive, indicating a

larger extent of the exposure. However, a prospective study on cases of endocarditis showed that only one of 329 patients had antibodies to *C. burnetii* indicating that chronic Q fever endocarditis is rare. Since Q fever became notifiable in humans in 2004, one to three cases have been reported annually until 2008, when an increase was observed. Only one case was classified as domestic during the period from 2004–2009. In 2010, the situation changed as eight of the totally 11 reported cases claimed to have been infected in Sweden. All these domestic cases were linked to a farm in southern Sweden, which was included in a national survey on dairy herds and where the bulk milk from the cows was shown to be antibody positive for *C. burnetii*. No active surveillance has been conducted after 2011.

DISEASE

Animals

Q fever in animals is usually asymptomatic but can also lead to reproductive failures such as abortions or still/weakborn calves. In herds where the agent has been proven to be present, the investigation of reproductive problems should still exclude other causes before reproductive failures are attributed to *C. burnetii* infection.

Humans

In humans the infection can vary from asymptomatic or flu-like illness to acute pneumonia. Liver complications and obstetric complications can also occur. Most patients recover but some may develop a chronic illness. The incubation period varies depending on the number of organisms inhaled but is usually 2–3 weeks.

LEGISLATION

Animals

Q fever is a notifiable disease (SJVFS 2013:23). Notification of a primary case of Q fever in animals is based on detection of the agent *C. burnetii* or increased antibody levels in paired samples.

Humans

Q fever has been notifiable according to the Communicable Disease Act since 2004 (SFS 2004:168) with the amendments of SFS 2013:634.

SURVEILLANCE

Animals

Surveillance for Q fever in animals is passive. Limited testing was done in 2017 on cattle and alpacas mainly for export reasons. Blood samples from 13 cattle and 5 alpacas were

analysed for the presence of antibodies by complement fixation test or ELISA. Animals from one herd were tested for *C. burnetii* in bulk milk by PCR.

Humans

The surveillance in humans is passive. For laboratory verification of the infection, serology and PCR are used.

RESULTS

Animals

Bulk milk from one cattle herd tested positive for Q fever with PCR. All other samples that were submitted for testing were negative.

Humans

Since the 1980s, few domestically acquired cases of Q fever have been reported apart from the cluster in 2010. Most reported cases have been infected in Mediterranean countries. In 2017, two cases of Q fever were reported. Both cases were reported as males that were infected in the southern parts of Europe.

During the period when Q fever has been a notifiable disease, only about 20% of the reported cases have been women. A similar difference in gender distribution has been described from other countries, but the cause is not clear.

DISCUSSION

After four years (2008–2011) of active surveillance for Q fever, as well as other related studies, the present surveillance in animals is passive. It is notable that awareness and concern with Q fever as a differential diagnosis has decreased. Due to the nature of the infection, this situation is not likely to change as long as the surveillance remains passive, i.e. dependent on the health or veterinary care seeking behaviour of individuals. Any future prioritisation of Q fever for active surveillance will most likely remain a function of the international situation.

REFERENCES

ECDC. Technical report: Risk assessment on Q fever. [46 pp] doi:10.2900/28860. Available online: http://www.ecdc.europa.eu/en/publications/Publications/1005_TER_Risk_Assessment_Qfever.pdf

EFSA Panel on Animal Health and Welfare (AHAW); Scientific Opinion on Q Fever. EFSA Journal 2010; 8(5):1595. [114 pp.]. doi:10.2903/j.efsa.2010.1595. Available online: <http://www.efsa.europa.eu>

Rabies



Since 2004, there has been an increasing problem with illegal importation of pets, mostly dogs. Illegally imported dogs from rabies-endemic countries are probably the greatest threat to the rabies-free status of Sweden. Photo: Bengt Ekberg

BACKGROUND

Rabies is caused by a lyssavirus in the family *Rhabdoviridae*, and can infect all warm-blooded animals. The disease occurs worldwide with some exceptions. Rabies is transmitted through contact with saliva, typically via animal bites. Most human cases are caused by bites from infected dogs. The reservoir animal species for rabies in endemic countries are most notably among carnivores of the family *Canidae*. In Europe, the reservoir species are red foxes and raccoon dogs.

Bats in Europe may carry another type of lyssavirus called European Bat Lyssavirus (EBLV), but not classical rabies. Sweden has been free from classical animal rabies since 1886. Findings suggest that EBLV is present in Sweden, but virus has never been isolated.

DISEASE

Humans and animals

Rabies virus infects the central nervous system of humans and mammals. Early symptoms of rabies are non-specific, consisting of fever, headache, and general malaise. As the disease progresses, neurological symptoms appear and may

include: insomnia, severe anxiety, confusion, slight or partial paralysis, excitation, hallucinations, agitation, hypersalivation and difficulties in swallowing. The incubation period of rabies is usually 3-6 weeks, but may vary from five days to one year.

There are still knowledge gaps on how EBLV infections affect bats. Experimentally infected bats have shown clinical signs as weight loss, disorientation, lack of coordination, muscle spasms and aggression. Some infected bats may still be normal in behavior.

LEGISLATION

Animals

Rabies is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and is notifiable on suspicion. If rabies is suspected or confirmed, measures will be taken to combat the disease and to prevent further spread.

To prevent the introduction of rabies, dogs and cats must be vaccinated against rabies before entering Sweden. In addition, depending on the country of origin, some must have their antibody titre tested. The rules are set in SJVFS 2011:49 (with amendments of SJVFS 2014:47) and in the EU Regulation 576/2013.

Humans

Rabies in humans is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

Passive surveillance

Animals with clinical signs where rabies cannot be excluded are tested on suspicion by fluorescent antibody test (FAT).

Active surveillance

Illegally imported pets that are detected and come from countries with endemic rabies, are euthanized and examined for rabies to exclude the possible spread of rabies in Sweden.

Humans

The surveillance in humans is passive.

RESULTS

Animals

In 2017, four cats and two dogs were examined for rabies due to clinical suspicion. Furthermore, two illegally introduced animals, one dog and one tenrec, were examined for rabies due to sudden death. The dog was at the time kept in home isolation after decision by the Swedish Board of Agriculture.

In addition, 23 illegally introduced euthanized dogs and two cats were examined after decision by the Swedish Board of Agriculture. The diagnostic method used was PCR. None of the animals had presented clinical signs associated with rabies. All animals tested negative for rabies.

Humans

No human cases were reported during the year.

DISCUSSION

During the recent decades, two people have been hospitalised for rabies in Sweden. In 1974, a Swedish man fell ill after having become infected in India. In 2000, a woman fell ill after a visit to Thailand. Both patients had most

probably been infected by rabid dogs. Since Sweden is free from classical rabies, the risk of acquiring the disease from Swedish animals is negligible. However, since 2004, there has been an increasing problem with illegal importation of pets, mostly dogs. Illegally imported dogs from endemic countries are probably the greatest threat to the rabies-free status of Sweden. During 2014, SVA made a risk assessment on rabies. The results suggest that the probability of introducing rabies with illegally imported pets is very low, but not negligible. The results are similar to the results from a previous risk assessment conducted in 2005. The Board of Agriculture changed the risk management of illegally imported pets during 2015 which resulted in fewer euthanized dogs. Instead the dogs are kept under the owner's control. The rabies situation in many countries, especially in the EU, is improving due to control and eradication programmes. All countries in the EU are now considered low-risk countries. EU co-finances control, eradication and surveillance programmes in member states as well as in some third countries adjacent to EU.

Almost every year since 1998, an enhanced passive surveillance programme where dead bats are examined for the presence of rabies has been implemented. Since 2016 this surveillance activity is performed every third year. In addition, from 2008 to 2013 an active surveillance programme for EBLV was performed in different regions in Sweden.

Antibodies to EBLV have been detected in specimens from live Daubenton's bats as part of the active surveillance programme, suggesting that EBLV is present in Sweden. Daubenton's bats (*Myotis daubentonii*), associated with EBLV-2, are common and may be found from the south up to the county of Ångermanland in the north. Six other *Myotis* species may also be found in Sweden. The Serotine Bat (*Eptesicus serotinus*), associated with findings of EBLV-1 in Europe, is found in certain habitats in the south of Sweden. The Northern Bat (*Eptesicus nilssonii*), which is related to the Serotine Bat, is the most common bat in Sweden, and may be found all over the country.

Salmonellosis

BACKGROUND

Salmonellosis is one of the most important bacterial zoonoses. The genus is divided into two species: *S. enterica* and *S. bongori*. Most *Salmonella* belong to *S. enterica* subspecies *enterica*. More than 2,500 different serovars belonging to this subspecies have been described. *Salmonella* can infect reptiles, all warm-blooded animals as well as humans. Humans are infected by contaminated food products of various types, through contact with infected animals, via person-to-person transmission or via a contaminated environment.

A severe domestic outbreak of *S. Typhimurium* in 1953 that involved more than 9,000 people prompted the need for a control programme for *Salmonella*. Since then, the strategy for control has been to prevent *Salmonella* in all parts of the production chain, from feed to food of animal origin. When Sweden joined the European Union in 1995, the Swedish *Salmonella* control programme was accepted. Sweden obtained additional guarantees that food products of animal origin from countries with a non-equivalent *Salmonella* status should be tested for the presence of *Salmonella* before being placed on the Swedish market. These additional guarantees constitute an important safeguard to Swedish public health.

The past ten years, an average of 3,000 human cases of salmonellosis have been reported annually to the Public Health Agency of Sweden. A majority (70-80%) of these cases were infected abroad. During this period, the total incidence has decreased. This is due to a decrease in cases infected abroad, whereas the domestic incidence remains constant. The low proportion of domestic infections is unique to Sweden compared to many other countries. A few larger outbreaks have been reported. The source, when identified, is often imported food. The contribution to the human disease burden from domestic animals is low.

DISEASE

Animals

Infected animals are often asymptomatic. However, *Salmonella* can cause clinical illness with diarrhoea, abortions and fever, and even lead to death. In Sweden, clinical signs are frequently seen in cattle, horses and cats, but infected pigs and poultry are most commonly asymptomatic.

Humans

Salmonella infects the gastrointestinal tract and causes an acute gastrointestinal illness. The symptoms can range from asymptomatic and mild to severe. The incubation period is typically between 1 and 3 days but can vary from 6 hours to 10 days. Most patients recover from the illness spontaneously but sequelae such as reactive arthritis occur in approximately 1-15% of the patients. Excretion of the pathogen normally lasts for four to six weeks but prolonged asymptomatic excretion occurs.

LEGISLATION

Feed

Control of animal feed is an integrated and essential part of the control programme for *Salmonella* in primary production. The feed business operator is responsible for producing *Salmonella*-free feed. Poultry feed must be heat treated according to the legislation. A major part of cattle and pig feed is also heat-treated. The production of feed is supervised by the Swedish Board of Agriculture which carries out announced and unannounced inspections at feed mills. The control of *Salmonella* in feed is regulated in national legislation (SJVFS 2006:81) as well as in an EU regulation (Commission Regulation (EU) No142/2011).

Animals

Investigation is required upon clinical suspicion of salmonellosis and any finding of *Salmonella*, regardless of serovar, is notifiable and action is taken to eliminate the infection or contamination. Vaccination is not used in Sweden. The *Salmonella* control programme is governed by the Swedish Act on Zoonoses (SFS 1999:658) and its regulations. The aim of the programme is that animals sent for slaughter and animal products should be free from *Salmonella*.

Food

Any finding of *Salmonella* in food is notifiable and a contaminated food product is considered unfit for human consumption. However, there is one exception, which is *Salmonella diarizonae* serovar 61:(k):1,5(7) in sheep meat, as this serovar is not considered to be of public health importance, (LIVFS 2005:20 with amendments).

Humans

Salmonellosis in humans is notifiable according to the Communicable Disease Act (SFS 2004:168 with amendments, SFS 2013:634).

SURVEILLANCE

Feed

In the control programme for feed, the emphasis is on control of feed raw materials, the heat treatment process and preventive measures for preventing recontamination of heat-treated feed. Suspected feed-borne infections are also investigated.

Surveillance of feed raw materials

Raw materials are the most important risk factor in feed production. In the domestic legislation, feed materials are classified according to the empirical risk of being contaminated, and high-risk feed materials must test negative for *Salmonella* contamination before being used for feed production. All consignments of intra-community traded or imported feed materials classified as a risk have to be sampled for *Salmonella*. The sampling plan is designed to detect a *Salmonella* contamination in 5% of the batch with 95% probability.

Surveillance of feed mills

The purpose of the surveillance is to ensure the absence of *Salmonella* in the production lines as well as in the feed mill environment. A safety management system is applied in the processing line according to HACCP (Hazard Analysis and Critical Control Points). The management system covers several specific GMP (Good Manufacturing Practices) requirements, according to Swedish legislation. A minimum of five samples from feed mills manufacturing compound feeding stuffs for poultry and a minimum of two samples from those manufacturing compound feeding stuffs for other food-producing animals must be collected in the processing line on a weekly basis. These samples are analysed at the National Veterinary Institute (using MSRV, amendment to ISO 6579:2002 Draft 251004) and any finding of *Salmonella* is reported to the Swedish Board of Agriculture. The feed manufacturers also take additional samples from the processing line and the feed mill environment as part of their own process quality control.

Animals

Poultry

The programme comprises a compulsory part and a voluntary part. All poultry species are included in the compulsory part, which sets the rules for mandatory sampling.

Compulsory programme

All breeding flocks with more than 250 birds are tested (Table 13). Grandparents of *Gallus gallus* broilers are imported as day-old chicks. Laying hens, turkeys, geese and ducks are imported as parents. Samples consist of sock samples or faecal samples taken from all parts of the building or the department where the bird flock is kept. From rearing flocks, two pairs of sock samples are taken and pooled into one whereas five pairs pooled to two are taken from production flocks of breeders.

All holdings selling eggs for consumption are sampled (Table 13). All poultry flocks having more than 500 birds, irrespective of species, are tested 1-2 weeks before slaughter. In practice, all poultry flocks are tested prior to slaughter. The results must be available before slaughter.

The producers pay the costs for laboratory analyses and the visits to the farms. Only accredited laboratories are allowed to perform the analyses. County Veterinary Officers supervise the poultry control programme regionally. The laboratory sends the test results to the County Veterinary Officer on a quarterly basis. According to regulations, the County Veterinary Officer must send a report on the test results of all poultry holdings to the Swedish Board of Agriculture once a year.

Voluntary programme

The voluntary programme has been in place for more than 40 years. Producers affiliated to the voluntary programme receive higher compensation in case of a *Salmonella* outbreak.

All broiler producers belonging to the Swedish Poultry Association are affiliated to the voluntary programme (approximately 99% of the slaughtered broilers). The voluntary preventive programme includes all-in all-out production, hygienic measures and a high standard for poultry houses, such as hygienic barriers between the clean and unclean parts. Purchases of animals may only occur from holdings affiliated to the voluntary programme and only heat-treated feed is allowed. The poultry houses must be cleaned and disinfected before introduction of a new flock. The broiler producer has to make an application to be accepted into the voluntary programme. An official veterinarian inspects the holding at least once a year.

Cattle and pig herds

The programme includes a compulsory and a voluntary part.

Compulsory programme

The compulsory part consists of annual faecal sampling from breeding pig herds and gilt-producing herds and biannual sampling from sow pools. There is no compulsory testing in cattle. *Salmonella* is also tested for in conjunction with post mortem investigations if an infection is suspected by macroscopic findings. All imported animals are tested. On clinical suspicion, herds or single animals should be tested for *Salmonella*.

Voluntary programme

The voluntary programme is a preventive hygienic programme aiming at decreasing the risk of *Salmonella*. Holdings affiliated to the programme receive higher compensation in case of positive findings. In addition, affiliated holdings are entitled to apply for a commercial *Salmonella* insurance. The majority of all breeding herds and many of the large dairy herds are affiliated to the programme.

Other animals

Animals are tested for *Salmonella* on suspicion or as part of trace-back investigations. Wild animals necropsied at the National Veterinary Institute are tested for *Salmonella* on suspicion.

All samples from animals (poultry, cattle and pigs and other animals) are analysed using the MSRV (EN-ISO 6579:2002/A1: 2007: Amendment 1: Annex D) method.

Food

Control of *Salmonella* is an important part of in-house quality control programmes in most food enterprises in Sweden. All findings must be reported to the competent authority.

Official sampling by local authorities at food enterprises, other than abattoirs and cutting plants, is at a level of approximately 1,000 samples per year and samples are analysed mainly using NMKL (nr 71:1999) and Vidas-SLM methods.

Surveillance at abattoirs and cutting plants

According to the Swedish *Salmonella* control programme, samples from intestinal lymph nodes and swabs from carcasses are taken from cattle and swine and neck skin samples are taken from slaughtered poultry. Sampling is proportional to slaughtering capacity. Altogether, approximately 20,000 samples from cattle, adult pigs, fattening pigs and poultry are collected at abattoirs annually.

At red meat cutting plants, approximately 5,000 samples are taken annually from crushed meat and meat scrapings and approximately 900 samples are taken in poultry meat cutting plants. The samples are analysed by regional laboratories using the current edition of the NMKL (nr 71:1999) method, except for approximately 700 samples analysed by Vidas-SLM.

Humans

Salmonella infection is notifiable in humans. A trace back investigation is completed for all domestic cases of *Salmonella*. All isolates sent to the Public Health Agency of Sweden are analysed according to the guidelines of the WHO Collaborating Centre for Reference and Research on *Salmonella*. Institute Pasteur, Paris, France Grimont, P. A. D. and Weill, F-X, 2007.

MEASURES IN CASE OF POSITIVE FINDINGS

Isolates

All suspected index isolates of *Salmonella* from non-human sources are sent to the National Veterinary Institute for confirmation, serotyping, resistance testing, and further typing. Index isolates of *Salmonella* from domestic human cases are sent to the Public Health Agency of Sweden for serotyping and further molecular typing. A subset of isolates from travel-associated cases are also typed. Already in 2013, phage typing of *S. Typhimurium* was completely replaced by MLVA (multi-locus variable number tandem repeat analysis). During 2016 MLVA was introduced also for *S. Enteritidis*.

Feed

Findings of *Salmonella* in intra-community traded or imported feed materials and compound feeds are reported in the Rapid Alert System for Food and Feed (RASFF). Measures are always taken when *Salmonella* is detected in feed samples. *Salmonella* positive feed materials are usually treated with organic acids. After acid treatment the feed material must be re-tested negative before use in feed production. Finished feed containing *Salmonella* must be withdrawn from the market. Extended sampling and cleaning are done in the production line if *Salmonella* is detected in the weekly surveillance. If *Salmonella* is found before heat treatment the contaminated part of the production line is thoroughly cleaned and disinfected, usually by dry cleaning, followed by disinfection. If *Salmonella* is found after heat treatment, the feed mill has to be thoroughly cleaned and disinfected. Environmental sampling must show negative results before production is resumed.

Animals

If *Salmonella* is suspected in an animal, a veterinarian is obligated to take samples and implement measures to prevent further transmission. When *Salmonella* is detected the laboratory must notify the Swedish Board of Agriculture and the County Veterinary Officer. When detected in a food-producing animal, the County Veterinary Officer informs the official veterinarian at the abattoir involved. When relevant, other persons are informed before confirmation.

When *Salmonella* is confirmed on a farm, the holding is put under restrictions, an epidemiological investigation is performed and a plan to eradicate *Salmonella* from the holding is defined. Animal movements to and from the holding are stopped.

All *Salmonella* positive poultry flocks are euthanised irrespective of serovar. The poultry house involved, and all possible contaminated areas are thoroughly cleaned and disinfected. Before introduction of new birds, all environmental samples must be negative for *Salmonella*.

In pigs and cattle, a combination of partial herd depopulation and hygienic measures controlled by repeated sampling is usually practiced. Cattle herds under restrictions for *Salmonella* are monitored by a combination of serological and bacteriological testing. Hygienic measures can include reducing the number of animals, control of animal feed and manure management on the farm and reduction of *Salmonella* contamination in the environment by cleaning and disinfection. Animals from restricted herds may be slaughtered after sampling with negative results. The restrictions are lifted when the cleaning and disinfection have been completed and *Salmonella* cannot be detected by culture from whole-herd sampling at two occasions performed four weeks apart.

If *Salmonella* is detected in companion animals advice is given to the owners. If *Salmonella* is detected in horses, the stables and/or the paddocks at risk are put under restrictions and follow up investigations are performed on the positive horse(s).

Food

Products released on the market will be withdrawn and contaminated products will be destroyed or sent for special treatment to eliminate the *Salmonella* bacteria which the exception of *Salmonella diarizonae* serovar 61:(k):1,5(7) in sheep meat.

Findings in imported consignments are reported in the RASFF system and the consignments will be returned to the country of origin, destroyed or sent for special treatment as applicable. RASFF is also used for informing about contaminated Swedish food products released on the EU-market.

In food enterprises where *Salmonella* has been detected, appropriate follow-up measures will be applied, such as careful cleaning and disinfection and environmental sampling.

RESULTS

Feed

Eleven major feed mills produce approximately 95% of the feed for food producing animals. In the weekly surveillance of feed mills, 8,052 samples were analysed for *Salmonella* with 12 samples (0.1%) being positive. Eight serovars were detected; *S. Typhimurium* was the most common (n = 4) (Table 14).

In addition, *Salmonella* was detected in 14 out of 1,830 analysed batches from feed materials of vegetable origin. The most common serovar was *S. Senftenberg* (n=5). *Salmonella* was not detected in any of the 1,242 batches tested from feed materials of animal origin and from pet food.

Animals

Poultry

Salmonella was detected in 2 (0.04%) of 4,723 broiler flocks tested in routine sampling before slaughter (Table 15) 13). *Salmonella* was not detected in any of the 675 flocks of layers tested or in any breeding flocks. *Salmonella* was neither detected in any flocks of turkeys, geese or ducks.

S. Pullorum was detected in two hobby flocks.

Cattle

In total, *Salmonella* was detected in three new herds in 2017 (Table 16);

By the end of 2017, six cattle herds were under restriction for *Salmonella*.

Salmonella was isolated from two (0.06%) of 3,629 mesenteric lymph nodes from cattle at slaughter (Table 17 and Figures 11 and 12).

Pigs

In 2017, *Salmonella* was not detected in any pig herd (Figure 14).

Salmonella was detected from one (0.03%) of 3,091 lymph node samples taken from adult pigs and from two (0.08%) of 2,886 lymph node samples from fattening pigs (Table 17, Figures 11 and 12).

Other animals

In 2017, *Salmonella* was detected in one large stable with 70 horses.

Salmonella was also detected in 129 (30.7%) cats of 420 tested (Table 18), which was less than the year before. In 2016, 54.2% of the 951 tested samples yielded *Salmonella*. Of the 96 serotyped cat isolates 93 belonged to the serovar *Typhimurium*.

Also, *Salmonella* was detected in seven dogs, 11 wild birds (mainly passerine), one squirrel and one porpoise (Table 18).

Food

In the Swedish *Salmonella* control programme, swab samples were taken from 5,089 pig carcasses and 3,656 cattle carcasses. Neck skins were sampled from 4,033 poultry carcasses. *Salmonella* was not detected in any of the

samples from carcasses of pig, cattle or poultry (Table 17). *Salmonella* was detected in one of the 5,147 samples of red meat taken at cutting plants, but in none of the 1,026 samples of poultry meat taken at cutting plants (Table 17 and Figures 11 and 12).

In addition to the sampling performed within the control programme, 802 samples were taken by local authorities. *Salmonella* was detected in five of these 802 samples. Three of these were from meat products from either pig or bovine animals.

Humans

In 2017, a total of 2,279 cases of salmonellosis were reported, compared to 2,246 cases in 2016 (Figure 17). Domestic cases increased by 24% from 645 cases in 2016 to 798 cases in 2017, giving an incidence of 7.9 cases per 100,000 inhabitants. The domestic incidence varies from year to year but is at a stable level over a longer period.

Most of the cases (n=1,465, 64%) were infected abroad. Since 2008, a steep decrease in the number of travel-associated cases has been noted, despite an increase in international travel. Travel-associated cases have decreased since the early 2000s. The observed decrease has been most apparent among those travelling in Europe. As in previous years, *Salmonella* infection was most commonly acquired in Thailand (341 cases). The number of cases infected in Spain increased from 109 to 156, while cases infected in Greece and Turkey decreased (from 131 to 89 and from 151 to 77, respectively)

Among the domestic cases, the median age was 39 years (0-98 years). Children below 10 years of age accounted for 344 of all reported cases (both the domestic and the travel-related cases). Among domestic cases 48% were men. Among travel-related cases 53% were men.

Of the isolates from domestic cases, 93% were serotyped. The most common serotype from domestic cases was *S. Typhimurium* (22%) and *S. Typhimurium* (21%) followed by *S. Enteritidis* (19%). Of the isolates of *S. Typhimurium*, MLVA profile 3-19-11-N-311 (72 cases) was the most common, followed by 2-5-N-13-212 (9 cases), MLVA profile 3-13-10-N-211 (27 cases) and 3-14-9-N-211 (17 cases) were most common among isolates of monophasic *S. Typhimurium* and MLVA-profile 3-10-5-4-1 and 2-10-7-3-2 (33 and 19 cases respectively) was the most common among isolates of *S. Enteritidis*.

A clear seasonal variation of domestic salmonellosis is usually observed, with most cases during the summer months. In 2017, due to a large outbreak, the highest number of domestic cases were observed in September. Most travel-associated cases of salmonellosis are normally reported from January to March when travelling to warmer destinations is common. Also, a clear peak in travel-associated cases is usually observed during the summer season when many people have holidays. These two seasonal peaks in cases infected abroad were also observed in 2016.

During 2017, the Public Health Agency was involved

in the investigation of 8 outbreaks of *Salmonella*. A European outbreak of *S. Enteritidis* linked to Polish egg detected in 2016 continued in 2017. Also, in a domestic outbreak with 10 cases Polish eggs were found to be the vehicle of infection. The largest domestic outbreak with 72 cases was caused by *S. Typhimurium* with MLVA-profile 3-19-11-N-311. The outbreak affected 10 counties in Sweden during September to November. An epidemiological investigation pointed out a specific salami product as the common exposure among cases. The product was recalled already at the suspicion of infection and the same strain was then identified in unopened packages. An outbreak of *S. Kentucky* was detected in October and continued in 2018. Almost all cases had recent hospital care or stayed in nursing homes prior to or during testing positive for *Salmonella* infection. The infection seems to be quite mild and most cases do not have a date for onset of disease, either due to their precondition or because the salmonellosis has passed asymptomatic. Therefore, a case-control study has not been considered feasible. Still, based on the dates for hospitalisation, a time frame where it is likely that the cases were infected has been identified. A questionnaire was sent out to all relevant hospital and nursing home kitchens to identify what foods they have in common. Several food items have been analysed, but the source has not been identified.

DISCUSSION

The low proportion of domestic human infections is unique to Sweden, Norway and Finland when compared to most European countries. To trace and further control the sources of infection it is important that both the total incidence and domestic incidence in humans continue to be reported. The total notified incidence in 2016, 22.5 cases per 100,000 inhabitants, is considerably higher than the domestic incidence of 6.5 cases per 100,000 inhabitants. The Swedish situation with few domestic human cases reflects the low *Salmonella* burden in domestic animals and food.

In the feed sector, data from 2017 showed that several different serovars were isolated in the weekly surveillance of feed mills where *S. Typhimurium* was the most common (n=4). More or less all the findings were in the feed material intake area in a number of different feed mills, even if the trend of findings has been decreasing the last years. This illustrates the importance to handle feed materials in a proper way even if the feed materials have been tested negative for *Salmonella* contamination.

In 2017, *Salmonella* was detected in only two broiler flocks, which was less than previous years. However, *Salmonella* was detected in chicken originating from a Swedish parent flock exported to Finland. In Sweden, an investigation was performed which led to detection of one infected broiler flock (included in the Swedish figures). This highlights a continuous need for stringent biosafety routines. However, a comparison of findings of *Salmonella* in indoor and outdoor poultry production did not indicate a higher risk of *Salmonella* in outdoor production in Sweden.

The poultry registries maintained by the Swedish Board

of Agriculture are not sufficiently updated which complicates supervision of the control as well as outbreak investigations. In addition, this leads to uncertain estimates of the poultry population. Thus, the Swedish figures on the number of flocks within the programme can only be considered as estimates. Approximately 20% of the poultry flocks lack an annual veterinary inspection. To exercise supervision of salmonella control in poultry some County Veterinary Officers have created their own poultry databases.

In the summer of 2017, an outbreak of *S. Pullorum* was detected in a small hobby flock. Detection was made at post mortem examination of recently bought chickens that had died. The chickens originated from another larger hobby flock which sold newly hatched chickens. This larger hobby flock was believed to be the source of the infection. The Swedish Board of Agriculture decided not to sample any further contact flocks found in the trace-forward investigation, as this was hobby flocks only, with no connection to commercial poultry.

In 2012, *Salmonella* Dublin was detected for the first time in decades in cattle herds in the county of Skåne. Altogether, 13 infected herds were detected in 2012-2015. All but one of them are located within a radius of 10 km, in a cattle dense area of Skåne. The only infected herd outside this region had purchased cattle from one of these herds. No newly infected herds were detected during 2016 or 2017 and at the end of the year, only three herds remained under restrictions, thus the outbreak may reasonably be considered to be in decline. Except this declining outbreak there were three newly detected cattle herds, two infected with *S. Dublin* and one with *S. infantis*.

In order to present a context for the history of *Salmonella* Dublin in Sweden, data was obtained for the period 1958-1967 (Robertsson, 1985) (Fig. 16). This indicates that *Salmonella* Dublin did not become dominant in Sweden until a dramatic rise in the proportion of positive herds in 1963, when 102 cattle herds were detected with this serotype that still today is a challenge for the industry.

In 2017, *Salmonella* was not detected in any pig herd (Fig. 14). This is consistent with the low incidence of *Salmonella* in pigs in previous years. However, the decrease in the number of pig herds in Sweden during the last few years may also play a role in the low incidence.

In 2017, *Salmonella* Infantis was detected in a stable with 70 horses. Detection was made at examination of faecal samples from diseased and dead foals. In total, four foals died within the outbreak. The same farm also has a small cattle herd, and these animals were *Salmonella* infected as well. Two horses were imported to the farm during the year, but none of them tested positive for salmonella when sampled during the outbreak. The source of the infection could not be determined.

Reported domestic human cases of *Salmonella* vary from year to year depending on the number of outbreaks. The largest decrease over the past ten years was seen for the travel-associated cases, especially from European countries. This decrease in *Salmonella* cases has been seen in countries

throughout the EU and is the result of the successful implementation of harmonised *Salmonella* control programmes in poultry across the union.

Thailand is the most common country for travel-associated salmonellosis, although the number of cases has decreased in the past years. However, it is still necessary to inform travellers about the risks of contracting *Salmonella* and other infectious diseases in order to further decrease the incidence. Also, information on how to prevent secondary transmission to other persons, to the environment and to animals when returning back to Sweden is crucial.

Routine MLVA typing and comparison of *S. Typhimurium* isolates from humans, animals, food, feed and the environment has proved to be a useful tool to detect clusters and outbreaks.

The Swedish *Salmonella* control programme has been in place for decades and resulted in a very low *Salmonella* burden in domestic animals (Figures 16, 14 and 15). However, the programme is costly and could be modernised. The Swedish Board of Agriculture, the National Food Agency, Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute have jointly published a common national strategy for the control and monitoring of *Salmonella* for the entire chain from animal feed to humans. The strategy includes goals and proposals for important actions to achieve goals, including how the control programme should be made more cost effective.

REFERENCES

Robertsson JÅ, Salmonella infections in cattle – Cellular and humoral immune reactivity against O-antigens and porins after infection and vaccination with killed and live vaccines. (Page 8, figure 3). Swedish University of Agricultural Sciences, College of Veterinary Medicine, Department of Veterinary Microbiology, Uppsala, Sweden 1985.

Sternberg Lewerin S, Skog L, Frössling J, Wahlström H. Geographical distribution of *Salmonella* infected pig, cattle and sheep herds in Sweden 1993-2010. *Acta Vet Scand.*

2011 Oct 5;53:51. doi: 10.1186/1751-0147-53-51.

Sundström K, Wahlström H, Ivarsson S, Sternberg Lewerin S. Economic effects of introducing alternative *Salmonella* control strategies in Sweden. *PLoS One.* 2014 May 15;9(5):e96446.

Sörén K, Lindblad M, Jernberg C, Eriksson E, Melin L, Wahlström H, Lundh M. Changes in the risk management of *Salmonella enterica* subspecies *diarizonae* serovar 61:(k):1, 5, (7) in Swedish sheep herds and sheep meat due to the results of a prevalence study 2012. *Acta Vet Scand.* 2015 Feb 3;57:6.

Wahlström H, Andersson Y, Plym-Forshell L, Pires SM. Source attribution of human *Salmonella* cases in Sweden. *Epidemiol Infect.* 2011;139(8):1246-53.

Wahlström H, Sternberg Lewerin S, Sundström K, Ivarsson S. Estimation of the expected change in domestic human *Salmonella* cases in Sweden in 2010, given a hypothetical relaxation of the current *Salmonella* control programme. *PLoS One.* 2014 Mar 3;9(3):e89833.

Wierup M, Wahlström H, Lahti E, Eriksson H, Jansson DS, Odelros Å, Ernholm L. Occurrence of *Salmonella* spp.: a comparison between indoor and outdoor housing of broilers and laying hens. *Acta Vet Scand.* 2017 Feb 21;59(1):13. doi: 10.1186/s13028-017-0281-4.

Wierup M, Widell S. Estimation of costs for control of *Salmonella* in high-risk feed materials and compound feed. *Infect Ecol Epidemiol.* 2014 Jun 12;4. doi: 10.3402/iee.v4.23496. eCollection 2014.

Ågren EC, Johansson J, Frössling J, Wahlström H, Emanuelson U, Sternberg-Lewerin S. Factors affecting costs for on-farm control of *Salmonella* in Swedish dairy herds. *Acta Vet Scand.* 2015 Jun 6;57:28.

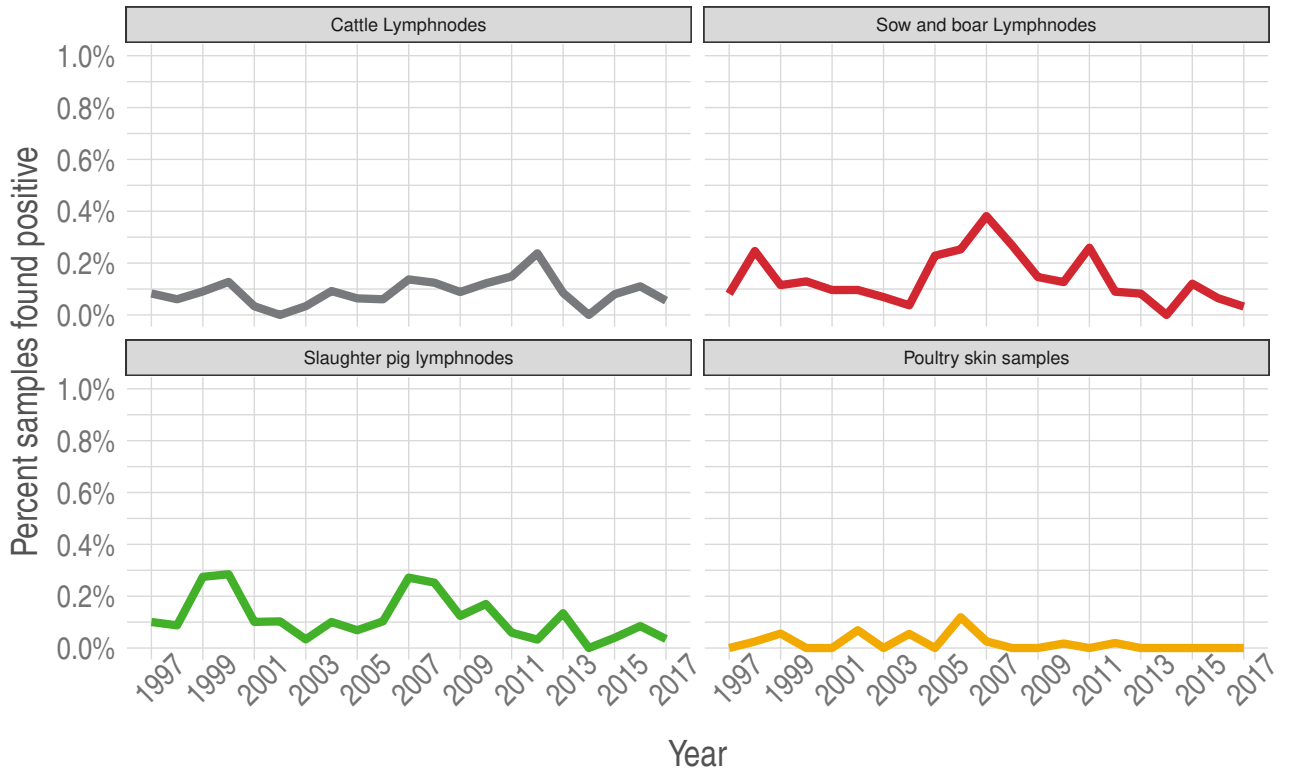


Figure 11: *Salmonella* found in lymph node samples from cattle, sows and boars and fattening pigs sampled at major abattoirs as well as neck skin samples from poultry at all abattoirs. In 2014, a new laboratory was chosen to perform *Salmonella* analyses of samples from abattoirs and cutting plants. The National Reference Laboratory (NRL) for *Salmonella* and the National Food Agency of Sweden inspected the laboratory and found that the analytical methods and laboratory routines needed improvement. The laboratory results from 2014 and 2015 are therefore considered to be unreliable. Since 2016, another laboratory performs these analyses.

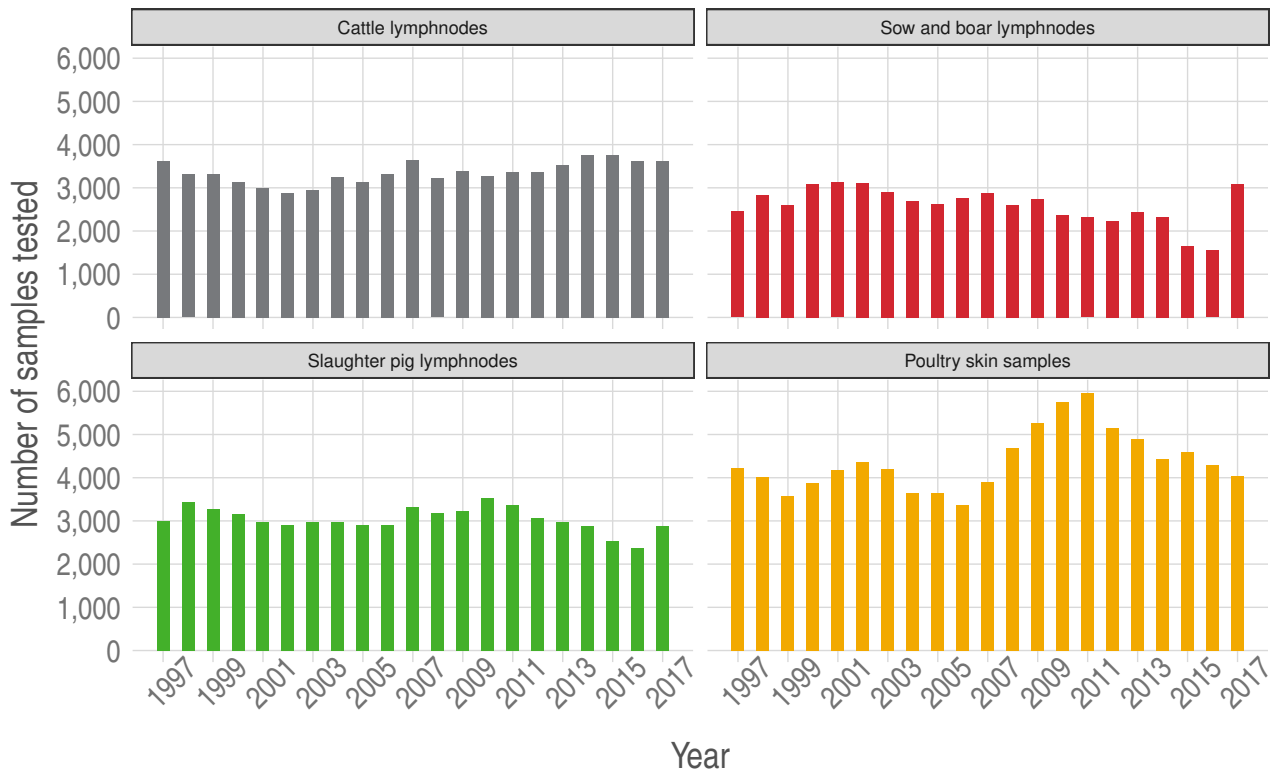


Figure 12: The number of lymph node samples from cattle, sows and boars and fattening pigs sampled at major abattoirs as well as the number of neck skin samples from poultry sampled at all abattoirs.

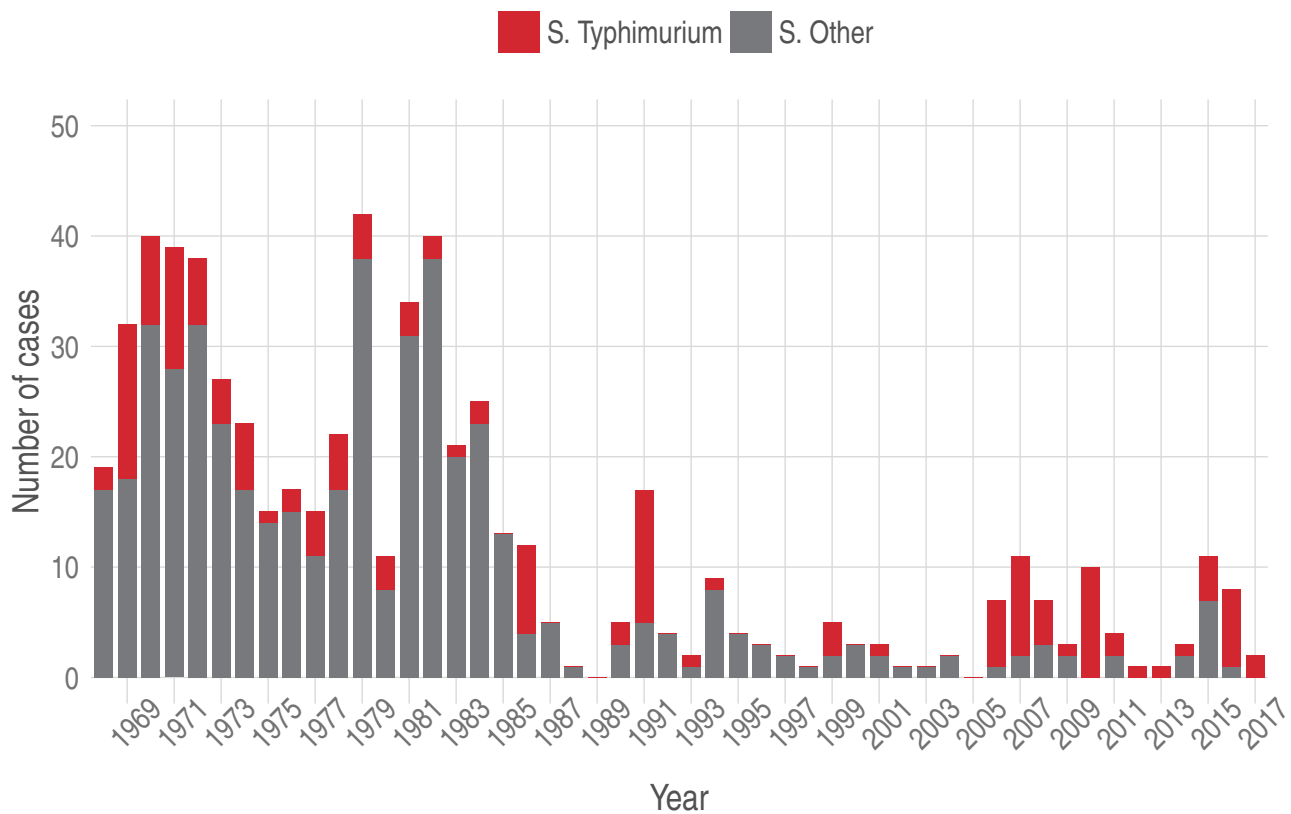


Figure 13: Frequency of notifications of *Salmonella* in broiler holdings during 1968-2017, breeding flocks included.

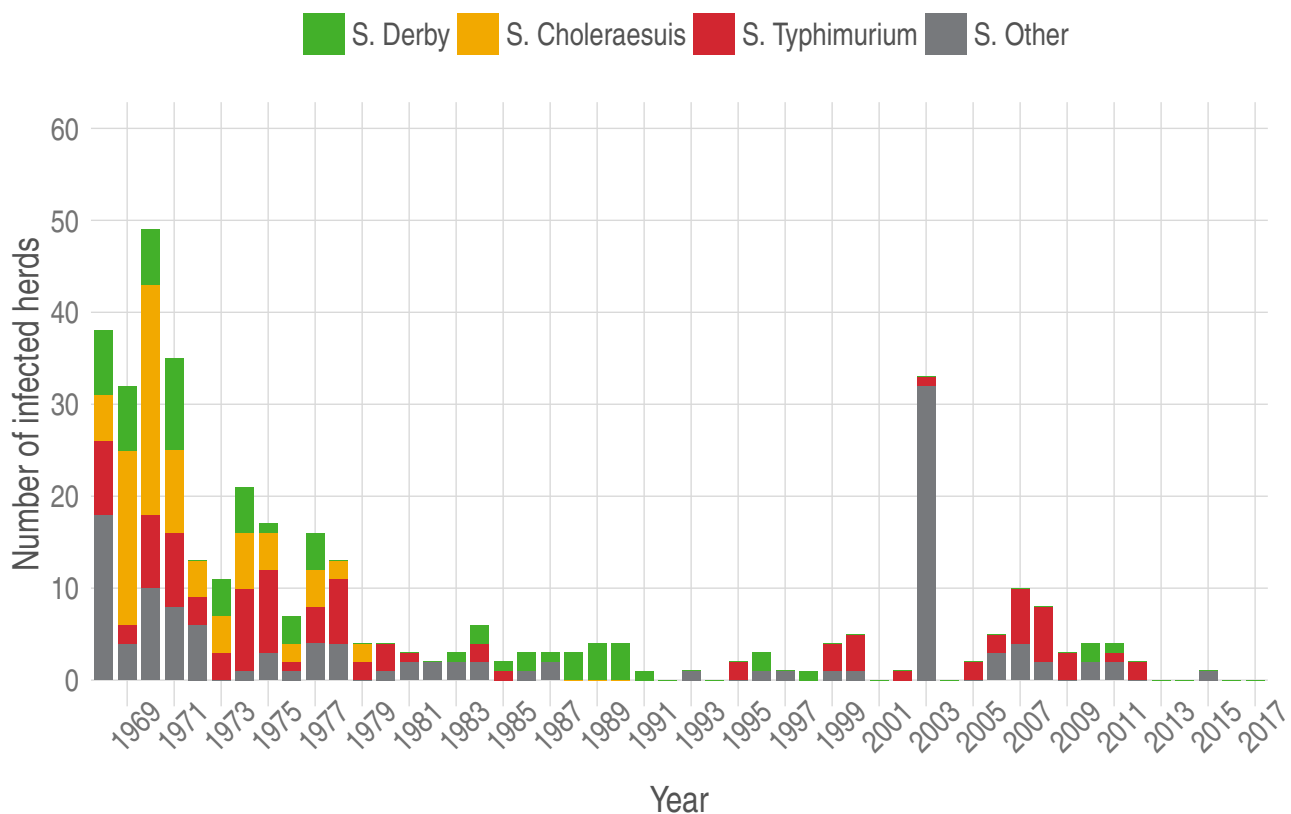


Figure 14: Frequency of notifications of *Salmonella* in swine herds during 1968-2017. In 2016 and 2017, *Salmonella* was not detected in any herd.

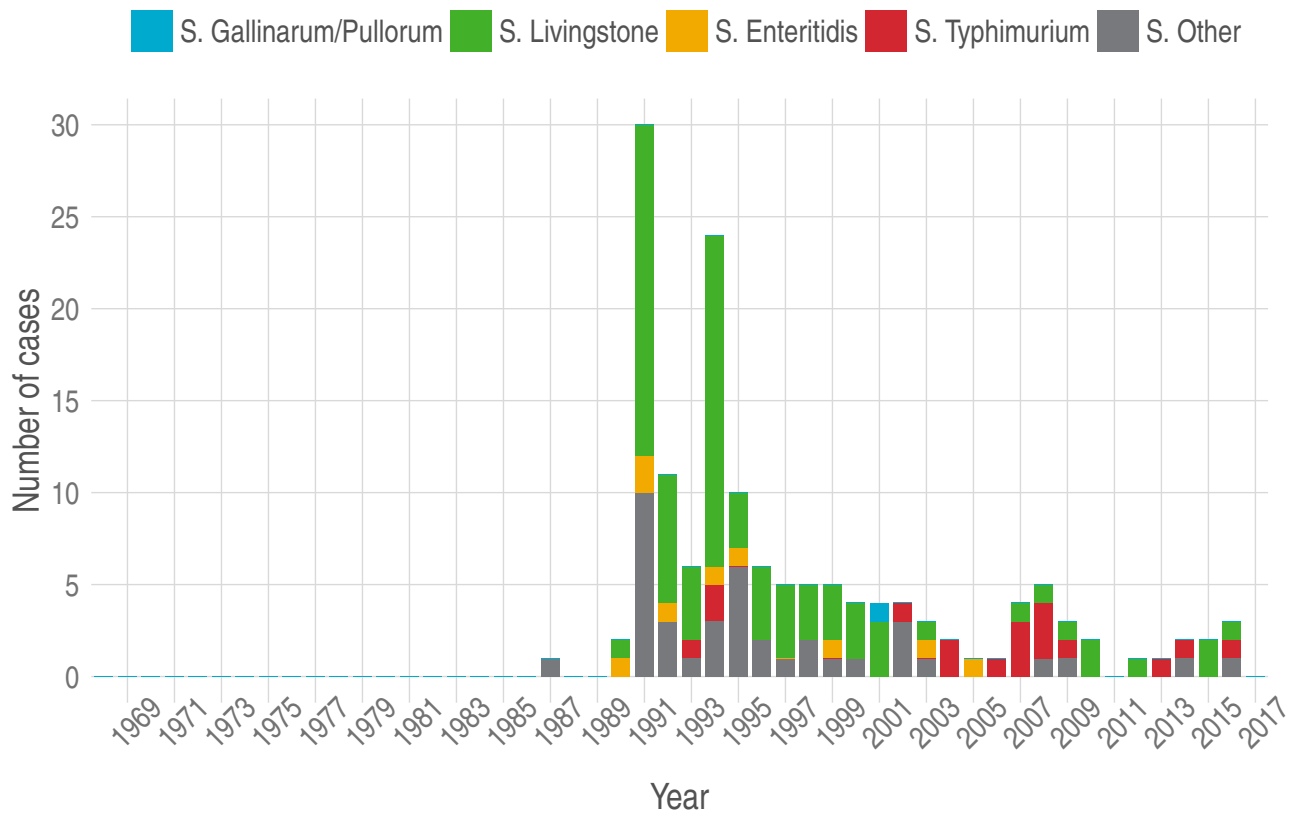


Figure 15: Frequency of notifications of *Salmonella* in layer holdings during 1968-2017.

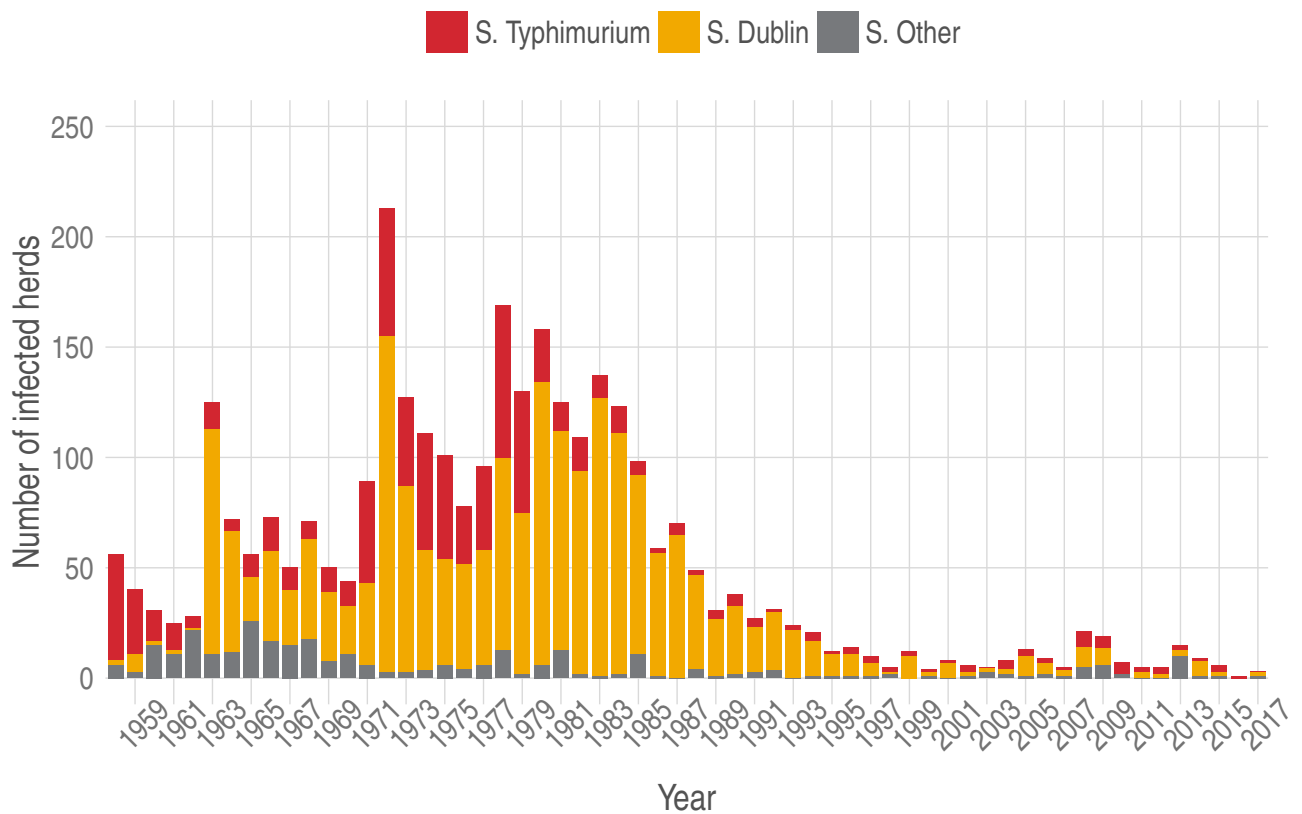


Figure 16: Frequency of notifications of *Salmonella* in Swedish cattle herds during 1958-2017. Data from 1958 through 1967 is extracted from a graph presented by J.Å. Robertsson (1985).

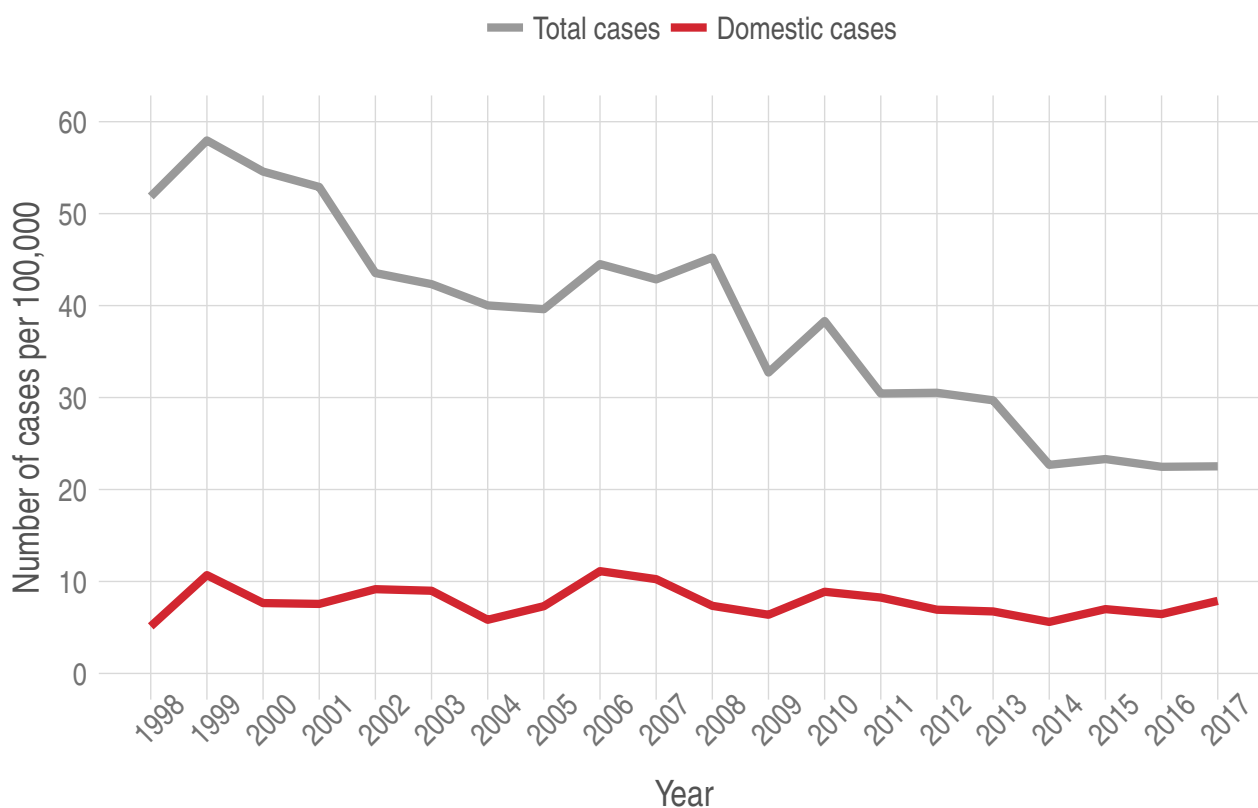


Figure 17: Incidence (per 100,000) of notified cases of human salmonellosis in Sweden, 1998-2017.

Table 13: Sampling scheme for poultry in the compulsory Swedish *Salmonella* programme.

Category of poultry	Sampling frequency	Sample type	Sampling before slaughter	Official veterinarian
Breeders in rearing	1 d, 4 weeks, 2 weeks prior to rearing or moving	2 pairs sock samples	14 d before slaughter	Once a year
Breeders in production	every 2 nd week	5 pairs sock samples	14 d before slaughter	3 times under production
Layers in rearing	2 weeks prior to moving	2 pairs sock samples or 2 faecal samples of 75 g	14 d before slaughter	Once a year
Layers in production	every 15 th week (start at 22-26 weeks)	2 pairs sock samples or 2 faecal samples of 75 g	14 d before slaughter	Once a year
Poultry for meat production (all species)		2 pairs sock samples or 2 faecal samples of 75 g	14 d before slaughter	Once a year

Table 14: Serotypes of *Salmonella* isolated in feed control in 2017.

Serotype	Feed material of animal origin ^A	Pet food	Feed material of oil seed origin ^B	Feed material of cereal grain origin	Other plants ^C	Process control feed mills	Process control rapeseed crushing plant
<i>S. Agona</i>	-	-	-	-	2	-	-
<i>S. Enteritidis</i>	-	-	-	-	-	1	-
<i>S. Hvitittingfoss</i>	-	-	-	-	-	1	-
<i>S. Kedougou</i>	-	-	1	-	-	-	-
<i>S. Kentucky</i>	-	-	-	-	-	1	-
<i>S. Mbandaka</i>	-	-	4	-	-	2	1
<i>S. Newport</i>	-	-	-	-	-	1	-
<i>S. Senftenberg</i>	-	-	5	-	-	-	-
<i>S. Tennessee</i>	-	-	2	-	-	1	-
<i>S. Typhimurium</i>	-	-	-	-	1	4	-
<i>S. enterica</i> subspecies <i>enterica</i>	-	-	1	-	-	-	-
Non-typeable	-	-	-	-	-	1	-
Total Positive	0	0	11^D	0	3	12	1
total number of samples	1,037	205	1,171	618	41	8,052	824

^A Meat and bone meal, animal fat, fish meal, greaves, protein meal, meat meal, milk products, poultry offal meal and animal by-products.

^B Derived from palm kernel, rape seed, soya bean, linseed, peanut and sunflower seed.

^C Peas, algae, leaves (dried), sugar beets, buckwheat and herbs (dried).

^D In two of the units positive for *Salmonella* two different serotypes were found in each unit.

Table 15: Results from the *Salmonella* control programme in poultry flocks

Animal species	Production type	Production stage	No. flocks tested	No. positives	Percentage	Serotype
<i>Gallus gallus</i>	Meat production	Adult Grand Parent	24	0	0.00%	<i>S. Typhimurium</i>
<i>Gallus gallus</i>	Meat production	Adult Parent	130	0	0.00%	
<i>Gallus gallus</i>	Meat production	Production	4,723	2	0.04%	
Turkeys	Meat production	Adult Parent	4	0	0.00%	
Turkeys	Meat production	Production	278	0	0.00%	
<i>Gallus gallus</i>	Egg production	Adult Parent	20	0	0.00%	
<i>Gallus gallus</i>	Egg production	Production	675	0	0.00%	
Geese	Meat production	Production	25	0	0.00%	
Ducks	Meat production	Production	22	0	0.00%	

Table 16: Cattle herds under restriction for *Salmonella* infection in 2017

Primary serotype	Restricted since	Restrictions lifted	Reason for sampling
<i>S. Aarhus</i>	2015	2017	Necropsy
<i>S. Dublin</i>	2012	2017	Necropsy
<i>S. Dublin</i>	2013	2017	Necropsy
<i>S. Dublin</i>	2014	-	Trace-back
<i>S. Dublin</i>	2014	-	Trace-back
<i>S. Dublin</i>	2015	-	Necropsy
<i>S. Dublin</i>	2017	-	Necropsy
<i>S. Dublin</i>	2017	-	Clinical suspicion
<i>S. Typhimurium</i>	2015	2017	Trace-back after a human case
<i>S. Typhimurium</i>	2015	2017	Trace-back
<i>S. Typhimurium</i>	2015	2017	Necropsy
<i>S. infantis</i>	2017	-	Trace-back after horse case

Table 17: Results from the *Salmonella* control programme at slaughterhouses and cutting plants in 2017

Animal species	Sample type	No. samples	Positive	Percent Positive	Serotypes
Cattle	Lymph node	3,629	2	0.06%	S. Duesseldorf, S. Typhimurium
	Carcass swab	3,656	0	0.00%	
Breeding swine	Lymph node	3,091	1	0.03%	S. Typhimurium
	Carcass swab	3,059	0	0.00%	
Slaughter swine	Lymph node	2,886	2	0.07%	S. Typhimurium
	Carcass swab	2,840	0	0.00%	
Cattle and swine	Meat scrapings	4,442	0	0.00%	
Poultry	Neck skin	4,033	0	0.00%	
	Meat scrapings	1,026	0	0.00%	

^A Isolation from pooled samples of lymph nodes

Table 18: Reported cases of *Salmonella* in cats, dogs, horses, sheep, wild birds and wild mammals in 2017

Serotype	Cats	Dogs	Horses	Sheep	Wild birds	Wild animals ^A
S. Agona	-	1	-	-	-	-
S. Derby	-	1	-	-	-	-
S. Enteritidis	1	-	-	-	-	-
S. Hessarek	1	-	-	-	-	-
S. Indiana	-	-	-	-	-	-
S. Infantis	-	2	1	-	-	-
S. Mbandaka	-	-	-	-	-	-
S. Typhimurium	33	2	-	-	8	1
<i>Salmonella enterica</i> sp <i>diarizonae</i> =61:-1,5	-	-	-	13	-	-
<i>Salmonella enterica</i> sp <i>diarizonae</i>	1	-	-	-	-	-
<i>Salmonella enterica</i> sp <i>enterica</i> (I) = 4,5:-:H5-	-	-	-	-	1	-
<i>Salmonella enterica</i> sp <i>enterica</i> (I) = 4,5:i:-	-	-	-	-	1	-
<i>Salmonella enterica</i> sp <i>enterica</i> (I) = 4,5:-:H5	-	-	-	-	1	-
<i>Salmonella enterica</i> sp <i>enterica</i> (I) =20:-:Z6	-	1	-	-	-	-
<i>Salmonella enterica</i> sp <i>enterica</i> ST-416	-	-	-	-	-	1
<i>Salmonella</i> , not serotyped	93	-	-	-	-	-
Total	129	7	1	13	11	2

^A One squirrel and one porpoise.

Scrapie

BACKGROUND

Scrapie belongs to a group of diseases called Transmissible Spongiform Encephalopathies (TSE) and was first described more than 250 years ago. The current theory about the causative agent is the protein-only hypothesis. This theory assumes that misfolded prions (small proteins) induce the same misfolded and pathological structure in normal proteins of the host, resulting in accumulation of prions and cellular damage without involvement of any microorganism. Susceptibility to scrapie is genetically related. All routes of transmission have not been established, however, it is clear that transmission of classical scrapie occurs within a flock at lambing and that pastures can be contaminated for long periods of time. Scrapie has, based on epidemiological data, not been considered a zoonotic disease, however, the question is regularly raised.

Classical scrapie has been detected in Sweden once, in a single flock in 1986. The whole flock was culled and the origin of the disease was never established.

After classical BSE became a disease of public health concern (see chapter on BSE), and the existence of BSE in small ruminants was suspected, both surveillance and control of TSE in small ruminants was increased within the European Union in 2002. Since the start of the increased surveillance, more than 75,000 sheep have been tested without any positive cases of classical scrapie detected. In 2014, Sweden sent an application to the European Commission to obtain status as country with negligible risk for classical scrapie. The dossier contained detailed information about the population, imports (which were limited), education about the disease, the EU-approved national control programme as well as results of estimates of the probability that Sweden is free from classical scrapie. The Commission evaluated the dossier and also asked the European Food Safety Authority (EFSA) for an opinion (doi:10.2903/j.efsa.2015.4292). In August 2016, the application was approved and Sweden was granted the status negligible risk for classical scrapie through Commission regulation (EC) 2016/1396.

In 1998, an atypical variant of scrapie was detected in Norway (Nor98), and this variant was also detected in Sweden in 2003. Since then, a number of cases have been detected in Sweden. Although atypical scrapie is experimentally transmissible, epidemiological studies on the European level indicate that atypical scrapie probably is a spontaneously occurring disease. When transmitted experimentally, atypical scrapie can cause disease indistinguishable from classical scrapie.

DISEASE

The incubation period is long, up to several years. Clinical signs of classical scrapie are related to the neurological system and include altered behaviour and sensation, affected movement and posture, as well as pruritus and skin lesions. The disease is progressive and always fatal.

LEGISLATION

Surveillance and control is regulated through Regulation (EC) 999/2001 of the European Parliament and of the Council of 22 May 2001. At the national level, the surveillance scheme and control were, until 2016, also regulated by an EU-approved national scrapie control programme which from 2003 also formed the basis for additional guarantees related to trade within the union (Commission Regulation (EC) 546/2006). The current rules in regulation (EC) 999/2001, cover both trade and surveillance requirements for countries with negligible risk. After 2016, when Sweden was granted the status: “negligible risk” for classical scrapie through Commission regulation (EC) 2016/1396 amending Regulation (EC) 999/2001, the rules in 999/2001 replace both the additional guarantees and previous surveillance scheme in the national programme.

Sampling at the national level is regulated by SJVFS 2010:9, last amended through SJVFS 2013:3. Scrapie is a notifiable disease under the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments).

SURVEILLANCE

The Swedish Board of Agriculture is responsible for the surveillance programme. It is carried out in cooperation with the National Veterinary Institute, which is appointed the National Reference Laboratory (Regulation (EC) 999/2001). Samples are analysed at the National Veterinary Institute.

Passive surveillance

All suspicions of scrapie must be reported to the authorities. The obligation to report applies to animal owners, veterinarians and everyone else who is responsible for the animals. Samples from animals with clinical suspicion of scrapie are examined with Bio-Rad TeSeE short assay protocol (SAP) in combination with Bio-Rad TeSeE Western Blot.

Active surveillance

The design of the surveillance programme is in accordance with Regulation (EC), 999/2001 Annex III and was until the approval of the negligible risk status, also in accordance with the EU-approved Swedish national control programme. Within that programme, all dead sheep and goats over 18 months of age that were not slaughtered for human consumption have been sampled. As part of the programme, the Swedish Board of Agriculture financed the collection of fallen sheep and goats above 18 months at the farm level and the farmers did, until 2016, not have any costs when sending fallen animals for rendering. This was changed in 2017 and the farmers now pay to have their fallen animals collected.

After Sweden was granted negligible risk status for classical scrapie in 2016, the surveillance was adapted in 2017 with the target to sample 1,500 fallen sheep and goats above the age of 18 months, and with the target that the samples should be representative for the population. The carcasses are

sampled at rendering plants and at necropsy, by employees at the rendering plant or veterinarians or veterinary assistants at necropsy.

Farms with confirmed cases of atypical scrapie are obligated to have increased surveillance in the herd for two years. In addition to fallen stock, healthy slaughtered animals above 18 months of age are examined from these flocks.

The samples from active surveillance were examined with Bio-Rad TeSeE short assay protocol (SAP) at the National Veterinary Institute in accordance with Regulation (EC) 999/2001. In case of positive or inconclusive results the material was examined by Bio-Rad TeSeE Western Blot.

RESULTS

Passive surveillance

In 2017, no sheep or goats were examined due to clinical suspicion of scrapie.

Active surveillance

Sheep

In 2017, the National Veterinary Institute examined 1,411 sheep from fallen stock for scrapie. Out of these, all samples were negative for classical scrapie and one was positive for atypical scrapie Nor98.

Goats

In 2017, the National Veterinary Institute examined 152 goats from fallen stock for scrapie. All were negative both for classical scrapie and for atypical scrapie.

DISCUSSION

Classical scrapie

After Sweden was granted status negligible risk and the surveillance programme was adapted, the Swedish Board of Agriculture decided not to fully subsidise collection of fallen stock on the farm. This had the consequence that the number of collected animals decreased dramatically and the sampling plan, which was based on data from previous years, needed to be revised at several occasions with the primary target to reach sufficient numbers, while not allowing for adjustments to ensure representativeness. Meetings were held with all stakeholders to identify the reasons. In parallel with decreased number of fallen stock, there was an increase in the number of slaughtered ewes. There was also a reported

higher demand for sheep meat and thus increased price, also for older ewes. Previously, the compensation for older ewes has been very low and there has been no financial benefit for farmers to send them to slaughter. However, when the price for sending animals for rendering increased, the conclusion is that farmers, to a higher extent, send old ewes to slaughter.

In 2018, the sampling scheme will be adapted taking the new data into account.

Atypical scrapie

Since the first case of atypical scrapie was detected in Sweden in 2003, approximately 50 cases have been detected. Out of these, two were detected through passive surveillance and the rest through active surveillance. Currently, the flocks are put under intensified monitoring in accordance with the regulation (EC) 999/2001. No additional cases of atypical scrapie have been found in the positive flocks. At the European level, two epidemiological studies have concluded that the prevalence is similar in different countries and that the prevalence in positive flocks does not differ from the prevalence in the rest of the sampled population. This pattern differs from the way contagious disease are normally distributed in the population and support the hypothesis that atypical scrapie is spontaneously occurring. Although within flock transmission between animals seems to be very low (if it exists) other routes of spread and the potential zoonotic aspect are being discussed.

REFERENCES

Fediaevsky A, Maurella C, Nöremark M, Ingravalle F, Thorgeirsdottir S, Orge L, Poizat R, Hautaniemi M, Liam B, Calavas D, Ru G, Hopp P. BMC Vet Res. 2010 Feb 7;6:9. The prevalence of atypical scrapie in sheep from positive flocks is not higher than in the general sheep population in 11 European countries.

Fediaevsky A, Tongue SC, Nöremark M, Calavas D, Ru G, Hopp P. BMC Vet Res. 2008 Jun 10;4:19. A descriptive study of the prevalence of atypical and classical scrapie in sheep in 20 European countries.

Elvander M, Engvall A, Klingeborn B. Acta vet Scand 02/1988. 29(3-4):509-10. Scrapie in sheep in Sweden.

Strangles

BACKGROUND

Strangles is a very contagious disease in horses, caused by *Streptococcus equi subsp. equi* (*S. equi*), belonging to Lancefield's group C streptococci. Strangles normally resolves without antibiotic treatment but can cause severe complications or persistent infection. To control and eradicate strangles, systematic surveillance by testing is necessary, and information must be disseminated about the disease and how it can be prevented, detected and stopped. It is equally important to understand and combat the social stigma associated with this disease. During the last decade, an array of new diagnostic tools has become available, to the benefit of surveillance and control.

DISEASE

Strangles affects horses, including donkeys and zebras. Common clinical signs include: fever, nasal discharge, depression, cough and enlarged submandibular or cervical lymph nodes. Other signs that may appear are: inappetence, dysphagia, painful movements, ruptured abscesses, dyspnoea and swollen limbs; and less commonly: spread of infection to other organs, so called "bastard strangles". Complications of strangles may be severe and lead to death.

So called "atypical strangles" with mild clinical signs is probably more typical than previously understood, which may lead to unnecessary large outbreaks due to delayed diagnoses. Also, recent findings indicate that subclinical infections with *S. equi* after an acute outbreak may be far more common than previously understood, and microbiological confirmation of the absence of *S. equi* can be required to rule out the horse being a carrier.

LEGISLATION

Strangles is a notifiable disease in Sweden (SJVFS 2013:23). It is notifiable already on clinical suspicion.

SURVEILLANCE

In Sweden, surveillance for strangles is passive; sampling and diagnostic testing is primarily performed on clinical suspicion. Typically, samples from airways and lymph nodes are submitted for bacterial analysis (culture or qPCR) to the National Veterinary Institute. Numbers from other veterinary laboratories were not available.

A yearly summary of notified, confirmed cases of strangles per county is given by the Board of Agriculture and presented below (Figure 18).

Detection of *S. equi* is influenced by site of specimen collection (nasal passage, nasopharynx, guttural pouch or abscess), method of sampling (flocked swab, rayon swab, or wash), and type of diagnostic test (culture or qPCR), as well as target gene for the PCR and the DNA amplification method that is performed. Timing of sampling is also crucial. Serology for serum antibodies against antigens A and

C of *S. equi* has been suggested for screening of subclinical *S. equi* carriers, but has limitations in both sensitivity and specificity.

RESULTS

The number of samples received by the National Veterinary Institute as a result of clinical surveillance has doubled since 2013 (Figure 19). In 2017, 1,448 samples were submitted from over 1,200 horses, of which 11% were positive to *S. equi* (Figure 19). The percentage of horses positive for strangles has increased 3-fold during the last five years (Figure 19). Nasopharyngeal lavage sampling, introduced in 2013, quickly became popular and now comprises almost one-third of the passive surveillance samples.

In 2017, there were 100 officially reported index cases of strangles in Sweden, each representing an outbreak in a farm. During the last 9 years, the number of affected farms increased from a level of under 50 per year during the years 2009-2014, to around 100 the last three years (Figure 18).

DISCUSSION

The passive surveillance results indicate that strangles is endemic in the Swedish horse population, and that the trend has been increasing during recent years. The observed lower number of cases detected through passive surveillance between 2009 to 2014 was possibly a reflection of the economic recession, which led to decreased breeding and trade in the horse industry at the time, resulting in less disease transmission. After 2015, the industry returned to higher activity, coincidentally with a return to strangles rates similar to before 2009 (Figure 18).

Other possible factors for a change in notifications over time might be varying knowledge about the disease, varying willingness to sample animals, and/or methodological changes over time, such as the increase in use of nasopharyngeal lavage. Substantial effort has been made to increase awareness among veterinarians and horse owners about new diagnostic developments and proper ways to investigate the infection. At the same time, the social media culture in society has led to more openness in private and delicate matters. It has contributed to a decrease in the stigma associated with strangles, and possibly increased compliance by owners to test horses, which is a benefit for the surveillance and for the possibility to control the infection.

Investigations of outbreaks point to a need for screening horses that recently have been moved for trade purposes, as these horses appear to be involved in most of the investigated acute outbreaks. It would also be of benefit with a programme for tracking the spread of strangles, by DNA characterisation of different isolates.

REFERENCES

Swedish Board of Agriculture, Statistics of index cases of notifiable animal diseases, <http://www.jordbruksverket.se>

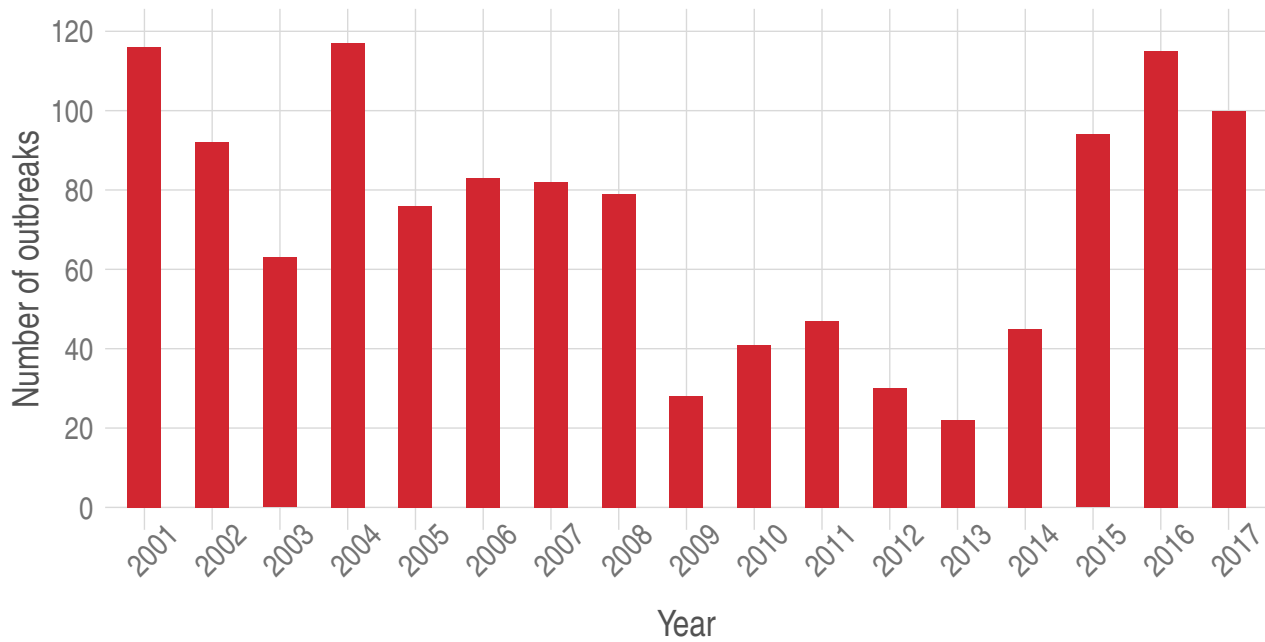


Figure 18: Reported index cases (farm outbreaks) of *Streptococcus equi* infections in horses in Sweden during years 2001-2017. Source: Swedish Board of Agriculture

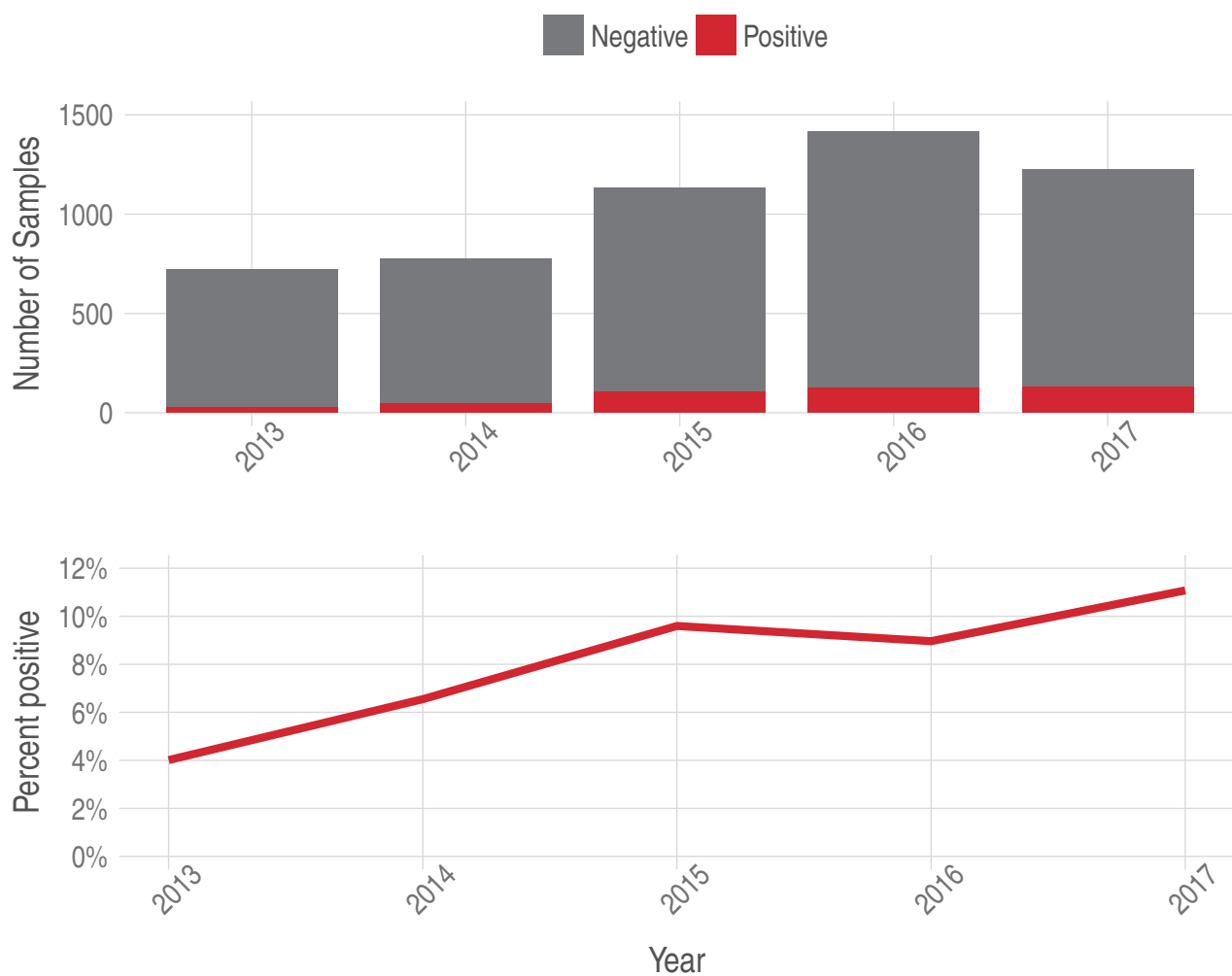


Figure 19: Numbers of individual horses sampled from airways and/or related lymph nodes for bacterial diagnosis, and the proportions of *S. equi* positive horses, National veterinary institute, 2013-2017

Tick-borne encephalitis

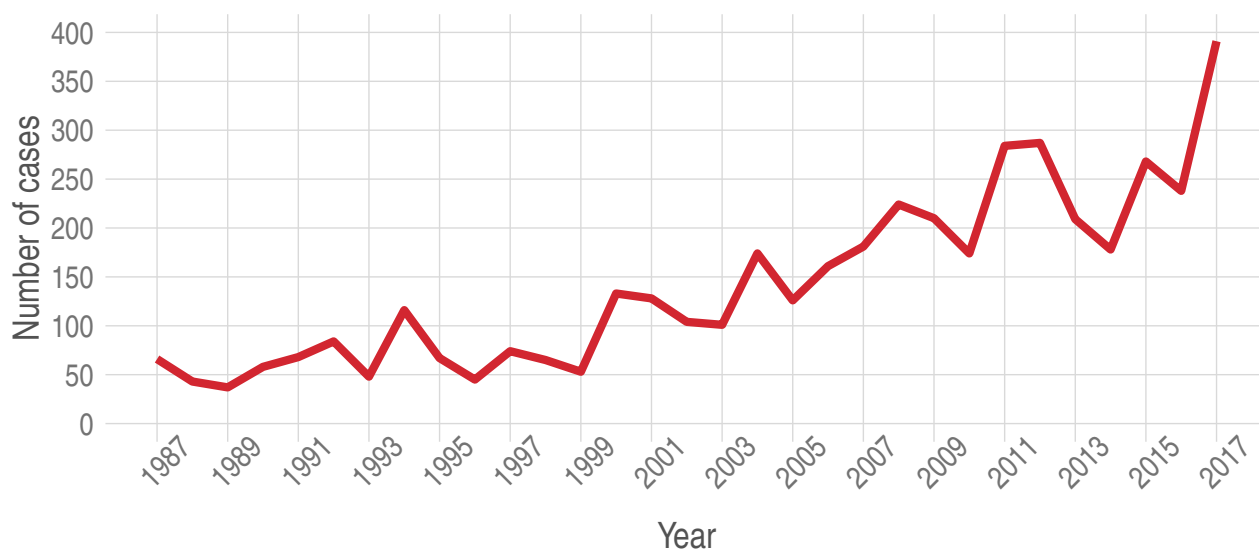


Figure 20: Number of notified cases of TBE in humans 1987-2017.

BACKGROUND

Tick-borne encephalitis virus (TBEV) belongs to the genus flavivirus in the family *Flaviviridae*. TBE virus is endemic in an area ranging from northern China and Japan, through far-eastern Russia to Europe. The virus may cause a neurological infection which may lead to long-term sequelae in the affected patients. The virus is spread by ticks (*Ixodes ricinus* and *I. persulcatus*), which are infected when they suck blood from infected rodents. Wild rodents are the natural reservoir for TBEV. The virus also circulates in the tick population through transovarial transmission without involvement of vertebrate hosts. Large mammals, predominantly ungulates, are important to the maintenance of large tick populations. Humans typically become infected via ticks, although unpasteurised cow's and goat's milk and milk products have also been reported as sources. Vaccination of persons living, visiting or working in endemic areas is recommended.

Three sub-types of TBEV are described: the "Western", "Siberian" and "Far eastern" subtypes. In Sweden, only the "Western" subtype has been identified.

The first case of TBE infection in Sweden was reported in 1954. During the following three decades, 10-40 annual cases were reported. From the mid-1980s a clearly increasing trend has been observed. In recent years about 150-400 cases have been reported annually. A majority of the cases acquire their infections in Sweden. Most have been infected on the east coast of Sweden and the Stockholm archipelago but in recent decades cases have been observed regularly on the west coast of the country. The age distribution is wide but most of the cases are between 30 and 70 years. There is a slight over-representation of men. A majority of the patients are diagnosed in July to October.

DISEASE

Animals

A few confirmed cases of disease in dogs have been reported. Seroconversion has been demonstrated in grazing goats and cows. Most authors consider these animals to be a dead-end hosts for the viral infection. Wild rodents are the natural reservoir for TBEV but are not reported to contract the disease. Roe deer have been shown to seroconvert and they have consequently been suggested as an indicator of the prevalence of the virus. However, there have been no reports of disease in this species.

Humans

In humans, a biphasic course of the disease is common. The first, viraemic phase lasts for about four days. After an interval of about a week, a meningoencephalitic phase appears in about one third of the patients. The symptoms may include fever, headache, nausea, cognitive dysfunctions or spinal paresis. The mortality is low, about 0.5%. The incubation period of TBE is usually between 7 and 14 days.

LEGISLATION

Animals

Demonstration of TBE virus or antibodies in animals is not notifiable.

Humans

TBE in humans is notifiable as a viral meningoencephalitis since 2004, according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

The surveillance in animals is passive. During 2017, six dogs were tested for TBE antibodies.

Humans

The surveillance is passive in humans.

RESULTS

Animals

One of the dogs was positive; it is however not known if clinical signs in this dog were caused by TBEV infection.

Humans

In 2017, 391 cases of TBE were reported, which is an increase of 64% from the year before, and more cases than have ever been reported in a single year (Figure 20). On a longer term, since 1983 the TBE incidence has shown a significantly rising trend of 7% each year.

More men (63%) than women were reported with TBE. The incidence was highest among people in the age group 50-69 years, but there were cases reported from 1 to 95 years of age.

All but ten cases had acquired their infections in Sweden. The majority of imported cases had been infected in Finland (six cases).

The first TBE cases became ill in mid-April and the last in mid-December. The peak occurred in August, but there were unusually many cases reported during the whole period from July until October.

The geographic distribution of the disease was mainly, as in previous years, concentrated in the coastal areas of Stockholm, Södermanland and Uppsala counties, both along the lake of Mälaren and the Baltic Sea (Figure 21). The incidence was highest in the counties of Uppsala (13 cases per 100,000 inhabitants) and Södermanland (12 cases per 100,000 inhabitants). However, the infection also occurs in many other parts of the country; from the county of Skåne in the south to southern Gävleborg and Dalarna in the north. TBE is successively spreading westwards and in 2017 there were unusually many cases infected in for example, Västra Götaland and Värmland.

DISCUSSION

The TBE incidence has shown a significantly rising trend during the last three decades, but there were still considerably more cases reported in 2017 than expected.

This general, long term increase is probably due to several interacting factors. The most important cause is presumably the very dense population of ticks, a consequence of a large roe deer population from the 1980s up until the recent snowy winters. This situation in combination with a high population of small host animals such as bank voles, and optimal weather for both virus spread and humans spending time outdoors, could explain the large number of cases reported. It is unknown why the incidence was unexpectedly high in 2017.

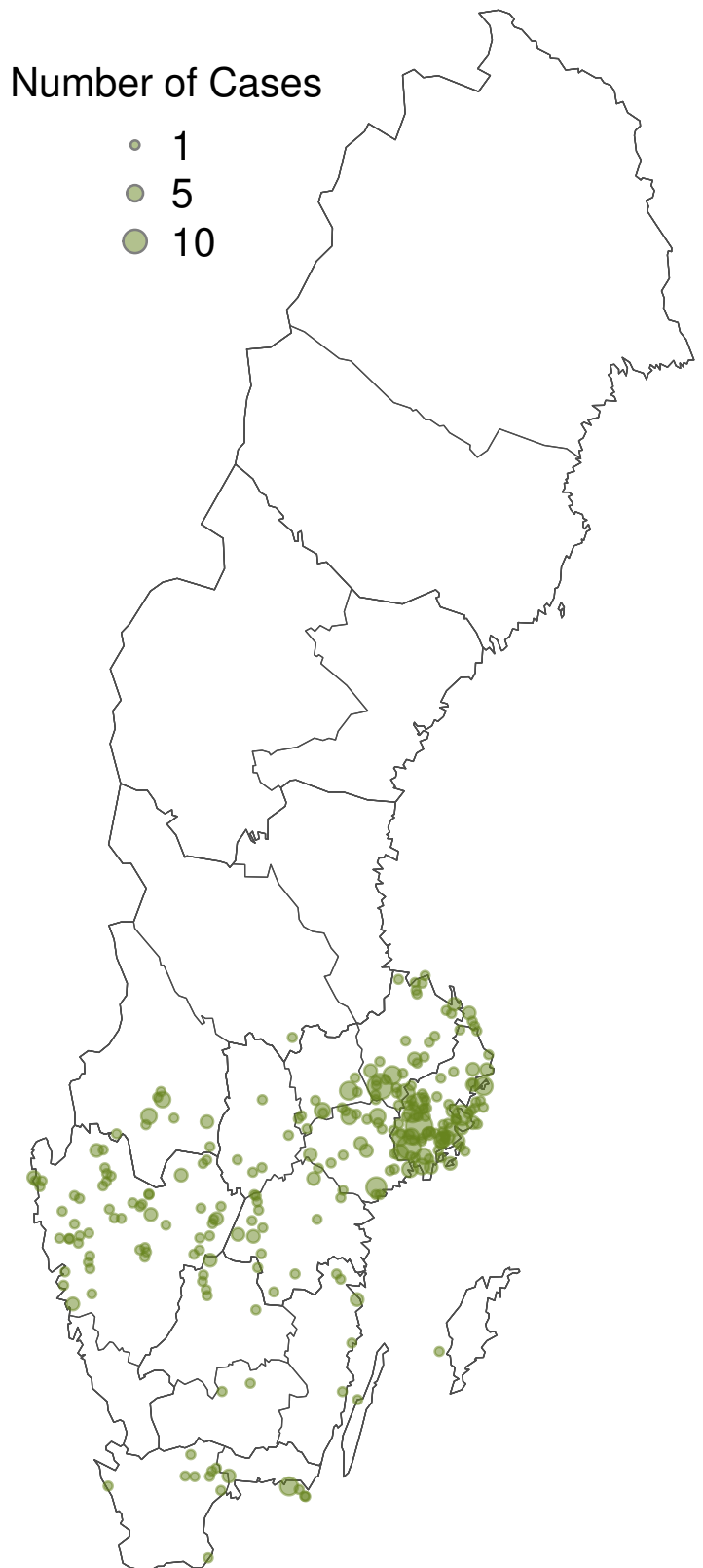


Figure 21: The geographic distribution of the place of infection of cases of TBE during 2017. The area of each circle marker is relative to the number of cases identified, the smallest markers are a single case.

©EuroGeographics for the administrative boundaries.

Trichinellosis



Production sites without controlled housing conditions should test all their slaughtered domestic pigs. Although *Trichinella* occurs in wild carnivores and wild boar in Sweden, the risk of becoming infected from domestic pigs and horses is negligible. Photo: Bengt Ekberg

BACKGROUND

Trichinellosis is caused by parasitic nematodes of the genus *Trichinella*. The parasites can be hosted by different mammals including domestic pigs and horses but the main reservoirs are wild carnivores and omnivores. Humans typically acquire the infection by eating raw or inadequately heated infected meat and meat products, often cold-smoked, fermented sausages. In Western Europe, the wild boar appears to be the main source of human infection.

In Europe, *T. spiralis* and *T. britovi* are the dominant causes of human infections. In Sweden, these species are also detected as well as *T. nativa* and *T. pseudospiralis*. *T. pseudospiralis* is mainly isolated from wild boars. In the gut, *Trichinella* larvae develop into adults and mate. After mating, the female releases larvae which penetrate the intestinal mucosa and travel via the bloodstream to various organs and muscles. In striated muscles the larvae may survive in an encapsulated form for years.

In Sweden, *Trichinella* has been monitored at slaughter in domestic pigs since the 20th century. From 1970-1990 sporadic cases were detected in domestic pigs, but since 1994 there have been no cases. The parasite is endemic in Swedish wildlife.

The disease is extremely rare in Sweden and detected human cases are usually infected abroad. During 2013 to 2016 three human cases with confirmed infection with *Trichinella* were reported, all infected abroad with country of infection being Poland, Eritrea and Georgia. Also, two cases were reported with clinical symptoms indicating infection with *Trichinella*, although the diagnoses could not be laboratory confirmed.

DISEASE

Animals

Animals rarely develop a clinical infection, although both pigs and rodents can exhibit clinical signs.

Humans

The disease in humans can range from subclinical infection to fatal disease. The incubation period varies from 5-15 days. Symptoms initially involve diarrhoea and abdominal pain and later muscle pain, fever, oedema of the upper eyelids and photosensitivity. Intestinal stages of the disease respond well to treatment. Cardiac and neurological complications may occur 3-6 weeks post infection. *Trichinella* is not transmitted between humans.

LEGISLATION

Animals

Trichinella is notifiable in animals according to SJVFS 2013:23. Official controls for *Trichinella* in meat is regulated by Commission Implementing Regulation EU 2015/1375 of 10 August 2015.

Humans

Trichinellosis is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634).

SURVEILLANCE

Animals

Pig production sites that are officially applying controlled housing conditions are obligated to test all carcasses of breeding sows and boars sent for slaughter. In addition, production sites without controlled housing conditions should test all their slaughtered domestic pigs. Fattening pigs originating from holdings officially recognised as applying controlled housing conditions are not obligated to test for *Trichinella*. The digestion method is the only method applied in testing for *Trichinella*.

All slaughtered horses, hunted wild boar and bears are tested for *Trichinella*. In addition, several species of wild animals are tested for *Trichinella*, including: foxes, lynxes, wolves, badgers, birds and wolverines. The testing of *Trichinella* in animals was performed by five laboratories during 2017.

Humans

Surveillance in humans is passive.

RESULTS

Animals

In 2017, all slaughtered horses (2,256) were tested. The number of tested pigs from controlled housing conditions were 25,728 breeding sows, 401 boars and 1,037,112 fattening pigs. In addition, 424,013 slaughtered pigs (all categories) from uncontrolled housing conditions were tested. *Trichinella* was not detected in domestic pigs or horses.

Trichinella spp. was detected in 7 out of a total of 111,845 (0.006%) wild boar samples and also in 4 lynx and 1 wolf, see Table 19. These figures are based on results from five laboratories testing for *Trichinella* and include samples from animals submitted to wild game establishments (16,130 wild boars and 69 bears) as well as samples taken by private hunters.

Humans

No human cases of trichinellosis were reported in 2017.

DISCUSSION

Trichinellosis is extremely rare in Swedish food-producing animals and the few detected human cases in the last decades were infected abroad. The *Trichinella* situation in Swedish animal population seems to be stable. *Trichinella* occurs in wild carnivores and wild boar but the risk of getting *Trichinella* from domestic pigs and horses is negligible.

Table 19: Findings of *Trichinella* in wild animals 2017

Animal species	No. samples	No. positives	Percentage	<i>T. britovi</i>	<i>T. nativa</i>	<i>T. pseudospiralis</i>	<i>T. spp</i>
Badgers	3	0	0.00%	-	-	-	-
Bears	180	0	0.00%	-	-	-	-
Beaver	3	0	0.00%	-	-	-	-
Lynx	80	4	5.00%	1	3	-	-
Lion	4	0	0.00%	-	-	-	-
Otter	1	0	0.00%	-	-	-	-
Red foxes	1	0	0.00%	-	-	-	-
Seal	12	0	0.00%	-	-	-	-
Tiger	1	0	0.00%	-	-	-	-
Wild birds	2	0	0.00%	-	-	-	-
Wild boar	111,845	7	0.006%	2	-	4	1
Wolves	45	1	2.22%	-	1	-	-
Total		12		5	4	4	1

Tuberculosis



The voluntary tuberculosis control programme in alpacas was launched in 2015. It is based on serological testing since the traditional intradermal skin fold tuberculin test is less sensitive in new world camelids. Photo: Public domain

BACKGROUND

Tuberculosis (TB) is a serious disease in humans and animals caused by bacteria included in the *Mycobacterium tuberculosis* complex. *Mycobacterium bovis* causes bovine tuberculosis in several animal species as well as in humans. Historically, the reservoir has been cattle but many other wild and domestic species can also maintain the infection. Wildlife reservoirs including badgers, deer and wild boar cause persistent problems in some countries. Humans usually acquire *M. bovis* infection via unpasteurised milk or via inhalation. The predominant cause of human tuberculosis is however *Mycobacterium tuberculosis*. In countries where human tuberculosis caused by *M. tuberculosis* is common, this bacterium is also frequently isolated from various species of animals.

Sweden was declared officially free from bovine tuberculosis in 1958. Since then, sporadic cases have occurred in cattle, the most recent in 1978. Compulsory tuberculin testing of all cattle was abolished in 1970 and the national tuberculosis control in cattle is now based on meat inspection and clinical surveillance.

When Sweden joined the European Union in 1995, the status of OTF (officially tuberculosis free) was obtained.

In 1987, *M. bovis* infection was introduced into the

farmed deer population. A control programme for tuberculosis in farmed deer was introduced in 1994 and made compulsory in 2003. The last case of tuberculosis in farmed deer was identified in 1997.

The yearly incidence among humans in Sweden in the early 1940's was above 300/100,000 inhabitants. This was followed by a rapid decline, beginning before effective treatment was available in the early 1950's. Currently, the yearly incidence is 5.3/100,000 inhabitants, which is among the lowest in the world. Around 90% of the cases are born outside of Sweden and the vast majority of them are immigrants originating from countries that still have a high incidence of tuberculosis. The yearly incidence among people born in Sweden is 1/100,000 inhabitants.

DISEASE

The symptoms caused by tuberculosis in both humans and animals depend largely on the localisation of the infection. The disease progresses slowly and clinical signs may take a long time to develop, even in cases with substantial lesions. Weight loss and sometimes coughing (in cases with respiratory tract infection), ascites (due to infection in intestinal lymph nodes or liver) or mastitis (mainly in cattle with udder infection) can be seen. The incubation period varies from weeks to years.

LEGISLATION

Animals

Suspect and confirmed cases of infection with *Mycobacterium bovis*, *M. tuberculosis*, or other mycobacteria in the *M. tuberculosis*-complex, are notifiable in all animal species according to the Swedish Act of Epizootic diseases (SFS 1999:657, with amendments).

Humans

Tuberculosis in humans is a notifiable disease according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634). Contact tracing is compulsory and the treatment is free of charge. Refusing treatment as a patient when being contagious can lead to detention.

SURVEILLANCE

Animals

From suspect animal cases, samples from organs with macroscopic lesions and adjacent lymph nodes are collected. In case of positive tuberculin test reactors samples from organs with macroscopic lesions and lymph nodes from five different areas (retropharyngeal, submandibular, mediastinal, mesenteric and inguinal) are collected. Histology and direct smears are performed on all materials. If TB cannot be ruled out by histology or if direct smears are positive, culture is performed. Cultures are performed on solid media (Löwenstein-Jensen and Stonebrink's) at the National Veterinary Institute and cultured for up to twelve weeks. Suspected colonies are tested with PCR and, if necessary, with sequencing of a specific gene. Isolates suspected to belong to the *M. tuberculosis*-complex or where the *M. tuberculosis*-complex cannot be ruled out are sent for confirmation to the Norwegian Veterinary Institute or the Public Health Agency of Sweden. Positive isolates are further subtyped.

Skin fold tuberculin tests are performed according to EC 1226/2002 (amending annex B of EC 64/432) and SJVFS 2003:33, (K62). The comparative intradermal test is used, mostly at the neck site. In case of a positive tuberculin test, the animal is culled and sampled as stated above. Culture is performed on all samples.

Since 2012, testing of alpacas for tuberculosis has been done using a serological test instead of an intradermal test as the intradermal test has a demonstrated low sensitivity in alpacas.

Humans

In humans, culture on sputum smear is the standard test when pulmonary tuberculosis is suspected. Otherwise culture from urine, faeces, blood or liquor is also a possibility, or biopsies from suspected site of infection.

Passive surveillance

Animals

As TB is notifiable on clinical suspicion, clinical signs in animals or lesions detected at necropsy of an animal prompt official investigations, including sampling for bacteriology,

tuberculin testing of contact animals and epidemiological investigations. A positive finding of *M. bovis* or *M. tuberculosis* in animals would generate contacts with public health representatives to ensure that possible exposure of humans can be investigated.

Humans

The surveillance in humans is mainly passive but contact tracing from diagnosed cases is compulsory and asylum seekers from high incidence countries are offered health examination where screening for TB is included.

Active surveillance

Animals

Surveillance for TB is mainly performed by meat inspection at slaughter of food producing animals. Official inspectors from the National Food Agency perform the inspections. Suspect lesions are sent to the National Veterinary Institute for histology and bacteriology.

The control programme in farmed deer was, until October 2012, based on regular whole-herd tuberculin testing, or whole-herd slaughter and meat inspection. Since October 2012, tuberculin tests are no longer performed in TB-free herds, but inspections at slaughter and necropsy of animals found dead or euthanized are still required.

A voluntary control programme in alpacas was launched by Farm & Animal Health in 2015. All adult animals in the herd are serologically tested and all animal purchases and contacts with other herds are recorded.

Furthermore, tuberculin tests are performed at artificial insemination centres and at export of animals as required according to EU-legislation (Council Directive 64/432/EEC).

RESULTS

Animals

Due to lesions detected at slaughter, three cattle, eight sheep, six pigs and one deer were investigated by histology and, where relevant, by culture. From these samples NTM (Non-tuberculous mycobacteria), from the *Mycobacterium avium/intracellulare*-complex were isolated in one pig. No other samples yielded any mycobacteria. Due to clinical suspicions or lesions found at necropsy, samples from one cow, two deer, one camel, three dogs and two cats were investigated. None of these samples yielded any mycobacteria. Due to a positive tuberculin test, one moose calf was euthanized, necropsied and cultures from relevant organs were performed. The NTM *Mycobacterium kansasii* were isolated from one sample; no other sample yielded any mycobacteria. An epidemiological investigation was performed and the mother of the calf, which was the only animal that had been in contact with the calf for considerable time, were tuberculin tested with negative result.

In 2017, there were 308 holdings with farmed deer that were considered active and had obtained TB free status. Eight herds were not tested. These herds are exempted from regular testing and instead they must slaughter 20% of the herd yearly with meat inspections and necropsies for 15 years and thereby obtain a free status. TB was not detected

in any farmed deer in Sweden during 2017.

During 2017, 53 alpacas, 2 llamas and 18 wisents were tested serologically before export or import. Two of the alpacas had positive final results, and they are now isolated and subject to further sampling. All other animals had negative final results. Within the voluntary control programme, 514 alpacas and 7 llamas were tested, all with negative final results.

Humans

Three cases of *M. bovis* were reported in humans in 2017; all three cases with extrapulmonary TB, one with peripheral lymphadenitis and two with skeletal involvement. The case with lymphadenitis was a young woman from Eritrea, most likely infected in her country of origin, and the cases with skeletal TB were both born in Sweden in the 1930's and probably infected in their childhood.

DISCUSSION

Animals

The officially free status for bovine tuberculosis has been maintained during 2017. The overall TB situation in animals and humans remains favourable. No cases of TB were detected in Swedish animals during 2017. Although the surveillance is mainly dependent on inspections of slaughtered animals, this is considered sufficient. However, the submission rates of lesions from slaughtered ruminants should be improved. Passive surveillance based on clinical suspicions and necropsy findings will always have a low sensitivity as clinical symptoms and massive lesions are mainly seen in late stages of the infection.

The eradication efforts in farmed deer have been successful and the probability that Swedish farmed deer are TB

free is high. The aim is to eventually declare the remaining deer herds officially free.

Humans

The rapid decline of tuberculosis in humans in the 1940's coincided with the eradication of tuberculosis in cattle and started before the introduction of effective treatment in the 1950's. A much larger part of the human population lived in close contact with domestic animals. This change in contact between humans and animals possibly played a role in the changing TB incidence in humans. Today, Sweden has one of the lowest incidences of human tuberculosis in the world.

REFERENCES

- Alvarez J, Bezos J, Juan Ld, Vordermeier M, Rodriguez S, Fernandez-de-Mera IG, Mateos A, Domínguez L. Diagnosis of tuberculosis in camelids: old problems, current solutions and future challenges. *Transbound Emerg Dis.* 2012 Feb;59(1):1-10. doi: 10.1111/j.1865-1682.2011.01233.x. Epub 2011 Jun 2
- Rhodes S, Holder T, Clifford D, Dexter I, Brewer J, Smith N, Waring L, Crawshaw T, Gillgan S, Lyashchenko K, Lawrence J, Clarke J, de la Rúa-Domenech R, Vordermeier M. Evaluation of gamma interferon and antibody tuberculosis tests in alpacas. *Clin Vaccine Immunol.* 2012 Oct;19(10):1677-83. Epub 2012 Aug 22.
- Wahlström, H., Frössling, J., Sternberg Lewerin, S., Ljung, A., Cedersmyg, M. and Cameron, A., 2010. Demonstrating freedom from infection with *Mycobacterium bovis* in Swedish farmed deer using non-survey data sources. *Preventive Veterinary Medicine* 94:108-118.

Tularaemia

BACKGROUND

The bacterium *Francisella tularensis* is the causative agent of tularaemia, a disease affecting many animal species, including humans. There are several subtypes of *F. tularensis* of variable virulence. *F. tularensis* subsp. *holarctica* (type B) is the main subspecies responsible for human and animal infection in Europe.

F. tularensis is capable of surviving for weeks at low temperatures in water, moist soil, or decaying plant and animal matter. Although many different animal species can be infected, tularaemia is typically found in hares and small rodents.

Humans become infected through a variety of mechanisms such as bites of infected insects or other arthropods, handling infected or dead animals, ingesting contaminated food or water, and inhaling aerosols of bacteria. Clinical disease is variable and dependent on the route of transmission. The infection is more often reported in men than in women, which might be attributed to their leisure and professional activities. The age group of 40-79 years is the most affected in both sexes. Tularaemia may occur during the whole year, but it is most frequent during late summer and early autumn.

Sweden has reported cases of tularaemia in humans and animals since 1931. Ever since the first Swedish tularaemia case was reported, endemic areas have been identified in northern and central Sweden.

The mountain hare and the European brown hare are the animal species in which tularaemia has most frequently been identified. Diseased animals have been found in the traditionally endemic areas in northern and central Sweden, as well as in regions south of these areas.

The annual numbers of reported human cases range from a few cases to more than 2,700 cases in 1967.

DISEASE

F. tularensis is highly infectious, as few as 10-50 colony forming units may cause infection. The incubation period is usually 3-5 days. Tularaemia can be manifested in different forms depending on the route of transmission and on the virulence of the organism.

Animals

In Swedish hares, and in many rodent species that die of tularaemia, the pathological presentation of the disease is a disseminated multi-organ septicaemic form.

Humans

The ulceroglandular form is the most common form, and is more frequently seen than the typhoidal form. The pneumonic, oculoglandular and oropharyngeal forms are rarely diagnosed. In the ulceroglandular form, a local ulcer usually appears at the site of infection and the adjacent lymph nodes are enlarged. The general symptoms of tularaemia are high fever, headache and nausea.

LEGISLATION

Animals

Tularaemia is notifiable in animals (SJVFS 2013:23).

Humans

Tularaemia has been a notifiable disease since 1970 according to the Communicable Disease Act (SFS 2004:168) with the amendments of SFS 2013:634.

SURVEILLANCE

Animals

Surveillance in animals is passive. It is based on voluntary submission of animals found dead or euthanised by hunters and the general public. Detection is based on PCR or immunohistochemistry of the animal sample.

Humans

The surveillance is passive. For laboratory verification of the infection, serology, PCR and isolation of the bacteria can be used.

RESULTS

Animals

In 2017, 31 European brown hares and eight mountain hares were examined. *F. tularensis* subsp. *holarctica* was detected in seven European brown hares and none of the mountain hares. The seven hares had all died of an acute disease spread to several organs, and finally ending with sepsis. All tularaemic hares originated from central-eastern parts of Sweden (one from Stockholm, two from Uppsala, and the remaining four from Östergötland), and one from Västra Götaland in the southwest part of the country. The number of cases in 2017 is approximately at the same level as other years without outbreaks, for example six cases in 2016 and two in 2014. This could be compared to the outbreak year 2015 when tularaemia was diagnosed in 31 hares, the majority coming from the outbreak area.

Humans

In 2017, 87 human cases of tularaemia were reported. As a rule, there are large natural fluctuations in the number of tularaemia cases observed between years and in different regions. This is probably due to several factors among others are the number of reservoirs and mosquitoes, as well as weather conditions. Even though the tularaemia incidence has varied a lot between years, the increasing incidence-trend for the last 25 years is significant different in comparison to the same time-period before 1992.

More men (73%) than women were reported to be infected in 2017, which is in accordance with previous years. The incidence of tularaemia was highest in the age group 40-79 years, which is also similar to previous years. The uneven distribution among age groups and sexes might partially be attributed to their somewhat different leisure and

professional activities.

As in previous years, except for a few sporadic cases, tularaemia was only reported from the northern, western and central parts of Sweden. During 2017, the incidence was highest in the county of Värmland with 6.1 cases per 100,000 inhabitants, followed by the counties of Örebro with five cases per 100,000 inhabitants. In 2017, two cases were reported to have been infected in Denmark and Ukraine respectively.

More than half of the cases for whom a route of transmission had been specified, an insect bite was reported. The true number may be both greater or smaller as the infection route is difficult to determine, both for the patient and the clinician. In 2017, 16 cases were assumed to have been infected through direct contact with animals.

During the first half of the year, just a few cases were reported each month. The number of cases started to increase in June and peaked in October. During the last two months of the year the number of cases subsided.

DISCUSSION

Tularaemia has been endemic in northern and central Sweden at least since the early 20th century with a marked annual variation. Years with high numbers of cases are often followed by periods when the disease is virtually absent. There is no obvious explanation for these fluctuations. The reservoir for the bacterium between outbreaks has not been clearly identified. During the last two decades, the epidemiology of tularaemia has changed and the number of reported cases in humans and animals, mainly European brown hares, infected south of the previous endemic region has increased. In animals, outbreaks of tularaemia have in some countries been associated with rises in rodent and hare populations, but this has not been confirmed in Sweden. It is possible that the European brown hare has become an important carrier of *F. tularensis* in many areas, but its epidemiological role remains unclear.

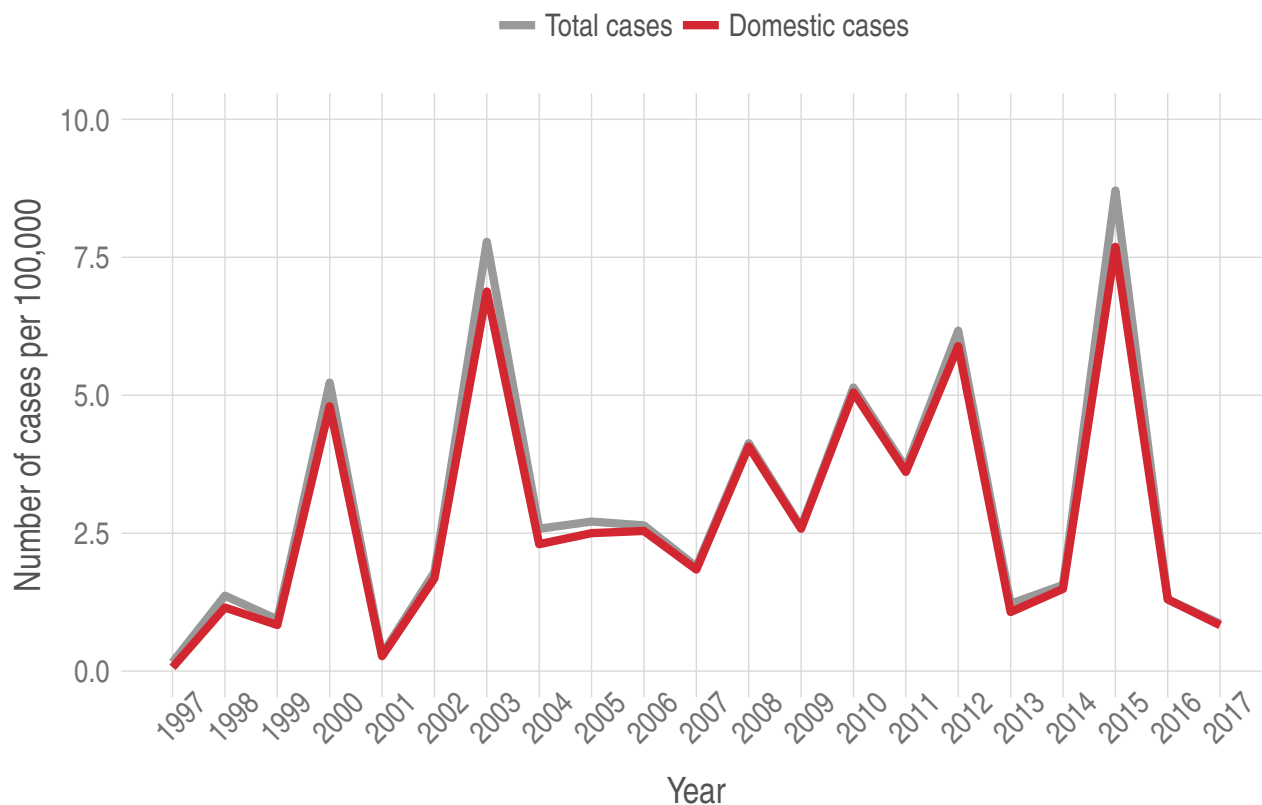


Figure 22: Incidence of notified human cases of tularaemia in Sweden 1997-2017

Verotoxinogenic *Escherichia coli*

BACKGROUND

Verotoxinogenic *Escherichia coli* (VTEC) may cause serious intestinal infections in humans. When these bacteria cause hemorrhagic diarrhoea they are called EHEC (enterohaemorrhagic *E. coli*). More than 380 different VTEC serotypes have been associated with human illness. Shiga toxin-producing *Escherichia coli* (STEC) is used synonymously with VTEC. The toxin can be divided into two main groups, shigatoxin 1 (stx1) and shigatoxin 2 (stx2), and then further divided into several subtypes, for example, stx1a. Previously, many outbreaks and severe disease were caused by serotype O157:H7, but in recent years other serogroups have emerged. Often the strains associated with severe disease carry the stx2 gene. Other common serotypes causing gastrointestinal illness are O26, O103, O111, O121 and O145. Cattle are the main reservoir of VTEC associated with human disease although other animal species may also carry the organisms. The infectious dose is low, probably less than 100 bacteria. Not only foods of bovine origin but also vegetable food items and drinking water have been implicated in outbreaks. The infection can also be transmitted through direct or indirect animal contact, via environment or person-to-person contacts.

VTEC was only sporadically detected in Sweden before 1995, when 114 human cases of EHEC O157:H7 were notified. In 1996, VTEC O157 was isolated from Swedish cattle for the first time and human EHEC O157 infection was traced to a cattle herd. In 2002, an outbreak of EHEC O157:H7 in the county of Skåne, affecting 30 persons, was caused by consumption of cold-smoked fermented sausage. The largest Swedish outbreak so far occurred in the summer of 2005 when 135 reported cases, including 11 (8%) HUS (haemolytic uraemic syndrome) cases, were infected with O157:H7 after eating contaminated fresh lettuce. The lettuce had been irrigated with water from a local stream positive for stx 2 at the time of harvest. Indistinguishable isolates from humans and cattle faeces from a farm upstream confirmed the implicated source, and control measures that lead to the termination of the outbreak were implemented.

Between 250-550 cases (3-6 cases per 100,000 inhabitants) of EHEC infections have been reported in Sweden annually, of which 50-60% are domestically acquired. Most of the domestic cases are reported during the period July to September.

Management of zoonotic agents requires collaboration between several authorities within the veterinary and public health sector. A national strategy document containing a plan to reduce the risk of domestic EHEC cases was published in 2014 by the Swedish Board of Agriculture, the National Food Agency, the Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute. The document is based on a synthesis of current knowledge and identifies what actions the authorities consider as important that should be prioritised to reduce

the risk of domestic infection with VTEC in humans.

DISEASE

Animals

Animals do not develop clinical disease.

Humans

The clinical picture may vary from asymptomatic infection to non-haemorrhagic or haemorrhagic diarrhoea associated with abdominal cramps. Most patients fully recover. In recent years, approximately 3% of the cases in Sweden have developed HUS, which is characterised by acute renal failure, thrombocytopenia, and microangiopathic haemolytic anaemia; a condition that may lead to death. A large proportion of the patients are young children, and severe complications are most common in this age group, as well as among elderly people.

LEGISLATION

Animals

Since 1999, VTEC O157 findings in animals are notifiable when associated with human infection (SJVFS 2013:23).

Humans

EHEC O157 has been notifiable for both clinicians and laboratories under the Swedish Communicable Disease Act since 1996. All EHEC serotypes that are pathogenic to humans have been notifiable since 1 July 2004 (SFS 2004:168 with the addition of SFS 2013:634). A laboratory confirmed case can also include cases that are only positive by PCR i.e. where no isolate has been obtained.

SURVEILLANCE

Animals

Surveillance of VTEC in animals is active and consists of traceback investigations from human EHEC cases and prevalence surveys of VTEC in abattoirs.

Passive - Traceback from human cases

If a County Medical Officer suspects an association between a human case of EHEC infection and animals, or a farm with animals, the County Veterinary Officer will be informed. A request will be made to the Swedish Board of Agriculture for a trace back investigation and sampling of suspected animals, and/or the environment of the animals.

Active

Between 1997 and 2002, annual prevalence studies of VTEC in cattle at abattoirs were conducted. Since 2002, prevalence studies have been performed every third year. In the studies conducted during 2011-2012 and 2014-2015, all positive VTEC O157:H7 were also examined for a variant of VTEC O157:H7, called clade 8. This variant is often isolated from cattle farms associated with human cases. A baseline study

on cattle carcasses was done in 2006-2007 and a prevalence study in sheep was done at nine abattoirs in 2007-2008. Results from a slaughter prevalence survey from 1998 showed that 0.1% of the pigs were positive for VTEC O157:H7.

Humans

Surveillance in humans is passive. Isolates from human cases are sent to the Public Health Agency of Sweden for typing using whole genome sequencing (WGS) to verify molecular serotype and for cluster detection. As a conventional nomenclature tool, not only the serotype but also the Multi Locus Sequence Typing (MLST) type, i.e. ST-type, is defined by WGS.

RESULTS

Animals

Passive - Traceback from human cases

During 2017, 16 cattle farms were investigated as suspected sources for human infection. An epidemiological association was established in four cases of VTEC O157:H7, one case of VTEC O26 and finally, one case of VTEC O121.

Active

VTEC O157 was detected in nine (1.8%) of 492 faecal and 2 (1.9%) of 105 ear samples from sheep in a survey performed in 2007-2008. In cattle, surveys during 1997-2002 showed a prevalence of approximately 1%. In the study done in 2005-2006, VTEC O157 was detected in 3.4% of faecal samples. In the abattoir survey conducted in 2008-2009 VTEC O157 was detected in 3.3% of 1993 faecal and 8.2% of 500 ear samples in cattle. In the study conducted during 2011-2012, VTEC O157 was detected in 73 of 2,376 faecal samples (3.1%) from cattle. Clade 8 was detected in 15 of the 73 positive samples. In the study conducted during 2014-2015, VTEC O157 was detected in 33 of 1,492 faecal samples (2.2%) from cattle. Clade 8 was detected in 5 of the 33 positive samples. In these studies, VTEC O157:H7 has predominantly been isolated from cattle in southern Sweden but rarely from the northern two thirds of the country. The collected samples during 2011-2012 were also analysed for VTEC O26 and VTEC O103. VTEC O26 was detected in 8 of 1,308 faecal samples (0.6%) and in 15 of 336 cattle ear samples (4.5%). VTEC O103 was detected in three of 1,000 faecal samples (0.3%) and in three of 500 ear samples (0.6%).

Food

Available results from official sampling by local authorities showed that analysis for *E. coli* O157 was done for 8 samples. The samples have been taken from different kinds of food. Out of these, 4 samples were taken as part of the investigation of food poisoning/complaints. All 8 samples were negative. There were also another 23 samples analysed with gene detection methods. Out of these, 18 were taken as part of the investigation of food poisoning/complaints. Five of these twenty-three samples were positive. Those five positive samples have been taken from meat and milk. Sampling at the border inspection posts, generated 126 samples;

all negative for genes associated with virulence. However, isolation of living strains with virulence genes was not successful.

Humans

In 2017, 504 human cases were reported of which 296 were domestic (59%); this corresponds to an overall incidence of 5.0 cases per 100,000 inhabitants. The domestic incidence in 2017 was 2.9 cases per 100,000 inhabitants compared to 4.7 cases per 100,000 inhabitants in 2016 (Figure 23). As in previous years, the age group of 1-4 years had the highest proportion of cases (19%).

EHEC normally has a seasonal variation with most cases reported during the summer months. In 2017, 38% of the domestic cases were reported from July to September.

The domestic incidence was lower in most counties in 2017 compared to 2016. In 2017 the domestic incidence was highest in the county of Västerbotten (8.6 cases per 100,000 inhabitants) followed by Örebro (7.7 cases per 100,000 inhabitants) and Halland (7.4 cases per 100,000 inhabitants). There are regional differences regarding when and how faecal samples are analysed for EHEC. For example, in some regions only children up to 10 are routinely screened, or only when bloody diarrhoea is present etc. Also, there is an ongoing change into using multiplexed PCR panels when faecal samples are analysed for gastrointestinal pathogens in local clinical microbiological laboratories (Folkhälsomyndigheten, 2015). This change will result in more samples being analysed for EHEC, as seen in the county of Örebro in 2017.

Of the total number of human cases, 40% were infected abroad and Turkey was the most common country of infection (20 cases) followed by Egypt (17) and Spain (16). Turkey and Egypt are usually the countries outside Sweden where most Swedes become infected with EHEC, although the numbers of infected cases from these countries have declined in recent years. This is probably a reflection of changed travel patterns.

A total of 18 cases of EHEC-associated HUS were reported of which 13 were domestically acquired infections. Eleven of the HUS cases were children under the age of 10. For nine of the HUS cases an isolate could be retrieved and thereby serotyped (Table 20). Six of the domestic HUS cases belonged to serotype O157:H7, clade 8 which is associated with more severe disease.

In 64% of the domestic EHEC cases, an isolate could be retrieved and thereby serotyped. The most common serotypes were O26:H11, O157:H7, O103:H2 and O121:H9.

The majority of reported human cases are sporadic and the source of infection unknown. In recent years there has been a number of large outbreaks. In 2017 however, no large outbreak occurred although two outbreaks starting in 2016 continued in the beginning of 2017. In one of the outbreaks minced beef meat was found to be the vehicle of infection. In the other outbreak the source of infection was not found.

DISCUSSION

Although there was a lower domestic incidence of EHEC in 2017 compared to 2016, there is an increasing trend since 2005. The ongoing change toward using multiplexed PCR panels when faecal samples are analysed for gastrointestinal pathogens will likely increase the number of detected cases. It is therefore important to follow these changing screening and analysis procedures to understand fluctuations in data over time.

Several investigations were performed based on suspected associations with farms and food items. Most reported cases from humans are in counties with high cattle density, typically in the southern parts of Sweden. The highest screening frequency of EHEC in faecal samples of children with diarrhoea has, in a previous investigation, been shown to also be the highest in the southern parts. The higher numbers of cases infected abroad, which can also be found in these parts of Sweden, can partly be explained by the differences in screening routines, but the cause of this difference has not been fully investigated.

The prevalence among cattle, based on samples taken at slaughter, has since 2005 been in the range of 2.2-3.4%. In these studies, VTEC O157:H7 has predominantly been isolated from cattle in southern Sweden and rarely from the northern two thirds of the country. In the latest survey, positive VTEC O157 samples were also analysed for the subgroup clade 8. There is a tendency for geographical clustering of clade 8.

REFERENCES

Frank C, Werber D, Cramer JP, Askar M, Faber M, an der Heiden M, Bernard H, Fruth A, Prager R, Spode A, Wadl M,

Zoufaly A, Jordan S, Kemper MJ, Follin P, Muller L, King LA, Rosner B, Buchholz U, Stark K, Krause G. HUS Investigation Team. Epidemic Profile of Shiga-Toxin-Producing *Escherichia coli* O104:H4 Outbreak in Germany, *N. Engl J Med* 2011; 365:1771-1780.

Ivarsson S, Jernberg C, Björkholm B, Hedenström I, Lopez G. Regional Investigation Team, Rapid detection and communication of Swedish cases provided early puzzle pieces in the German STEC O104 outbreak, poster Escaide conference 2011.

Sartz L, De Jong B, Hjertqvist M, Plym Forshell L, Alsterlund R, Löfdahl S, Osterman B, Ståhl A, Eriksson E, Hansson H-B, Karpman D. An outbreak of *Escherichia coli* O157:H7 infection in southern Sweden associated with consumption of fermented sausage; aspects of sausage production that increase the risk of contamination, *Epidemiol. Infect.* 2008; 136; 370-380.

Söderström A, Österberg P, Lindqvist A, Jönsson B, Lindberg A, Blide Ulander S, Welinder-Olsson C, Löfdahl S, Kaijser B, De Jong B, Kühlmann-Berenzon S, Boqvist S, Eriksson E, Szanto E, Andersson S, Allestam G, Hedenström I, Ledet Muller L, Andersson Y. A large *Escherichia coli* O157 outbreak in Sweden associated with locally produced lettuce, *Foodborne Pathog. Dis.*, Vol 5, Nr 3 2008.

National guidelines: Infektion med EHEC/VTEC Ett nationellt strategidokument. Available from: www.folkhalsomyndigheten.se

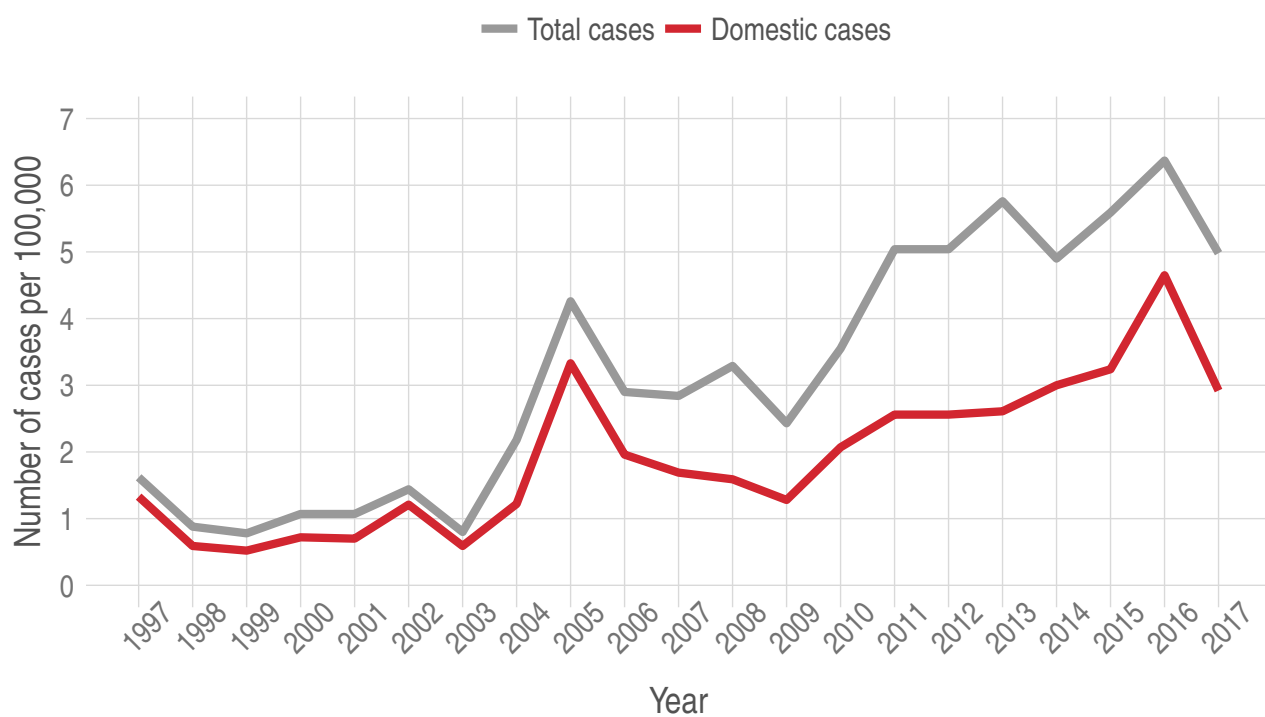


Figure 23: Notified incidence per 100,000 inhabitants of human EHEC cases in Sweden, 1997-2017.

Table 20: Distribution of serotypes and shigatoxin-subtypes in HUS (haemolytic uraemic syndrome) cases in 2017.

Serotype	Subtype of Shigatoxin			
	stx1a+stx2a	stx1c+stx2b	stx2a	stx2a+stx2c
O157:H7, clade 8	-	-	1	-
O157:H7, clade 8	-	-	-	5
O157:H7	1	-	-	-
O113:H4	-	2	-	-

Yersiniosis

BACKGROUND

The genus *Yersinia* has been associated with human and animal diseases for centuries. Two enteropathogenic species of the genus are zoonotic: *Yersinia enterocolitica* and *Yersinia pseudotuberculosis*. Pigs are considered the main reservoir of *Y. enterocolitica*. *Yersinia* bacteria are widespread in nature, among which nonpathogenic strains are most frequent. The most common human pathogenic bioserotype is *Y. enterocolitica* 4/O:3.

Wild animals, especially rodents and birds are considered the principal reservoir of *Y. pseudotuberculosis*. Both *Y. enterocolitica* and *Y. pseudotuberculosis* are frequently found in pig tonsils and porcine intestinal contents. Infections caused by *Y. enterocolitica* are thought to be foodborne and pigs are considered the main source of infection. The sources and vehicles of *Y. pseudotuberculosis* infections in humans remain unclear but infections caused by consumption of contaminated carrots and iceberg lettuce have been described in Finland. *Yersinia* bacteria are killed by heating (pasteurisation and cooking); however, they are able to grow at refrigerator temperature and can therefore grow in food that is kept cool. In addition, they can grow in vacuum and modified atmosphere packages.

Y. pseudotuberculosis was isolated from diseased guinea pigs in the 1880s. Mainly sporadic cases of yersiniosis were reported in humans until a large outbreak of *Y. enterocolitica* associated with chocolate milk occurred in the USA in 1976. The first food and waterborne outbreaks of *Y. pseudotuberculosis* were reported in 1980s.

During 2014-2015, a survey of the presence of *Y. enterocolitica* on Swedish finishing pig farms was completed. A herd level prevalence of 30.5% was found from 105 farms, and the identified bioserotypes were *ail*-gene positive 4/O:3 and 2/O:9, which are considered to be human pathogens. These results indicate that the Swedish domestic pig population has a similar *Y. enterocolitica* status to other pig producing countries in Europe. In the 2016 longitudinal study of 8 previously positive pig herds, all herds were identified as positive again for *Y. enterocolitica* in at least one of the samples collected indicating that *Yersinia* is persistent in positive pig herds.

DISEASE

Animals

Pigs are asymptomatic intestinal carriers of pathogenic *Y. enterocolitica* and *Y. pseudotuberculosis*. Infection with *Y. pseudotuberculosis* in other animals may vary from asymptomatic to severe mesenteric lymphadenitis and lead to septicæmia and death. *Y. enterocolitica* has occasionally been isolated from cats and dogs with diarrhoea.

Humans

Y. enterocolitica causes gastrointestinal symptoms in humans ranging from mild self-limiting diarrhoea to acute

mesenteric lymphadenitis, which might be difficult to differentiate from appendicitis. Prolonged carriage has been reported in children as well as in adults. In adults, gastrointestinal symptoms are usually mild and the clinical signs are dominated by the longterm sequelae including reactive arthritis, uveitis and glomerulonephritis which occasionally occurs.

LEGISLATION

Animals

Y. enterocolitica and *Y. pseudotuberculosis* are not notifiable in animals.

Food

Findings of *Y. enterocolitica* and *Y. pseudotuberculosis* in food are not notifiable.

Humans

Yersiniosis (isolation or identification by PCR of *Y. enterocolitica* (other than biotype 1A) or *Y. pseudotuberculosis* from a clinical sample) is notifiable according to the Communicable Disease Act (SFS 2004:168 with the amendments of SFS 2013:634). Diagnosis of yersiniosis by serology is not notifiable.

SURVEILLANCE

Animals

Surveillance for *Yersinia* was not conducted during 2017.

Food

There is no active surveillance in food, but complaints may lead to sampling and testing in conjunction with investigation of food-borne outbreaks.

Humans

The surveillance in humans is passive.

RESULTS

Animals

There are no results for surveillance of *Yersinia* in animals in 2017.

Food

In 2017, one sample was taken by a local authority. The sample was taken from meat as a part of an investigation of food poisoning and consumer complaints. The result of this investigation was negative for *Yersinia*.

Humans

Yersiniosis is mainly an infection of domestic origin. Of the 243 cases reported in 2017, 72% were infected in Sweden. Of the 57 cases infected abroad, eight cases were infected in each of Spain and Cuba and a further five in Greece. From other countries, only a few cases were reported from each.

During the years 2000-2004, the number of domestic cases of yersiniosis increased until 2004 when 594 domestic cases were reported (Figure 24). Since 2004, the total number of cases has decreased.

Similar to previous years, the incidence was highest among children younger than five years. The incidence was 6.0 (cases per 100,000 inhabitants) for infants and 6.4 for children 1-4 years old, compared to 2.4 for all cases.

The summer months May-August usually have a higher proportion of reported domestic cases compared with the rest of the year. However, deviations from that pattern occur, some years, where there have been peaks in January. In 2017, a peak was observed in November.

In 2017, the Public Health Agency was involved in one outbreak investigation of yersiniosis. The outbreak was located in the county of Örebro. Seventeen people fell ill after attending a conference. Insufficiently fried minced meat was suspected to be the source of infection but that could not be confirmed.

DISCUSSION

Enteric infection with *Yersinia* is one of the zoonoses with the highest number of reported domestic human cases in Sweden. However, since 2004, the number of reported cases has decreased not only in Sweden but also in entire EU. This decrease has occurred without any active interventions in the food chain.

In 2012, the case definition for notification of yersiniosis was revised and infection with *Y. enterocolitica* biotype 1A was excluded. Since 2013, notification was also extended to include both culture and PCR identification. The new case definition is thought to have had marginal effect on the decrease in the number of reported cases.

Yersiniosis in humans is considered foodborne. Outbreaks are rare, and most infections seem to be sporadic but under-reporting may be considerable. Approximately 75%

of the infected cases are domestic. Case-control studies suggest that consumption of pork products is a risk factor. Thus, good slaughter hygiene and good manufacturing practices in food processing are essential for control of *Yersinia*.

In 2013, a national 5-year strategy plan for human pathogenic *Y. enterocolitica* was published to help identify measures that should be prioritised to decrease human incidence of yersiniosis. The strategy was developed in co-operation between the Swedish Board of Agriculture, National Food Agency, the Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute. The knowledge raising surveillance activities conducted in 2014-2016 are a result of this strategy plan.

REFERENCES

Sannö A, Aspán A, Hestvik G, Jacobson M. Presence of *Salmonella* spp., *Yersinia enterocolitica*, *Yersinia pseudotuberculosis* and *Escherichia coli* O157:H7 in wild boars. *Epidemiol Infect.* 2014; 142(12):2542-2547.

Lindblad M, Lindmark H, Thisted Lambertz S, Lindqvist R. Microbiological baseline study of swine carcasses at Swedish slaughterhouses. *J Food Prot.* 2007;70(8):1790-7.

Boqvist S, Pettersson H, Svensson A, Andersson Y Sources of sporadic *Yersinia enterocolitica* infection in children in Sweden, 2004: a case-control study. *Epidemiol Infect.* 2009;137(6):897-905.

Swedish Board of Agriculture, National Food Agency, the Public Health Agency of Sweden, the National Board of Health and Welfare and the National Veterinary Institute. Infektion med *Yersinia enterocolitica* – ett nationellt strategidokument ISBN 978-91-7555-116-6 Artikelnr 2013-11-18

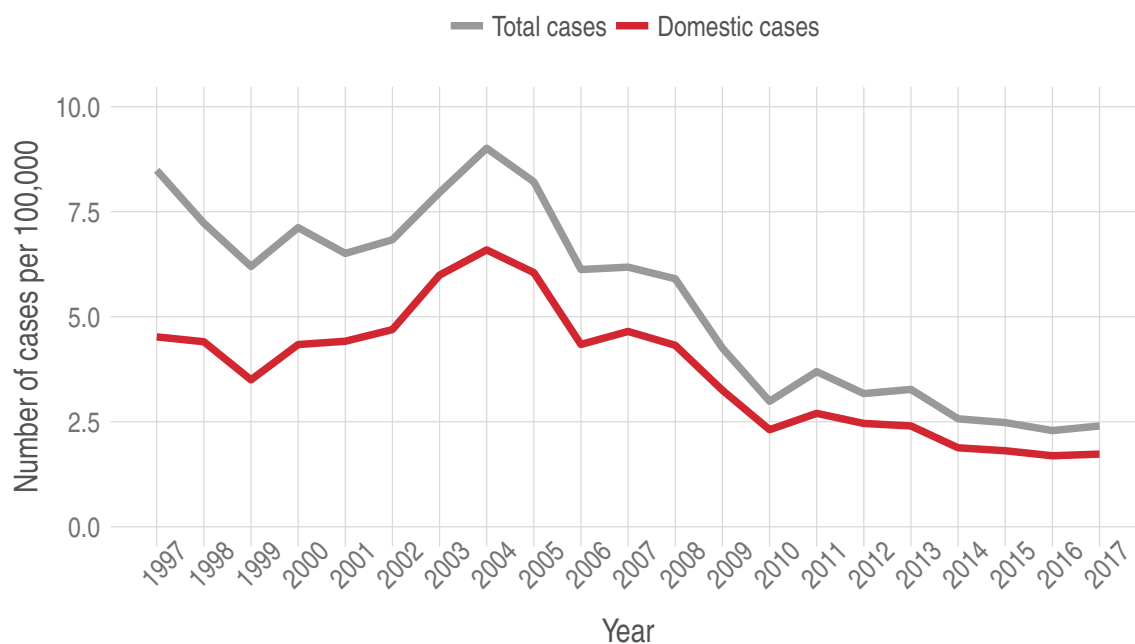


Figure 24: Notified incidence (per 100,000 inhabitants) of human cases of yersiniosis in Sweden, 1997-2017

Additional Surveillance 2017

Clinical surveillance



The District Veterinarians (Distriktsveterinärerna) under the Board of Agriculture, maintain veterinary preparedness 24/7 in large parts of the country including more remote areas. They play an important role for the national clinical surveillance capacity. Photo: Anders Karlsson

BACKGROUND

Clinical (also referred to as passive) surveillance is a fundamental component of disease surveillance for both endemic and epizootic diseases. Especially in the case of epizootic and emerging diseases, early detection is of utmost importance in order to prevent spread and reduce the impact. For diseases with severe and obvious clinical signs, such as foot-and-mouth disease, African swine fever and anthrax, early detection is most efficiently achieved through clinical surveillance. For other diseases the clinical surveillance is complementary to active surveillance activities. In this chapter clinical surveillance of epizootic diseases is described. Specifically, clinical surveillance approaches to foot-and-mouth disease, African swine fever and anthrax are described in more detail. Diseases with both passive and active surveillance components are presented in specific chapters.

DISEASES

African swine fever

African swine fever (ASF) is a contagious disease of domestic and wild pigs, in its acute form characterized by haemorrhagic fever and high case fatality rates. The disease is endemic in large parts of sub-Saharan Africa and on the Is-

land of Sardinia, Italy, and since 2007 also in Caucasus and parts of Eastern Europe. In the EU, ASF is now considered endemic in wild boar in large parts of Estonia, Latvia, Lithuania and Poland, with sporadic outbreaks reported also in domestic pigs. In 2017, the disease spread further and affected the wild boar population of parts of the Czech Republic and caused a number of outbreaks in domestic pigs in Romania. The risk for further spread within EU is considered high. Because of the typically acute clinical course associated with the strains of ASF virus currently circulating in domestic pigs in Eastern Europe, early detection is most efficiently achieved through clinical surveillance.

Anthrax

Anthrax is a serious zoonotic disease that may affect most mammals, especially herbivores. It is caused by *Bacillus anthracis*, a spore forming bacterium. The spores are highly resistant and may survive in the soil for decades. The disease was common in Swedish livestock in the beginning of the 20th century, with a significant reduction in frequency of outbreaks during the latter part of the century. During the last decade, however, the disease has re-emerged in the country with reported outbreaks in 2008, 2011, 2013 and 2016. The disease is endemic in most countries of the world.

Foot-and-mouth disease

Foot-and-mouth disease (FMD) is a highly contagious disease of cloven-hoofed animals such as pigs, cattle, sheep and goats. The case fatality rate in FMD is low, but morbidity very high and convalescence is extended, which makes this disease especially important in countries previously free from the disease. FMD is endemic in many parts of the world, but since 2011 the disease is absent in Europe. However, the major FMD epidemics that affected several European countries during the last decade demonstrated that the continent is continuously at risk for FMD virus introduction, and that early detection is crucial.

LEGISLATION

Clinical suspicions of epizootic diseases must be notified to the Swedish Board of Agriculture in accordance with the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). This obligation applies to animal keepers, official and private veterinarians, veterinary laboratories, and other relevant stakeholders. Suspicions are investigated after consultation with disease experts at the National Veterinary Institute and following notification to the Swedish Board of Agriculture.

SURVEILLANCE

Every year, hundreds of suspicions of serious infectious diseases are reported by field veterinarians, animal owners or private veterinary pathologists to the experts at the National Veterinary Institute. Many of these suspicions can be ruled out already based on anamnesis and initial clinical investigation, whereas others require notification to the Swedish Board of Agriculture and further investigation including sampling of sick or dead animals, with movement restrictions imposed on the farms during the investigation. Also, in cases in which an epizootic disease is not primarily suspected, but where it cannot be excluded based on clinical investigation, samples can be submitted for laboratory investigation to exclude a diagnosis. This can only be done after discussions with experts at the National Veterinary Institute and in consultation with the Swedish Board of Agriculture. This approach serves to reduce the threshold for submitting samples for analysis of notifiable diseases, and thereby increasing the sensitivity of the system. The Swedish Board of Agriculture covers all costs for veterinary visits, transports, and diagnostic analyses related to the investigation.

African swine fever

Reported cases of increased mortality or serious morbidity, with clinical signs such as haemorrhagic disorders or reproductive failures in pigs are considered suspicions of ASF until ruled out through further clinical investigation, with or without sampling of affected animals. Due to clinical similarity, samples from domestic pigs collected for ASF are also analysed for CSF. This strategy is strongly recommended by the EU.

Given the current situation in Eastern Europe as regards ASF in wild boar, the clinical surveillance is enhanced, and Swedish hunters are encouraged to report all findings of dead

wild boar. If possible, carcasses or samples are taken in and investigated to rule out ASF as the cause of death (see also specific chapter on infectious diseases in wild boars).

Anthrax

Cases with a history of sudden deaths in one or more animals on the premise are considered suspicions of anthrax. Clinical signs such as fever, bloody discharges from the nose, mouth, anus or vagina, uncoagulated blood, subcutaneous oedematous swellings and lack of rigor mortis, as well as recent site disturbances (dredging or digging) strengthens the suspicion. In addition, cases with gross pathological lesions suggestive of anthrax found at post mortem are considered suspicions of anthrax.

During 2017, the clinical surveillance in the area affected by anthrax during 2016 was enhanced. All cattle, sheep and wild ruminants found dead in the area, with no obvious cause of death, were investigated to rule out anthrax.

Foot-and-mouth disease

Reported cases of disease in cattle, pigs, sheep or goats which presents with vesicular lesions of the feet, buccal mucosa or mammary glands, are considered suspicions of FMD until ruled out through further clinical investigation, with or without sampling of affected animals.

RESULTS

The suspicions of epizootic diseases that were reported and further investigated based on sampling of sick or dead animals in 2017 are compiled in Table 21.

Two clinical suspicions of ASF in domestic pigs were investigated. Samples were collected and sent to the National Veterinary Institute for PCR analyses with negative results. Samples were also analysed for CSF with negative results. Sixteen samples from wild boar found dead were also analysed for ASF with negative results.

Twenty clinical suspicions of anthrax in cattle, one in sheep, one in fallow deer and one in a dog were reported and investigated. In addition, four suspicions in cattle and one in sheep, with pathological lesions suggestive of anthrax, were raised at post mortem, and three cattle, two roe deer and one moose found dead without further clinical signs were investigated as part of the enhanced clinical surveillance in the area affected by anthrax during 2016. All suspected cases were bled or sampled, and samples were sent to the National Veterinary Institute for examination using multiplex RT-PCR. Carcasses were left on the premises, covered to prevent any direct contact with the carcass and possibly contaminated surfaces. In none of the cases, anthrax could be confirmed.

No clinical suspicion of FMD was investigated during 2017.

DISCUSSION

Clinical surveillance constitutes a fundamental part of the animal disease surveillance system and is particularly important as regards early detection of epizootic and/or emerging diseases. This surveillance component depends on the

level of cooperation and trust between the relevant stakeholders in the field (including animal keepers and official and private veterinarians, among others) and the central veterinary authorities, but also on the level of knowledge and awareness among all involved. In Sweden, cooperation between the relevant stakeholders is long-standing at a high level, and the level of knowledge and awareness as regards epizootic diseases as well as the obligation to report suspicions thereof is considered good. Based on this and given the relatively high numbers of suspicions of epizootic diseases investigated each year, the performance of the clinical surveillance is considered adequate. However, a systematic evaluation of this performance has never been carried out. Therefore, to get a better understanding of the coverage and representativeness of the clinical surveillance and thus the performance, and to identify gaps, an evaluation of the clinical surveillance using data from the last ten years will be carried out during 2018.

Given the current situation in Eastern Europe as regards ASF in wild boar with a continuous albeit slow spread westwards, the risk for introduction also to Swedish wild boar is considered increased. In case of introduction, early detection is crucial in order to prevent a longer-term establishment of the disease. The timeliness of detection depends, to a large extent, on the capacity of Swedish hunters to detect,

and their willingness to report, findings of dead wild boar. Despite information and awareness campaigns carried out in this regard during the last few years, targeting the hunting community, and in spite of a well-established network of hunters, which is fundamental for the general surveillance for diseases in wildlife (also described in the specific chapter on Post mortem examinations in wildlife), less than 20 wild boar found dead are investigated annually as part of the surveillance for ASF. Given the population size of Swedish wild boar (estimated at 250 000) and the expected number of wild boar that would die from other causes than hunting, and thus constitute the potential sampling frame for the surveillance, this number is not adequate. Further measures will therefore be taken during 2018 to increase the numbers.

REFERENCES

EFSA AHAW Panel (EFSA Panel on Animal Health and Welfare), 2015. Scientific opinion on African swine fever. *EFSA Journal* 2015;13(7):4163, 92 pp. doi:10.2903/j.efsa.2015.4163

DG(SANCO) 2013-6780. Report from an audit carried out in Sweden on Animal health - disease contingency plans; protection during depopulation for disease control, pp 14-17. http://ec.europa.eu/food/audits-analysis/act_get-PDF.cfm?PDF_ID=11146

Table 21: Number of suspicions of epizootic diseases reported through the clinical surveillance system during 2017 and investigated by experts at the National Veterinary Institute after notification to the Swedish Board of Agriculture.

Disease	Investigated ^A	Confirmed
African swine fever	18 ^B	0
Anthrax	34	0
Aujesky's disease	0	0
Avian influenza	28 ^C	4 ^C
Bluetongue	2	0
BSE	2	0
CWD	1	0
Classical swine fever	3	0
FMD	0	0
Lumpy skin disease	0	0
Newcastle disease	29 ^C	3 ^C
Paratuberculosis	5	0
PRRS	2	0
Rabies	6	0
Tuberculosis	9	0
West Nile fever	2	0

^A In many cases clinical suspicions were investigated for several diseases with similar clinical picture (e.g. ASF/CSF/PRRS, AI/ND)

^B Includes 16 wild boars found dead also described in the specific chapter on infectious diseases in wild boar

^C Does not include surveillance of, or cases in, wild birds

Poultry Health Control Programme

BACKGROUND

The aim of the Poultry Health Control Programme is to document freedom from the included diseases, to prevent the introduction and further spread of diseases and to allow trade from the participating companies.

The Poultry Health Control Programme is based on provisions (SJVFS 2010:58) issued by the Swedish Board of Agriculture. The programme is mandatory for all hatcheries producing more than 50,000 day-old chicks per year and all breeding establishments (grandparent and parent flocks of layers, broilers and turkeys) delivering hatching eggs to these hatcheries. In addition to serological sampling for several infectious diseases, the programme consists of biosecurity requirements, standards for poultry houses, management and clinical surveillance.

LEGISLATION AND DISEASES

All diseases covered by the programme, except for *Mycoplasma synoviae*, are notifiable according to provisions issued by the Swedish Board of Agriculture (SJVFS 2013:23). The diseases included in the programme during 2017 are briefly described below.

Fowl typhoid and pullorum disease

Fowl typhoid and pullorum disease are two poultry diseases caused by *Salmonella enterica* subspecies *enterica* serovar Gallinarum biovar Gallinarum (*Salmonella* Gallinarum, fowl typhoid) and biovar Pullorum (*Salmonella* Pullorum, pullorum disease) respectively. These two biovars of the same serovar are specially adapted to poultry and vertical transmission (from the hen to the chicken via the egg) is an important feature in addition to the common horizontal spread. Pullorum disease mainly affects foetuses and chickens up to 3 weeks of age while *Salmonella* Gallinarum commonly infects and causes disease (diarrhoea, inappetence, production losses and mortality) in older birds. Both biovars are included in the Swedish zoonosis legislation (SJVFS 2004:2) as well as in the European legislation on trade in poultry and hatching eggs (Council Directive 2009/158/EC). The diseases were eradicated from the Swedish commercial poultry population in the beginning of the 1960's. A single case of fowl typhoid (*Salmonella* Gallinarum) was detected in a backyard flock in 1984 but has not been diagnosed since then. *Salmonella* Pullorum is however present in the Swedish backyard poultry population; the last outbreak was diagnosed in 2017.

Mycoplasma gallisepticum, *Mycoplasma synoviae* and *Mycoplasma meleagridis*

M. gallisepticum, *M. synoviae* and *M. meleagridis* are important poultry pathogens. However, *M. meleagridis* is only pathogenic for turkeys. These three mycoplasmas can spread both horizontally and vertically. They mainly cause respiratory disease and egg production losses. *M. gallisepticum* and

M. synoviae may also cause arthritis and are present in the backyard poultry population in Sweden. Testing of breeding flocks for *M. gallisepticum* and *M. meleagridis* (only turkey flocks) is included in the European legislation on trade in poultry and hatching eggs (Council Directive 2009/158/EC). Due to its potential to cause disease and production losses, testing for *M. synoviae* was included in the programme between 1995 and 2010. During a revision of the programme the agent was excluded but is since 1 June 2015 included again. In 2016, testing for *M. synoviae* was further intensified.

Avian avulavirus 1

Avian avulavirus 1 (previously paramyxovirus type 1) may cause outbreaks of Newcastle disease, with egg production losses, increased mortality, nervous signs and respiratory disease; the severity of the disease may vary. The virus is transmitted through direct and indirect contacts with infected birds and for shorter distances also with the wind. Wild birds are an important reservoir. Since 1995, sixteen outbreaks of Newcastle Disease have occurred in Sweden. The disease is included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments). Since all outbreaks have been successfully eradicated, Sweden has a status of Newcastle free country without vaccination according to Commission Decision 95/98/EEC.

Egg drop syndrome

Egg drop syndrome. The virus is a naturally occurring adenovirus in waterfowl (including the wild population) in which it does not cause any clinical disease. In chickens, the clinical signs are only seen during the production period as decreased egg production in an otherwise clinically healthy flock. The virus is able to spread both vertically and horizontally. The Swedish poultry breeding population is free from the disease.

SURVEILLANCE

Serological screening within the programme is administered by the National Veterinary Institute and financed by the Swedish Board of Agriculture and the participating companies. In 2017, seven breeding companies participated in the programme; five broiler-, two laying hen- and one turkey breeding company (one company with both broiler- and laying hen parent flocks). In accordance with the provisions, sixty blood samples were taken from the breeding flocks included in the programme, once during the rearing period and several times during the production period. The blood samples were sent by mail to the National Veterinary Institute where serological tests were performed. The sampling and testing schemes are presented in tables 22 and 23.

RESULTS

Table 24 gives an overview of all samples taken in breeding flocks of chickens and turkeys, and the laboratory methods used, during 2017. All analysed samples tested negative for *M. gallisepticum*, *M. meleagridis* and avian avulavirus 1.

Antibodies to *M. synoviae* were detected in seven chicken flocks (five parent flocks and two grandparent flocks). One of the flocks was sampled at 60 weeks of age and no additional samples were available from this flock. In two parent and one grandparent flock new samples obtained two weeks later were also positive for *M. synoviae*. For the other three flocks the positive samples were considered as unspecific serological reactions after testing new samples from these flocks.

Seven chicken parent flocks were further investigated due to a few positive samples for egg drop syndrome. In addition, two chicken parent flocks were investigated due to a few positive samples for *Salmonella Gallinarum/Salmonella Pullorum*. No clinical signs were seen in these flocks and after testing new samples from these flocks, the previous positive samples were considered as unspecific serological reactions.

DISCUSSION

In conclusion, the results from the serological screening in the Poultry Health Control Programme in 2017 support the status of freedom from several important infectious diseases in the Swedish breeding poultry population. However, the findings of *M. synoviae* antibodies in chicken breeding flocks and possible implications on animal health and production both in breeding and offspring flocks need to be further considered. *M. synoviae* may spread both horizontally and vertically (from the hen to the chicken via the egg), hence infection in breeders may have consequences for the next generation as well. Infection may result in respiratory signs, articular disease and egg production losses. In addition, egg shell abnormalities associated with infection with *M. synoviae* have been reported.

Finally, the clinical surveillance of the poultry breeding population is also of utmost importance.

Table 22: Sampling schedule for chicken grandparent and parent flocks. Number of blood samples tested at different weeks of age.

Agent	Age in weeks				
	16	24	36	48	60
<i>S. Pullorum/ S. Gallinarum</i>	-	60	-	-	-
<i>Mycoplasma gallisepticum</i>	60	60	60	60	60
<i>Mycoplasma synoviae</i>	60	60	60	60	60
Avian avulavirus 1	-	-	-	60	-
Egg drop syndrome-virus	-	30	-	-	-

Table 23: Sampling schedule for turkey parent flocks. Number of blood samples tested at different weeks of age.

Agent	Age in weeks			
	20	32	44	56
<i>S. Pullorum/ S. Gallinarum</i>	-	60	-	-
<i>Mycoplasma gallisepticum</i>	60	60	60	60
<i>Mycoplasma meleagridis</i>	60	60	60	60
<i>Mycoplasma synoviae</i>	60	60	60	60
Avian avulavirus 1	-	-	-	60

Table 24: Number of sampling occasions for grandparent (GP) and parent (P) flocks of chickens and turkeys and total number of samples tested during 2017.

Agent	No. of sampling occasions			No. of samples			Method
	Chickens		Turkeys	Chickens		Turkeys	
	GP	P	P	GP	P	P	
<i>S. Pullorum /S. Gallinarum</i>	16	90	4	960	5,400	240	Serum plate agglutination test, antigen, ID.Vet
<i>Mycoplasma gallisepticum / Mycoplasma synoviae</i>	79	445	16	4,740	26,700	960	<i>Mycoplasma gallisepticum/synoviae</i> Antibody Test Kit, ID.Vet
<i>Mycoplasma meleagridis</i>	0	0	16	0	0	960	Serum plate agglutination test, antigen, ID.Vet
Avian avulavirus 1	16	85	4	960	5,100	240	NDV screen competition ELISA, ID.Vet
Egg drop Syndrome-virus	16	90	0	480	2,700	0	Antibody haemagglutination inhibition test, antigen, in-house (Until May 2017. From May 2017 antigen from GD Animal Health)

Infectious diseases in wild boars

BACKGROUND

Wild boars are susceptible to contagious diseases that affect domestic pigs and therefore they have a potential role in spreading diseases to and from domestic pigs. This is particularly the case for classical swine fever which has been transmitted between wild boars and domestic pigs in several European countries. Also, the ongoing spread of African swine fever (ASF) in Eastern Europe and within the EU involves wild boar, and the direct and indirect contacts between domestic pigs and wild boar in these areas hamper the control and management of the disease. The Swedish wild boar population is increasing rapidly and is presently estimated at 250,000 animals before the reproductive season of 2018. The northern border of the wild boar habitat is extending and has at present passed the level of the river Dalälven. Since the year 2000, hunted wild boars from different parts of the country have been blood sampled yearly for surveillance purposes. The samples have been sent to the National Veterinary Institute for analysis for antibodies to infectious agents that are of importance for the domestic pig production. Due to the worrying situation regarding ASF in Eastern Europe and within EU, passive surveillance for the disease in wild boars found dead has been included in the surveillance programme since 2013.

LEGISLATION

The infections investigated in the wild boar surveillance programme of 2017 are all included in the Swedish Act of Epizootic diseases (SFS 1999:657 with amendments) and are notifiable on suspicion. If any of them are suspected or confirmed, measures will be taken to control the disease and to prevent further spread.

SURVEILLANCE

Passive surveillance

Organ samples from, or whole carcasses of, wild boar found dead were submitted for post mortem examination at the National Veterinary Institute. All were subjected to African swine fever virus genome analysis irrespective of pathological lesions.

All wild boar with clinical or post mortem signs leading to suspicion of a disease included in the Act of Epizootic Diseases are sampled and investigated.

Active surveillance

Blood samples from hunted wild boars were used for active surveillance of antibodies to Aujeszky's disease virus, classical swine fever virus and *Brucella suis*. The samples were collected voluntarily by hunters recruited through information on the webpage of the National Veterinary Institute, in hunter's magazines and through using informal networks including information meetings. The surveillance was designed to detect the investigated diseases at 1% prevalence with 99% confidence level. To reach this level of confidence

500 samples were needed. The samples were analysed using the serological methods described in the respective disease chapters in this report.

RESULTS

Passive surveillance

One clinical suspicion of classical or African swine fever in a wild boar was investigated during 2017 due to post mortem findings including severe circulatory disorder with organ hemorrhages. Following investigation, including sampling, the wild boar could be declared negative for CSF and ASF.

Sixteen wild boars found dead were examined for African swine fever virus genome and all analyses were negative. The geographical distribution of the sampled dead wild boars is visualised in Figure 25. Additional post mortem findings in these wild boars are reported in the chapter "Post mortem examinations in wildlife" in this report.

Active surveillance

In 2017, 136 samples were collected from hunted wild boars and analysed for antibodies to Aujeszky's disease virus and classical swine fever virus. All samples were negative for antibodies to these two pathogens. Antibodies to *Brucella suis* were analysed in 100 of the samples. In three of the samples the results were inconclusive due to hemolysis, the remaining samples were negative. The geographical distribution of sampled wild boars was roughly correlated to the distribution and density of the Swedish wild boar population (Figure 25). The goal of 500 samples was not met, but the surveillance evidence was sufficient to indicate that the prevalence of the investigated diseases in the wildboar population was <2% with a certainty of 98%.

DISCUSSION

The Swedish wild boar population is growing and the boundary of the population is moving north. In areas where wild boars are already present, the population is also becoming more dense, which increases the risk of direct and indirect contact between wild boars and domestic pigs. The area in Sweden populated by wild boars is surrounded by the sea. Therefore, there is no risk of wild boars migrating into Sweden. Instead, the role of the wild boar in disease spread might be to pick up infectious agents introduced into Sweden by other routes. It is possible that wild boars could gain access to infected meat or other infected animal products for example in garbage or following indirect spread by other means from people, vehicles or equipment. All diseases monitored in 2017 are or have recently been present in neighbouring countries or in close proximity to Sweden. The unfavourable development of the African swine fever situation in Russia, Eastern Europe and within EU is of special concern and calls for efficient approaches to early detection of disease in the wild boar population.

Infectious diseases and parasites in honeybees

BACKGROUND

Every beekeeper in Sweden has the responsibility to prevent the spread of bee diseases and are obligated to register the location of their apiaries to the County Administrative Boards (CABs). There is no national bee register, but the number of apiaries and colonies must be reported by the beekeepers and recorded by the respective CABs. The health of honeybees is controlled by local bee inspectors appointed and given the responsibility over local inspection districts, by seven of the CABs. The country is divided into approximately 500 bee districts and the bee inspectors are responsible for the actual control of the apiaries located in the district. The Swedish Board of Agriculture (SBA), is the central authority for the control of bee diseases. The SBA is responsible for the regulations and guidelines for management and control of the honeybee diseases regulated in SJVFS 1992:38 including American foulbrood and *Varroa* mite infestation. There are regulations for the import and export of bees, bee-related products and beekeeping equipment to prevent contagious bee diseases from entering the country and reduce further spread. Applications for permits to import bees must be made to the SBA at each point of entry. The conditions for import are the same in all EU Member States. If bees are introduced without permission, it is considered to be a violation of the law on smuggling of goods.

DISEASES AND LEGISLATION

All veterinarians, as well as laboratories analyzing samples from honeybee colonies, are obligated to notify the SBA if American or European foulbrood, tracheal mite infestation/ acariosis (*Acarapis woodi*), *Varroa mite* infestation/varroosis (*Varroa destructor*), *Tropilaelaps* mite infestation (*Tropilaelaps* spp) or the small hive beetle (*Aethina tumida*) are found. This is regulated in the law of bee diseases (1974:211), the regulation of bee diseases (1974:212) and the SBA's regulation on the control of American foulbrood, AFB, and *Varroa* mites (SJVFS 1992:38). A beekeeper needs a permit issued by a bee inspector to move the bees out of a parish which has been declared infected with AFB by the SBA. Visual inspection of clinical symptoms of AFB and *Varroa* mites are carried out at the same time. In case of an outbreak of AFB or if *Varroa* mites are reported from an area or region where it has not been present earlier, the bee inspector notifies the CAB, which in turn notifies the SBA. The SBA then declares the parish in which the apiary is situated infected/infested. Bee inspectors can send samples of diseased brood, larvae or pupae to the National Reference Laboratory for Bee Health, NRL, at the Swedish University of Agricultural Sciences, SLU, where the diagnosis of honeybee diseases included in the legislation is performed on behalf of the SBA. This is a yearly, laboratory-based, passive surveillance of honeybee diseases.

American foulbrood

American foulbrood (AFB) of honeybees is a contagious bacterial disease caused by the spore-forming bacterium, *Paenibacillus larvae*. The disease is widely distributed across the world causing great economic losses in apiculture. The disease is classified as an epizootic and is notifiable in most countries. As the name indicates, the disease only affects the larval stages of honeybees. AFB is highly infectious, lethal to the individual honeybee larva and potentially lethal to infected colonies. AFB is a statutory notifiable disease in the European Union in the framework of trade and export requirements (Directive 92/65/EEC). In many European countries, Sweden included, the disease is controlled through burning of symptomatic colonies and the use of beekeeping management techniques to avoid the spread of the infectious agent to uninfected hives. Current legislation do not allow European beekeepers to use antibiotics since there is no maximum residue limit (MRL) set for the antibiotic substances used to control AFB (oxytetracycline and tylosine). No antibiotics can be legally used since there is a zero tolerance limit to antibiotic residues in honey. Sweden has strict rules for movement of bees, apiculture equipment and honeybee products from areas where AFB has been reported. The bee inspectors burn any colony with clinical signs of American foulbrood and inspect all other apiaries within a 3-km radius from the infected apiary.

European foulbrood

European foulbrood (EFB), is a serious disease of honeybees caused by the bacterium *Melissococcus plutonius*. EFB affects mainly young honeybee larvae usually between 4 and 5 days old. A massive loss of brood resulting from severe infection, weakens the colony and can lead to its collapse. Regional variations in disease burden have been reported and recent decades have seen dramatic increases in the incidence of EFB in parts of Europe. Large disease outbreaks have been identified in areas previously thought to be disease free, such as Norway.

Tracheal mite infestation (acariosis)

The honeybee tracheal mite *Acarapis woodi* is an internal parasite of the respiratory system of adult honeybees. The tracheal mite has spread through global beekeeping exchanges and has been reported from all European countries except Sweden. It is therefore regulated in Swedish legislation.

Varroa mite infestation (varroosis) and associated virus infections

The honeybee parasitic mite, *Varroa destructor*, was originally confined to the Eastern honeybee, *Apis cerana*, where a stable host-parasite relationship exists due to a long period

of coevolution. After a shift in the last century, from the native host to the Western honeybee, *Apis mellifera*, the mite dispersed around the globe and is currently considered the greatest threat to honeybees and apiculture worldwide. The mite was reported in Europe in the late 1970s, was found on Gotland in 1989 and in the county of Skåne, in 1991. The regulations from the SBA has since been aimed at limiting the spread of the *Varroa* mite in the country. *Varroa* mites have so far not been reported from the northern half of Sweden (Västerbotten, Jämtland, as well as most of Västernorrland, Norrbotten, Dalarna and Gävleborg) except close to the Finnish border. The rest of the country has a varying level of infestation.

Honeybee viruses such as *Deformed wing virus* (DWV) and *Acute bee paralysis virus* (ABPV) are associated with the *Varroa* mite and DWV is the actual cause of the clinical signs observed in connection with high *Varroa* numbers. The mite acts as a biological vector for both viruses.

Tropilaelaps mite infestation

Mites of the genus *Tropilaelaps* affect both developing brood and adult bees mainly in Asia. *Tropilaelaps mercedesae* and *Tropilaelaps clareae* are the only species found reproducing on brood of *A. mellifera*. The distribution of the emerging mite is currently restricted to tropical and subtropical regions of Asia and Africa but is regulated within the EU and honeybee queen imports are visually inspected for the occurrence *Tropilaelaps* mites. The mite has not been reported from Europe.

The small hive beetle

The small hive beetle, *Aethina tumida*, is endemic to sub-Saharan Africa, but has spread to many other locations, including North America, Australia, the Philippines and was recently reported in Italy. The small hive beetle can be a destructive pest of honeybee colonies, causing damage to comb, stored honey and pollen. The primary damage to colonies and stored honey is caused through the activity of the larvae tunneling through honey combs, feeding and defecating, causing discolouration and fermentation of the honey. If a beetle infestation is sufficiently heavy, they may cause bees to abandon their hive.

SURVEILLANCE

Passive surveillance

Passive disease surveillance of honeybee diseases and parasites is done through diagnostics related to disease outbreaks and reported by the NRL to the SBA yearly (Table 25).

Enhanced passive surveillance by visual inspection of clinical symptoms of AFB is done when a beekeeper needs a permit issued by the bee inspector in order to move the bees out of a parish which is declared infected by the SBA. This is reported by the bee inspectors to the CABs (Figure 26).

Active surveillance

Active surveillance for the occurrence of the tracheal mite, *A. woodi* completed by the SBA in 1993 and 2010-11. To date, *A. woodi* has not been detected in Sweden.

In 2016, a base-line study of the prevalence of *Varroa* mites, the viruses DWV, ABPV, the bacteria *M. plutonius* and *P. larvae* was completed by the NRL for bee health in collaboration with the National Veterinary Institute (SVA). Samples of adult bees were collected from honeybee colonies in 382 randomly selected apiaries distributed throughout the country. The goal was to sample 385 apiaries (≤ 5 colonies per apiary). Samples were collected during the 2016 beekeeping season and the samples were sent to the NRL at SLU for analysis. The samples were examined macroscopically for *Varroa* mites and analyzed by molecular methods (RT-qPCR for ABPV and CBPV and qPCR for *M. plutonius*) and by microbial culturing (*P. larvae*).

Paenibacillus larvae, the causative agent of AFB was detected in 6% of all sampled apiaries (Figure 30).

Melissococcus plutonius, the causative agent of EFB, was detected in 2 apiaries in Östergötland (Figure 29).

Varroa mites was detected in 53% of the sampled apiaries and in all counties except Jämtlands, Västerbottens and Norrbottens county (Figure 31) which reinforces earlier observations and reports from bee inspectors. DWV was detected in 30% of the investigated apiaries and in all counties except Jämtlands, Västerbottens, Norrbottens and Västernorrlands counties and ABPV was detected in one apiary in Skåne and one apiary on Gotland (Figures 28, 27).

DISCUSSION

The reporting of AFB incidences, thus far, has been based on the information that the bee inspectors report to the CABs based on visual observation of clinical signs (Figure 26). In the 2016 base-line study, microbiological cultivation of *P. larvae* from samples of adult bees was used. This method was previously shown to be well correlated with clinical signs of disease. Only young larvae develop clinical signs, but adult bees are carriers of the bacterium. In the base-line study, we investigated the subclinical presence of the bacterium in a selection of the country's apiaries. The bacteria could not be detected in the majority of the examined apiaries (94%), which is an important argument in the ongoing discussion between beekeepers and the regulatory authorities about simplifying the regulations on the management and movement of bee colonies in the country. It is important to highlight that there are many apiaries in areas free from this pathogen and that this status is worth preserving.

The bacteria *Melissococcus plutonius* that causes EFB was detected in only two apiaries in Östergötland. Historically, EFB has been considered to be less serious than AFB but reports of more aggressive forms of the bacterium and more serious disease outbreaks have become increasingly common in recent years. A few years ago, Norway had an outbreak of EFB that led to extensive investigations and sanitation which highlights the value in continued monitoring for this disease to prevent outbreaks in Sweden.

After the introduction of the *Varroa* mite in Sweden, the SBA introduced regulations to prevent or at least slow down the spread of the mite in the country. This has not completely prevented the spread but led to the fact that we still have apiaries in the northern parts of the country that are

apparently free from *Varroa* mites. This can be further confirmed by the results of this survey which reinforces earlier observations and reports from bee inspectors. In Norrbotten, however, there have been findings of *Varroa* mites in Haparanda, Övertorneå, Kalix and Luleå, which may be a result of introduction of the disease from northern Finland where the mite is present. The *Varroa* mite acts as a biological vector for viruses like DWV and ABPV. In the survey, DWV was detected in all counties except Västerbotten, Jämtland, Norrbotten and Västernorrland. The spread of DWV coincides with the presence of *Varroa* and follows the spread of the mite. In Västernorrland, the mite has recently been introduced and the virus infection has not yet been spread. Another virus associated with *Varroa* is ABPV which was detected only in a single apiary on Gotland and one in Skåne. It is possible that the virus is so virulent that it kills its host faster than it can effectively spread. This could explain why the less virulent virus DWV has such a high incidence while ABPV is rare. It is also worth noting that

the counties where ABPV is detected, Gotland and Skåne, are the counties where *Varroa* was first introduced into the country. At that time (late 80s, early 90s), ABPV was the most dominant *Varroa*-associated virus in Europe before being surpassed by DWV. Perhaps it is that ABPV was established in parts of the honeybee population in these counties before DWV became more widely spread.

The lack of a national bee register makes it difficult to organize and collect samples of bees. There has been resistance to a central bee register from some beekeepers, but an initiative has now been taken by the CABs and the SBA to establish a register. This would facilitate disease surveillance in the future and is a prerequisite for being able to follow the contingency plans for certain exotic pests in honeybees. In summary, the health situation for Swedish honeybees is good and we should continue to promote regular disease monitoring as a basis for legislation and prevention measures regarding honeybee health.

Table 25: Number of samples analysed in the Swedish honeybee population during 2017. Testing conducted based mainly on clinical suspicions.

Disease/parasite	No. of tested beekeeping operations	No. of infected/infested operations	No. of tested bee hives	No. of infected/infested bee hives
AFB	95	31	168	51
EFB	8	0	8	0
<i>A. woodi</i>	13	0	47	0
<i>Varroa</i> mites	34	29	87	61
<i>Tropilaelaps</i>	0	0	0	0
<i>A. tumida</i>	2	0	2	0

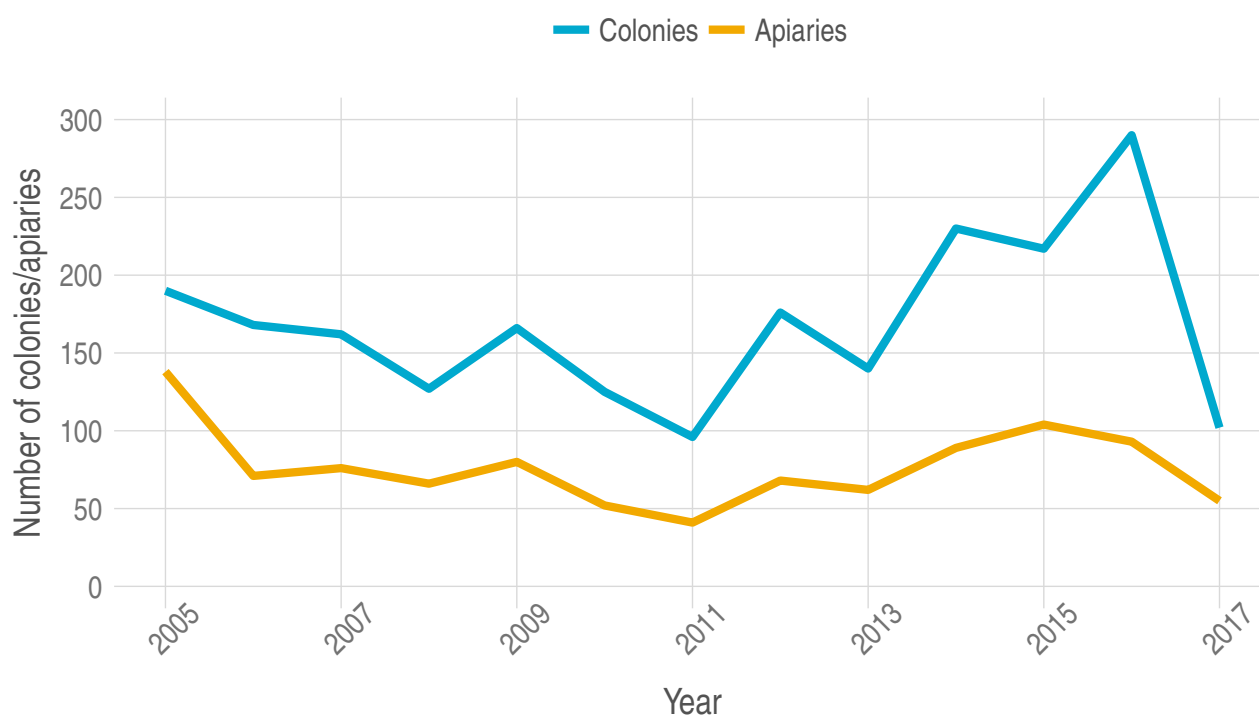


Figure 26: Number of new cases of American foulbrood during 2005-2017 in bee colonies and apiaries based on reports from bee inspectors to the County Administrative Boards

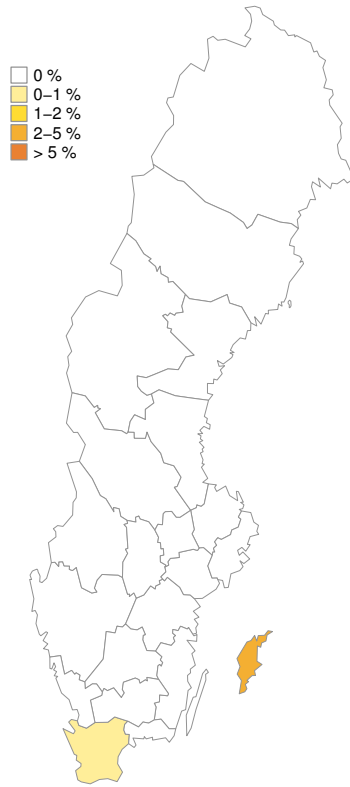


Figure 27: Prevalence of ABPV in 2016

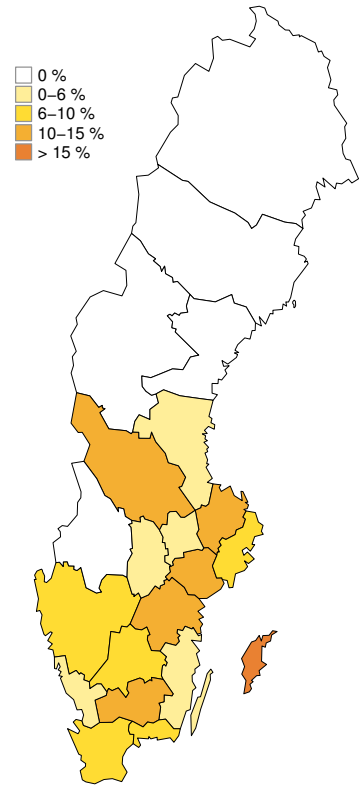


Figure 28: Prevalence of DWV in 2016

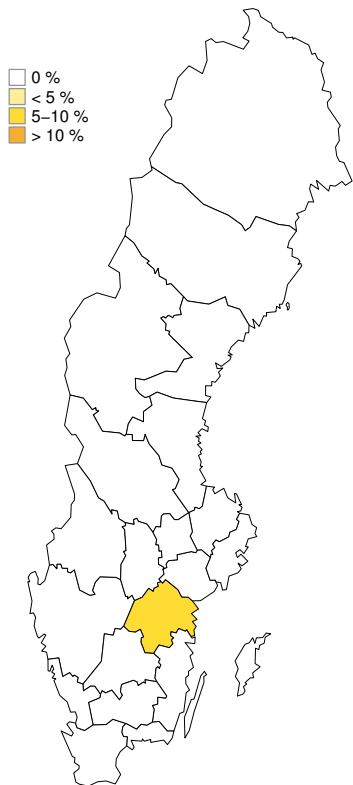


Figure 29: Prevalence of *M. plutonius* in 2016

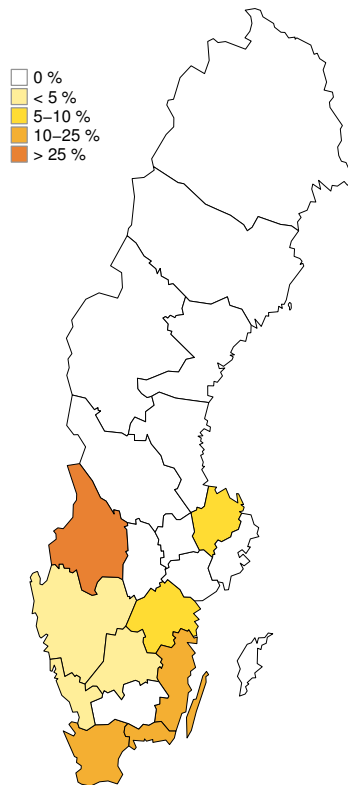


Figure 30: Prevalence of *P. larvae* in 2016

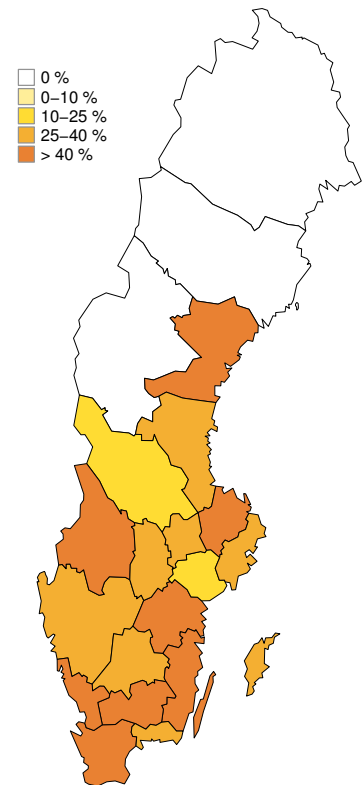


Figure 31: Prevalence of *Varroa destructor* in 2016

Infectious diseases in fish, crustaceans and molluscs



European/flat oyster, *Ostrea edulis*, top shell half to the left, bottom shell half to the right. The bottom shell half is attached to a *Littorina* shell.
Photo: Anders Alfjorden

BACKGROUND

All registered aquaculture farming sites are obligated to participate in the Official Health Control Programme, regulated in accordance with SJVFS 2014:4, and by Council Directive 2006/88/EG. Sweden has a very healthy aquaculture as well as wild populations of fish and shellfish. None of the serious diseases that occur throughout Europe are prevalent in Sweden. A restrictive approach to imports of live fish for restocking/farming, an early introduction of health control in farms and the presence of hydroelectric dams in most Swedish rivers (acting as migration barriers for feral fish from the coastal zone) all contribute to maintaining this health status. The presence of dams also results in a different health status at the coast compared to the more disease free continental zone. To maintain this situation, all transport of live fish from the coast to the inland zone is forbidden and Sweden has a national restocking programme for salmonids to compensate for the lack of natural migration.

LEGISLATION AND DISEASES

All Swedish fish farms have participated in surveillance for the diseases mentioned below since the late 1980's in accordance with EU Directives 2001/183 (now replaced by 2015/1554) and 2006/88. Sweden has an approved disease free zone status (2002/308/EC) for Viral haemorrhagic septicaemia (VHS) and Infectious haematopoietic necrosis

(IHN) (2008/427/EG). Additional guarantees are in place for the whole country for Spring Viraemia of Carp (SVC) and for the continental zone for Infectious Pancreatic Necrosis (IPN) (2010/221/EC). The zone has an eradication programme for Renibacteriosis/bacterial kidney disease (BKD) and the coastal zone for IPN (2010/221/EU). These diseases are included in the Swedish legislation of notifiable diseases (SJVFS 2013:23). Further, IHN, VHS, IPN (other than serotype ab) and SVC are included in the Swedish Act of epizootic diseases (SFS 1999:657 with amendments). In addition, testing is routinely done for Koi herpes virus (KHV) in imported, quarantined koi, and for Crayfish plague in crayfish. These diseases are also regulated by the Swedish legislation for notifiable diseases (SJVFS 2013:23). Other notifiable diseases such as furunculosis (*Aeromonas salmonicida salmonicida*/ASS), yersiniosis/Enteric redmouth disease (ERM), Marteilirosis and Bonamiosis (shellfish) and Whitespot disease (crayfish) are not actively tested for within surveillance programmes.

Infectious haematopoietic necrosis (IHN) and viral haemorrhagic septicaemia (VHS)

Both diseases are caused by rhabdoviruses and occur frequently in Europe. They are transferred horizontally, but vertical transmission cannot be completely ruled out for IHN.

Both diseases have greatest impact in aquaculture of rainbow trout (*Oncorhynchus mykiss*) in freshwater, but have also been detected in several other species. Infected fish exhibit behavioral changes, lethargy and abnormal swimming (whirling). The fish are anemic with varying degrees of hemorrhage in multiple organs. VHS is found in a marine form, and a low frequency in wild populations of sensitive species cannot be excluded in the Swedish coastal zone.

Infectious pancreatic necrosis (IPN)

IPN is caused by a Birnavirus that is highly infectious to juvenile salmonids. Susceptibility declines with increasing age. Fish that survive infection become subclinical carriers. In addition to salmonids, virus has been detected in several other species. The virus is transmitted both horizontally and vertically.

The disease has large consequences, with high mortality in young fish, and is considered as one of the most costly in several European countries. Symptoms include darkening, abdominal distension and corkscrew swimming. Petechial hemorrhage in abdominal fat and internal organs are the most dominant internal findings. Mortality rates can vary between 10-90%.

Renibacteriosis (BKD)

BKD is caused by a gram positive bacterium, *Renibacterium salmoninarum*. The infection can be transmitted both horizontally and vertically. The disease favours low water temperatures, and outbreaks occur mainly at temperatures between 7-15°C.

Salmon and arctic char are most susceptible to BKD and mortality can reach 80%. In rainbow trout, the disease is chronic with a continuous low mortality of about 5-10%, however outbreaks of up to 40% mortality can occur. Infected fish may have reduced growth and disease can result in a deterioration of the meat quality.

Spring viraemia of carp (SVC)

SVC is caused by a rhabdovirus. The disease occurs in Asia and several European countries. The virus has been detected in several fish species in the cyprinid family. The virus is transmitted horizontally. The clinical signs are usually general, such as darkening, exophthalmia and a slow breathing. The fish swim lazily with sporadic periods of hyperactivity. Other common findings are pale gills, ascites and hemorrhage in the skin and gills. Internally, bleedings are found in various organs including muscle, swim bladder and the brain.

Koi Herpes virus (KHV) infection

KHV is a DNA virus and affects common carp (*Cyprinus carpio*) and variants thereof, including koi. The virus was first detected in 1998 and has since then been reported from all continents except Australia. The virus is transmitted horizontally. KHV can cause severe problems and is associated with high mortality. Infected fish usually swim at the surface and have an increased breathing frequency. Symptoms include enophthalmia, spotted gills and secondary bacterial

or parasitic infections on gills and skin. Surviving carps can become subclinical carriers.

Crayfish plague

Crayfish plague is caused by an aquatic fungus (*Aphanomyces astaci*), which spread to Europe in the late 1800's from the United States with live crayfish. The disease occurs throughout Europe and North America. The fungus reproduces by spores spread in the water. When the spores infect crayfish they grow through the skin and attack the underlying tissues.

The signal crayfish becomes subclinically infected and may exhibit black (melaninated) areas in the shell adjacent to the presence of the fungus in the skin. The spots will disappear when the shell is shed, but may gradually reappear.

When noble crayfish is infected the first sign is high mortality in affected populations. Disease in the individual is characterised by behavioural changes such as moving during daytime, reduced coordination and balance difficulties.

White spot disease (WSD)

WSD is caused by a Whispovirus (WSSv) that can infect a wide range of aquatic crustaceans including marine, brackish and freshwater prawns, crabs, crayfish and lobsters. Outbreaks occur at water temperatures of 18-30°C. The most common clinical sign is white spots in the exoskeleton, but the disease can occur without obvious external signs.

The virus is transmitted both horizontally and vertically and has a long survival time outside the host animal. The virus is present in imported frozen raw giant shrimps. There is a non-negligible risk that the virus will be introduced to the aquatic environment by anglers using these shrimps for bait. The consequences are difficult to predict but may have a negative impact on Swedish crustacean populations.

Marteiliosis

Marteiliosis, a disease in oysters and blue mussels, is caused by a unicellular parasite (*Marteilia refringens* in oysters and *M. pararefringens* in blue mussels). The parasite needs a crustacean (*Paracartia grani*) as an intermediate host. The disease causes reduced fitness, impaired growth and resorption of the gonads and hence reduced reproductive capacity. When the animals weaken, they cannot keep the shell halves closed.

Bonamiosis

Bonamiosis is a disease in oysters caused by the protistan parasite *Bonamia ostreae*. The parasite invades and destroys the haemocytes. Usually the only sign of disease is increased mortality in the infected oyster population. *B. ostreae* is found along the European Atlantic coast as far up as Denmark, where it has now been found in Limfjorden.

SURVEILLANCE

Within the Official Control Programme, there is active surveillance for the viruses causing IHN, VHS, IPN and SVC, and also for renibacteriosis/BKD. Sampling frequency

is based on classification of each farm into one of three categories (high (I), medium (II) or low risk (III)) after a risk analysis, based on the risk for the farm becoming infected, the risk that the farm will further spread the pathogen and the impact of the pathogen. The risk categorization is performed by the Board of Agriculture. Farms within risk category I and II are tested every year and every second year, respectively, but farms within risk category III are only tested upon suspicion of disease. The aim of the Official Control Programme is to document freedom from disease and to contribute to the maintenance of this status.

There is also active surveillance in imported quarantined fish (eel - IPN and koi/carp - KHV). Active surveillance is also done when potential invasive alien species - like the marble crayfish - are discovered.

Crayfish plague is monitored by passive surveillance and testing is done based on suspicion of disease outbreaks.

Except for the control program, passive disease surveillance has been done through diagnostics related to disease outbreaks in farms and wild fish.

DIAGNOSTIC PROCEDURES

All diagnostic analyses are performed according to recommendation by EU or OIE at the Swedish reference laboratory, the National Veterinary Institute. VHS, IHN, IPN and SVC are tested for on pooled organ material (spleen, kidney, heart/brain) by a cell culturing method. A pool consists of organs from up to ten fish. A cell culture is defined as virus positive if a cytopathogenic effect is detected within two weeks, after which the virus is identified by ELISA and confirmed by PCR or in some cases by serum neutralisation (SN test). KHV is tested for on individual fish (pooled gill and kidney) by PCR. Thirty fish are sampled in regular fish farms, and in restocking farms all females are sampled after stripping of roe. In the case of carp/koi, only a few fish may be sampled. In eel quarantine, 120 glass eels are sampled at arrival and after 2 months, 120 co-habitated rainbow trout are sampled for detection of virus.

BKD is tested for on kidney tissue from individual fish and demonstrated by an ELISA method. Verification is done by PCR. Thirty fish are sampled in regular farms, and in restocking farms up to 120 fish are sampled after stripping of roe.

A. astaci is demonstrated by light microscopy and cultivation and verified by realtime (rt) PCR, and WSSv is detected by rt-PCR. The number of sampled animals varies from case to case.

RESULTS

Official health programme for fish farmers and crustacean surveillance

The number of samples analysed and results are shown in table 26. In summary, the active surveillance detected (one case=one outbreak):

- 1 case of IPN serogroup 2 in the coastal zone
- 2 cases of BKD in arctic char, one of these in a new location

- 1 case of BKD in rainbow trout
- 1 case of eel virus European X (EVEX) in quarantined glass eels
- 5 cases of Crayfish plague

Voluntary health programme for fish farmers

There was one recorded outbreak of other notifiable diseases in fish during 2017, when furunculosis (ASS) was identified in an inland farm with concurrent BKD infection.

One farm imported 2,000 siberian sturgeon fry from Italy and the fry was infected with *Acipenser iridovirus* European-I. The mortality was 95% in 2.5 months. The remaining 5% were then euthanized to clean and disinfect the farm.

Flavobacteriosis due to *Flavobacterium psychrophilum* continues to be the dominant cause of production disease in fry and young fish. Resistance against oxolinic acid and oxytetracycline is becoming more and more common in the bacterium. The cause for this is not known. Usually florfenicol (for which there is yet no resistance) is used for treatment of the bacterium, and the other two antibiotics are rarely used in aquaculture.

Voluntary health control in wild fish

Due to the detection of IPN genogroup 6 in broodstock trout from Lake Vänern in December 2016, the County boards of Värmland and Västra Götaland took an initiative to sample wild trout and salmon from the lake. A total of 144 adult salmon and trout, plus five organ pools without stated number of fish (1 to max. 10 fish) and two pools of yearlings from upper Klarälven have so far been investigated by virus cell culture. No virus has been detected. The investigations will continue in 2018 in an aim to reach 500 sampled individuals.

Outbreaks in wild fish, crustaceans and molluscs

Investigations into mortality in the freshwater pearl mussel (*Margaritifera margaritifera*) were continued in two additional sites. The cause of the disease has not yet (May 2018) been fully understood and investigations continue.

DISCUSSION

The number of farms that were sampled are listed in table 26. Swedish aquaculture has a good health status, where all severe diseases of importance are absent.

The most problematic disease to control is renibacteriosis/BKD, due to its vertical transmission and variable clinical presentation. Prolonged time from diagnosis to slaughter can lead to secondary health issues and increased antibiotic use as well as decreased welfare. As an example: the last two years ASS has been causing problems in one BKD infected farm and mortalities continued despite antibiotic treatment. The reason is probably the underlying BKD infection, facilitating the ASS infection and itself being accelerated by the concurrent ASS infection. Control of BKD is expected to be improved by modified sampling and improved methodology, from today's post mortem sampling to an in vivo method.

Additional resources must be invested in risk-based analysis of individual aquaculture farms to get a more reliable assessment for health surveillance. One new geographic location was found to be infected in 2017. The other two cases were re-infections of previously sanitised farm sites. In addition to detected cases, one sample from another farm was positive by ELISA, but negative by PCR although the ELISA OD value was high. The farm is suspected to be positive, and the cause of the negative PCR could be localised infection in the kidney, meaning that the PCR swab did not pick up any bacterial DNA.

The detected IPN case was due to reinfection of a farm site that was sanitised a few years ago. Genogroup 2 is of low pathogenicity, and the fish in the farm are outside the age range where serious symptoms generally occur.

EVEX in glass eel was detected by virus cell culture from eels sampled when the fish had just arrived at the quarantine. SVA noted lethargy in the eels, which are usually

very lively upon arrival to the lab. Mortalities in the quarantine occurred at the time of arrival but were thought to be due to poor transport conditions. EVEX has been detected in imported glass eel once before. Usually import is done from Great Britain, but on both of these occasions, glass eel was imported from France instead. Since EVEX is a notifiable disease (rhabdoviruses other than VHSV), discussions about the fate of the eels were held several times between the different involved authorities. The eels were doing well, and the Swedish Agency for Marine and Water management was about to allow restocking in the wild at the end of quarantine time, when mortalities started to occur again. In the end, 2 million eels were euthanized, causing a major loss in the Swedish restocking programme.

The number of identified crayfish plague outbreaks are at the same level as in 2016.

Table 26: Samples taken in the Swedish surveillance programmes for notifiable diseases in fish, crustaceans and molluscs

Disease	No. of sampled production sites	No. of infected production sites	No. of tested individuals	No. of tested pools	No. of infected individuals/pools
Fish					
VHS	64	0	-	417	-/0
IHN	64	0	-	417	-/0
IPN	64	1	-	417	-/1 ^B
SVC	2	0	-	7	-/0
KHV	1	0	4	-	0/0
BKD	85	3	3,418	-	43 ^C /-
Crustaceans					
<i>Aphanomyces astaci</i>	18 ^A	5	39	0	15/0
WSSv	0 ^A	0	0	0	0/-
Molluscs					
<i>Bonamia ostreae</i> ^D	5	0	150	0	0/-
<i>Marteilia refringens</i> ^D	5	0	150	0	0/-

^A Wild fish/crayfish

^B Virus isolation in cell culture, virus identified by ELISA and confirmed by RT-PCR and sequencing.

^C By ELISA. Infection was confirmed in 16/18 fish that were further tested by qPCR.

^D This sampling was performed as part of a project withing the European Sea and Fisheries Fund

Abbreviations:

VHS	Viral hemorrhagic septicemia
IHN	Infectious Haematopoietic Necrosis
IPN	Infectious pancreatic necrosis
ISAV	Infectious salmon anaemia virus
SVC	Spring viraemia of carp
SAV	Salmonid alphavirus (Pancreas disease)
PRV1	Piscine reovirus (PRV1 causes Heart and skeletal muscle inflammation(HSMI))
KHV	Koi herpesvirus
BKD	Bacterial Kidney Disease

Examination of abortions in food producing animals

BACKGROUND

Post mortem examinations are considered important for early detection and national surveillance for infectious and emerging disease. As mentioned in the chapter “Post Mortem examinations in food producing animals”, the Swedish Board of Agriculture has for the past 20 years financed a programme to encourage such examinations. Many infections, however, show no macroscopic lesions or cause nonspecific changes not detected at necropsy. Brucellosis, porcine reproductive and respiratory syndrome (PRRS) and classical swine fever (CSF) are examples of infections that may be present without specific macroscopic findings. Moreover, the clinical picture in the herd may be non-specific, which may cause a delay before the suspicion of these diseases occurs in clinical surveillance.

SURVEILLANCE

This surveillance component was introduced in 2008. It includes examinations for brucellosis in all ruminant foetuses and for brucellosis, PRRS and CSF in all pig foetuses submitted for necropsy as part of the post mortem examination programme. During the second half of 2012 and 2013, Schmallenberg virus (SBV) was tested for as well. These infections often cause abortion, therefore sampling of aborted foetuses means sampling within a risk group and increases the chance of detecting the infectious agent if present in the country. The Swedish Board of Agriculture finances sampling and testing of foetuses for *Brucella*, PRRS and CSF. All diagnostic testing was performed at the National Veterinary Institute. The foetuses were analysed for the CSFV and

PRRS genome with PCR and for *Brucella* by bacterial culture.

RESULTS

Since the start in 2008, a varying number of foetuses of different species have been examined each year (Table 27). The numbers for 2012 and 2013 were extraordinarily high, most likely because of increased attention due to the newly identified infection with Schmallenberg virus (SBV). During 2017, the lowest number of foetuses since 2008 were submitted to the programme (Table 27).

All analysed samples were negative for *Brucella*, PRRS and CSF.

DISCUSSION

The post mortem examinations and sampling of foetuses are an important part of the national surveillance for infectious and emerging diseases, as illustrated by the detection of infections with Schmallenberg virus in 2012 and 2013. Testing for SBV ended in 2013 because the disease, at that time, had become established in Sweden and therefore was considered endemic. During the last four years, the number of examinations has been less than the anticipated, approximation of 140 foetal examinations per year. Actions have been taken to increase the numbers during 2017, for example improving awareness by reminding about the possibility to submit foetuses for examination to herd veterinarians. These actions will continue and will be complemented by awareness-raising activities directed towards farmers during 2018.

Table 27: Number of aborted foetuses examined in the surveillance since the start in 2008

Species	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Cattle	14	15	62	21	63	114	32	29	34	20
Goat	0	0	9	3	5	4	2	0	2	2
Sheep	0	29	70	45	79	89	28	31	16	22
Alpaca	0	2	5	0	0	4	0	2	1	0
Bison	0	0	0	0	1	1	0	0	1	0
Gnu	0	0	0	0	0	1	0	0	0	0
Visent	1	1	0	2	1	0	0	0	0	0
Pig	37	79	61	51	54	46	31	17	43	6
Water buffalo	0	0	0	0	0	0	0	0	0	1
Total	52	126	207	122	203	259	93	79	97	51

Post mortem examinations in food producing animals



Post mortem examinations are an important part of early detection surveillance, and key in understanding and describing new emerging threats. In 2017, almost 500 pigs were investigated. Photo: Bengt Ekberg

BACKGROUND

Early detection of infectious diseases is of utmost importance to prevent negative effects. For diseases with severe clinical signs the first line of defence is the detection of disease by animal owners, field veterinarians and pathologists. International and national experience show that post mortem examinations remain a vital part in disease control and detection of emerging diseases.

As post mortem examinations are considered an important part in the early detection and national disease surveillance, a specific programme for such examinations started in the early nineties. The Swedish Board of Agriculture finances the programme, complemented by fees from the animal owners. Farm & Animal Health is responsible for the organisation of the post mortem examination programme.

SURVEILLANCE

The programme subsidises post mortem examinations in all food producing animals, including poultry. The latter were included in the programme in 2007. Since 2008, domesticated exotic ungulates are also included. Approximately

3,000 animals have been examined yearly within the programme since 1999. In conjunction with post mortem examinations, samples are routinely collected from defined categories of animals for surveillance of salmonellosis, paratuberculosis, PRRS, CSF, brucellosis, TSE and antimicrobial resistance.

The programme also includes further training of veterinarians and the veterinary employees at the post mortem facilities. Yearly courses are held and quarterly newsletters are produced.

Transportation of the carcasses to the laboratories is arranged and financed by the owner. This can be a problem for large animals, particularly when the distance between the farm and post mortem facility is long.

RESULTS

During 2017, post mortem examinations were performed at five different sites, all located in the southern half of Sweden: Skara (Animalycen AB), Kristianstad (Farm & Animal Health), Uppsala (the National Veterinary Institute and the Swedish University of Agricultural Sciences (SLU)), Visby (Farm & Animal Health) and Karlskoga (Farm & Animal Health). Large animals, such as adult cattle, were examined

at four of these sites, Uppsala, Kristianstad, Karlskoga and Visby. A total of 3,283 post mortem examinations were performed within the programme during 2017.

The distribution of species examined over the last 10 years are shown in table 28. The variation in the number of animals submitted for post mortem examination within the largest livestock producing sectors (pigs, cattle, sheep and poultry) is illustrated in figure 32.

In 2017, 88 cases were diagnosed with a notifiable disease at post mortem examination. Table 29 shows the number of reported index cases of notifiable diseases.

To facilitate timely necropsies of large animals in remote areas of Sweden, a project financed by the Board of Agriculture and carried out by SLU has trained sixteen Swedish veterinarians in a field necropsy method, developed by the Feedlot Health Management Services in Canada. The method "Remote Digital Autopsy" (RDA) utilises a process where a simplified gross post mortem examination is done at the farm. Digital photographs of key organs are taken and, together with available anamnestic information sent to a pathologist for a presumptive diagnosis.

DISCUSSION

Post mortem examinations are a vital part of the national surveillance for infectious and emerging diseases, as illustrated by the detection of 88 index cases of notifiable disease in 2017. Post mortem examination is also an important tool for the veterinarians to solve animal health problems at the individual farm. During the last decade, the number of post mortem examinations has been around 3,000 per year with a shift in species examined. Pigs were on a steady decline but seems to have settled at around 500 animals per year. The number of cattle and sheep are stable around 800 and 500 animals examined respectively. This year poultry had a substantial increase in numbers examined. This increase of submissions may reflect both the increasing population of poultry and by raised awareness due to disease outbreaks. For 2017, approximately 2/3 of the examined poultry comes from commercial flocks and the rest from hobby flocks.

A regional imbalance can be seen in that more examinations are done in the regions closer to post mortem examination facilities. The highest numbers of examinations are performed in regions with high animal density and access to a regional laboratory performing post mortem examinations. If the RDA-method is found to be useful under Swedish conditions, this method may be a valuable complement to increase post mortem examinations in more remote areas.

Distance, and transportation method to facilities where thorough post mortem examinations can be performed, is important for quality reasons. A long delay before cold storage and examination will result in more cadaverous changes and will influence the quality of the post-mortem examination negatively. A project financed by the Swedish Civil Contingency Agencies on improving transportation and logistics for transportation of dead animals submitted for post mortem, to improve quality of the examinations, was initiated and carried out in 2014 - 2015. The project resulted in better logistics and better post mortem examinations due to less carcasses affected by cadaverous changes. The transportation project has since then become a permanent solution. The designated transports have, in part, been funded by an extra fee for the farmers using the service and by the programme. In 2017, this transport became more frequently used and due to funding constraints the service is now limited to three days a week, reduced from five previously.

REFERENCES

Wahlström, H. 2003. Sjukdomsövervakning hos animalieproducerande djur - en översyn på uppdrag av Jordbruksverket och Köttböndernas Forskningsprogram.

Redovisning av uppdrag om veterinär obduktionsverksamhet. veterinär obduktionsverksamhet (SJV Dnr 33-10225/10)

Personal communication, Ulrika Rockström Swedish Farm & Animal Health.

Table 28: Number of submissions to post mortem examination of food producing species, 2008-2017.

Year	Pigs	Cattle	Sheep	Goat	Farmed deer	Poultry	Exotic ungulates	Reindeer	Other	Total
2008	1,173	646	613	15	43	480	10	0	1	2,981
2009	1,112	655	510	11	10	656	18	0	5	2,977
2010	932	773	637	24	13	391	25	0	2	2,797
2011	737	707	611	23	11	460	28	0	1	2,578
2012	862	826	749	35	11	630	37	0	1	3,151
2013	667	983	840	34	18	749	43	0	2	3,338
2014	502	747	548	14	11	1,006	40	0	0	2,868
2015	529	707	557	21	3	778	42	0	3	2,640
2016	651	845	617	34	17	642	31	0	0	2,837
2017	498	777	458	17	15	1478	36	4	0	3,283

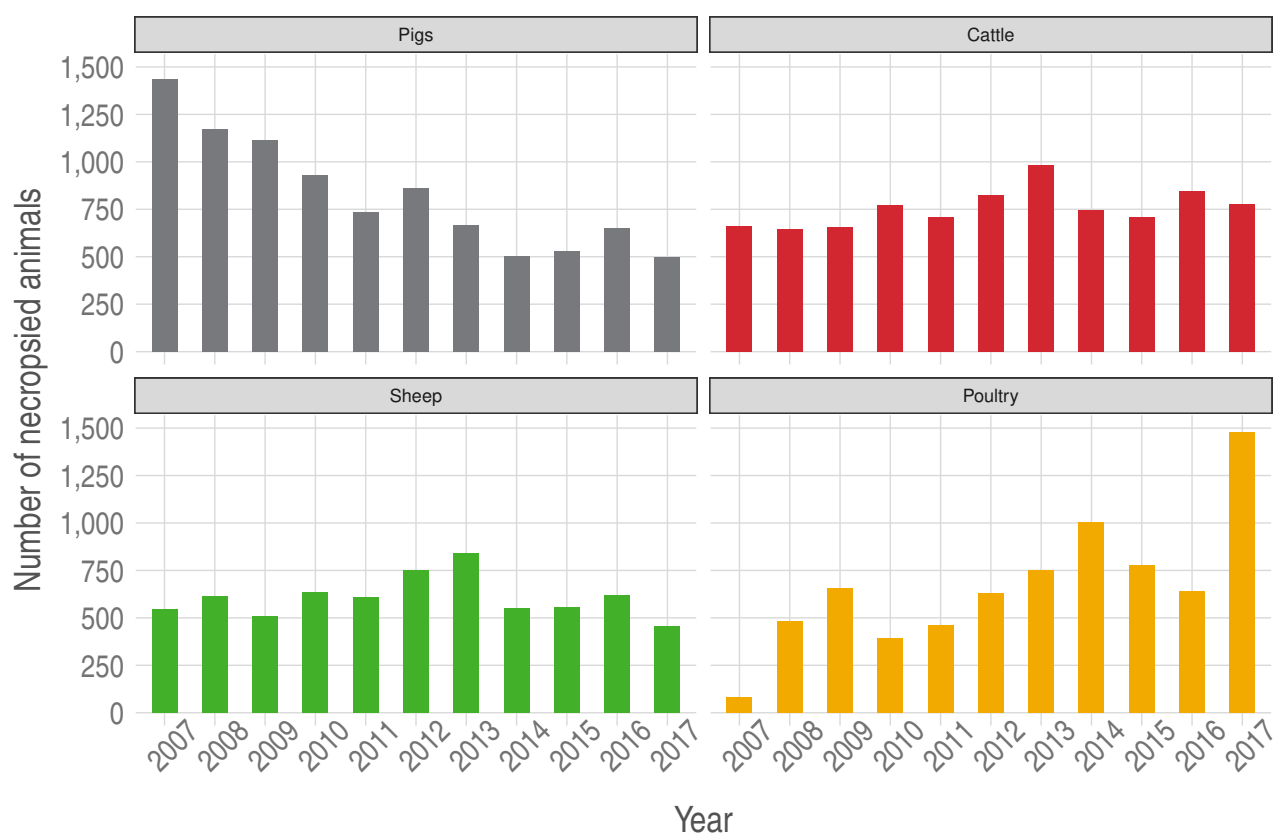


Figure 32: Number of post mortem examinations by selected animal species over a 10 year period

Table 29: Number of index cases of a notifiable disease 2013-2017, diagnosed from samples taken at post mortem examination.

Disease	2013	2014	2015	2016	2017
Anthrax	0	0	0	1	0
Avian rhinotracheitis	1	0	0	0	0
Blackleg	7	4	19	26	25
Bovine Malignant Catarrhal fever	3	1	1	6	6
Chorioptes (sheep/goat)	-	-	-	-	1
Duck Viral Enteritis ^A	-	1	0	0	0
Fowl Cholera (pasteurellosis)	0	0	0	3	4
Fowl typhoid (<i>S. Gallinarum</i>)	0	0	0	0	3
Gumboro (Very virulent IBDV)	-	-	-	-	5
Infectious Bronchitis	0	0	0	0	0
Infectious laryngotracheitis	36	35	26	26	17
Influenza, pigs	1	1	0	0	1
Influenza A typ (H1N1) 2009	3	0	0	0	1
Listeriosis	49	31	22	20	22
Lymphoma (not EBL)	0	0	0	2	0
<i>Mycoplasma gallisepticum</i>	0	4	4	0	1
<i>Mycoplasma, poultry (not gallisepticum)</i>	0	0	0	2	0
Necrotic haemorrhagic enteritis (<i>Clostridium perfringens</i> type C)	0	0	0	0	0
Salmonellosis	2	3	3	1	2
Total	102	80	75	87	88

Statistics from Farm & Animal Health.

^A This disease was not diagnosed in Sweden prior to 2014

Post mortem examinations in wildlife



White-tailed eagle (*Haliaeetus albicilla*), in a rehabilitation center. Several eagles were affected by the H5N8 avian influenza outbreak in 2017. Photo: S. Sköldås.

BACKGROUND

A general surveillance programme for diseases of wildlife based on pathology and ancillary testing was established in Sweden in the late 1940s. The surveillance programme is financed partly by annual state hunting permit fees, and partly by governmental funding. The aim of the general and targeted wildlife disease surveillance programmes is to monitor the health status of wildlife in Sweden, as well as presence or absence of diseases. The mission is to diagnose and acquire knowledge on present and emerging diseases in Swedish wildlife. The disease surveillance and diagnostics provide key information for wildlife management. It is also part of

zoonotic and epizootic disease surveillance efforts and can serve as an indicator of environmental and ecosystem health. The National Veterinary Institute (SVA) is the only laboratory in Sweden where post mortem examination of fallen wildlife is performed. SVA is also the national wildlife focal point for OIE and submits reports of OIE-listed diseases in wildlife, as well as OIE-specified non-listed wildlife diseases.

SURVEILLANCE

The general public, local authorities, and especially hunters submit wildlife that is found dead, or found sick and then

euthanized, to the National Veterinary Institute for examination. This includes fallen wildlife and standard samples collected from hunted large carnivores or other game species within research projects and bio-bank sampling. Hunter-harvested wild boar and brown bear (*Ursus arctos*) samples for *Trichinella* analysis are not included in these numbers. All large carnivores: brown bear, lynx (*Lynx lynx*), wolf (*Canis lupus*) and wolverine (*Gulo gulo*), found dead, euthanized or shot in licensed hunting are submitted to SVA for necropsy as skinned carcasses or tissue samples. Whenever possible, disease causing agents are identified and cause of death established.

RESULTS

In 2017, whole carcasses or parts of 2,312 wild animals were submitted and examined at the Department of Pathology and Wildlife Diseases. Some notable wildlife diseases were cases of high pathogenic avian influenza virus type H5N6, outbreaks of pigeon paramyxovirus, and local outbreaks of rabbit viral hemorrhagic disease type 2. Chronic

Wasting Disease (CWD) screening of fallen or euthanized sick cervids continued in Sweden pending decision from the EU on compulsory CWD testing. In all, over 400 Swedish cervids have been tested since 2016, all have been negative. For more details, see the CWD chapter.

DISCUSSION

The general disease surveillance in wildlife is based on citizen science, with the interested public and hunters especially, reporting and submitting samples. A high public interest in wildlife health and conservation continues to make this work possible, together with state financing. Among the health care community and relevant authorities, it is well recognised that wildlife disease surveillance is an integral part of the One Health concept. The surveillance results (Table 30) show that Sweden has few serious infectious disease threats in wildlife.

REFERENCES

Sjukdomsövervakning av Vilda Djur i Sverige 2017. Editors Erik Ågren, Gete Hestvik; SVA:s rapportserie:2018.

Table 30: OIE non-listed wildlife diseases and number of outbreaks/cases reported to the OIE for 2017.

Disease	Number of cases	Species affected
Avian influenza (H5N8)	34	Goshawk (2), Mallard (4), White-tailed eagle (7), Crow (1), Buzzard (1), Rook (2), Peregrine falcon (2), Northern hawk-owl (1)
Meningeal worm	6	Moose
Myxomatosis	6	Wild rabbit
Paramyxovirus (PMV-1)	6	Rock pigeon
Pasteurellosis	2	Fallow deer
Pox virus	1	Porpoise
Pseudotuberculosis	1	Mountain hare
Rabbit Hemorrhagic Disease (RHD)	10	Wild rabbit (43), Mountain hare (1)
Sarcoptic mange	17	Lynx (7), Wolf (5), Wild boar (1), Red fox (3), Raccoon dog (1)
"Salmonellosis"	13	Bullfinch (5), Common redpoll (1), Siskin (2), Green woodpecker (1), Great spotted woodpecker (1), Common kestrel (1), Gray owl (1), Red squirrel (1), Porpoise (1)
Trichomoniasis	24	Rock pigeon (1), Common wood pigeon (4), Chaffinch (1), Greenfinch (17), Common kestrel (1)
Trichinellosis	12	Lynx (4), Wolf (1), Wild boar (7)
Total	139	

Antibiotic resistance in bacteria from animals and food

BACKGROUND

The National Veterinary Institute (SVA) has the mandate from the Government to monitor and analyse the development of antimicrobial resistance in bacteria from animals and from food of animal origin. Also, the European Commission has decided on mandatory harmonised monitoring of antibiotic resistance in bacteria from food-producing animals and food thereof. The monitoring activities are carried out through the Swedish Veterinary Antibiotic Resistance Monitoring Programme (Svarm), which has been running since 2000.

The objectives of Svarm are to detect changes in trends in resistance and to provide a basis for recommendations on the use of antibiotics in animals. Three types of bacteria are monitored: zoonotic bacteria, specific animal pathogens and indicator bacteria from healthy animals and meat. In addition, intestinal content from healthy farm animals and fresh meat thereof are screened for *E. coli* producing extended spectrum beta-lactamases (ESBL), AmpC-enzymes and carbapenemases. The rationale for monitoring indicator bacteria, i.e. commensal *Escherichia coli* and *Enterococcus* spp. from the normal intestinal flora of healthy animals, is that resistance among these bacteria reflects the selection pressure caused by the use of antibiotics in an animal population. These commensal bacteria can also be a reservoir of mobile resistance genes that can reach humans through the food chain. Thus, the prevalence of resistance in bacteria that contaminate meat indicates the magnitude of the potential human exposure to such reservoirs in food-producing animals.

The Svarm programme adheres to the instructions for the mandatory monitoring of resistance in EU according to directive (2003/99/EG) and subsequent decisions (2013/652/EU). According to the directive, resistance in *Salmonella*, *Campylobacter jejuni* and in indicator bacteria shall be regularly monitored in broilers, pigs and cattle using harmonised methodology. Briefly, for Sweden, this implies that each year, isolates of *Salmonella* from all notified outbreaks in food-producing animals, as well as, 100-200 isolates of *Campylobacter* from either broilers, pigs or calves are tested for antibiotic susceptibility. Also, each year 170 isolates of *E. coli* from intestinal content of healthy broilers or from pigs and cattle are tested. In addition, each year 300 samples of intestinal content and 300 samples of fresh retail meat from either broilers or from pigs and cattle are screened for ESBL/AmpC- and carbapenemase producing *E. coli*.

In addition to this mandatory monitoring, Svarm is complemented with data on resistance in clinical isolates of bacteria from the routine testing of clinical submissions at SVA. Svarm is also complemented with data from research projects and specifically from the SvarmPat project focusing on resistance in animal pathogens from farm animals. SvarmPat is run in cooperation with Farm & Animal Health

and is financed by the Swedish Board of Agriculture.

Results of Svarm, i.e. data on antimicrobial resistance in bacteria from animals and food are presented in a yearly report together with data on sales of antimicrobials for use in animals. These results are published together with corresponding data for human medicine from the Swedres programme at the Public Health Agency of Sweden in an integrated report - Swedres-Svarm - available at www.folkhalsomyndigheten.se or at www.sva.se. The different data sources compiled in this report are illustrated schematically in Figure 33.

SUMMARY OF RESULTS

The situation in Sweden regarding antibiotic resistance in bacteria from humans and animals is still favourable from an international perspective. This confirms that strategies to promote the rational use of antibiotics and to limit the spread of antibiotic resistance are effective. In the last decades, the consumption of antibiotics in Sweden has decreased in both humans and in veterinary medicine. In addition, the sales of broad-spectrum antibiotics have decreased while the use of narrow-spectrum antibiotics has increased. Despite this, some of the monitored types of antibiotic resistance have continued to increase.

Antibiotic sales in veterinary medicine

In 2017, reported sales of antibiotics for animals were 10,310 kg, of which 57% were benzyl penicillin. The corresponding figures for 2008 were 16,364 kg and 47%, respectively. These figures include products for intramammary treatment.

Since the withdrawal of growth-promoting antibiotics from the market in 1986, the total sales of antibiotics have decreased by two thirds when corrected for different population sizes over time. During the 1990s, sales of veterinary products for medication of groups of animals decreased, and in the past decade there has also been a decrease in sales of products for use in individual animals (Figure 34).

Extended spectrum beta-lactamase (ESBL) producing Enterobacteriaceae

ESBL-producing *Enterobacteriaceae* are, with the exception of broilers, rare among animals in Sweden. In 2017, the occurrence of ESBL-producing *E. coli* in intestinal samples from pigs, samples of pork and beef, and in intestinal samples from broilers was investigated with screening methods. Such bacteria were isolated from 4% of the intestinal samples from pigs, 0 and <1% of the pork and beef samples of Swedish origin, and 34% of the intestinal samples from broilers. The occurrence in intestinal samples from broilers was comparable with previous years. Changes in the screening methodology prevent any direct comparisons with the figures from previous years.

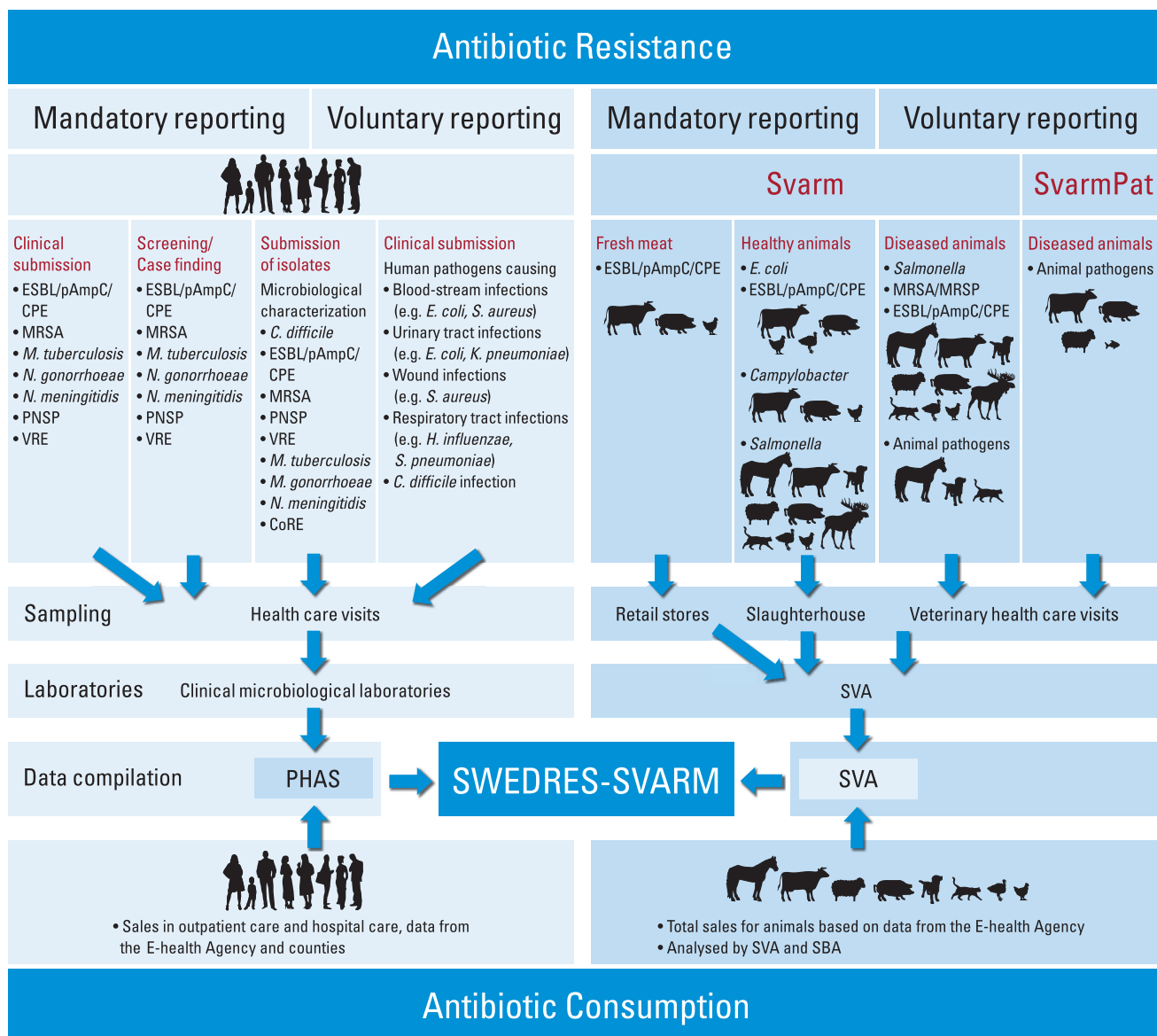


Figure 33: A schematic illustration of data included in the Swedres-Svarm report.

Methicillin resistant *Staphylococcus aureus* (MRSA)

MRSA is notifiable in animals in Sweden. The occurrence is still low, which limits the spread from animals to humans. In 2017, MRSA was isolated from the animal species horse, dog, cat, rabbit, cattle, goat and sheep. MRSA with *mecC* was isolated from several animals in a goat herd. In companion animals, the same types of MRSA as in humans dominate, indicating a human source of MRSA in these animals. In horses, livestock-associated MRSA CC398 is the most common type but other types occur. On two occasions in 2017, spread of MRSA was suspected between horses in equine clinic facilities.

Methicillin resistant *Staphylococcus pseudintermedius* (MRSP)

In 2017, the number of notified cases of MRSP was on the same level as 2016. In total, 47 cases were notified in 2017, which can be compared to 55 cases in 2016 and 60 cases in 2015. All cases in 2017 were dogs. In previous years, the clone ST71 has dominated among Swedish cases, but now the picture is becoming more diverse. The clones ST71 and

ST258 are most common but several other types were also detected in 2017.

Resistance in zoonotic pathogens

Salmonella is rare in animals in Sweden, and few incidents involve antibiotic-resistant strains. Strains with ESBL resistance have never been found in isolates from animals in Sweden, and resistance to fluoroquinolones is rare. Usually humans diagnosed with *Salmonella* in Sweden has contracted the infection abroad or through imported foodstuffs. This is most likely the explanation to the higher levels of resistance, e.g. to fluoroquinolones, in isolates from humans than in isolates from Swedish animals.

Campylobacter from animals in Sweden are mostly susceptible, and resistance to erythromycin, for example, is most uncommon.

Resistance in animal clinical isolates

Bacteria causing clinical disease in animals are mostly susceptible to antibiotics relevant for treatment. Respiratory

pathogens from farm animals and horses are generally susceptible to benzylpenicillin, but penicillin resistance is common in *Staphylococcus pseudintermedius* from dogs and occurs in *S. aureus* from horses and *Staphylococcus felis* from cats. Resistance in *E. coli* occurs in all animals but is most prominent in enteric isolates from young calves. Susceptibility testing for guidance in antibiotic therapy is warranted, especially for staphylococci, *E. coli* and *Brachyspira* spp.

Resistance in indicator bacteria from healthy animals

Antibiotic resistance in *E. coli* from the intestinal flora of healthy animals serves as an indicator for the presence of resistance in an animal population. The prevalence of acquired resistance in such commensal bacteria also indirectly indicates the magnitude of the selective pressure from the use of antibiotics in an animal population. The prevalence of resistance in indicator bacteria from animals in Sweden is low, and the situation is favourable in an international perspective.

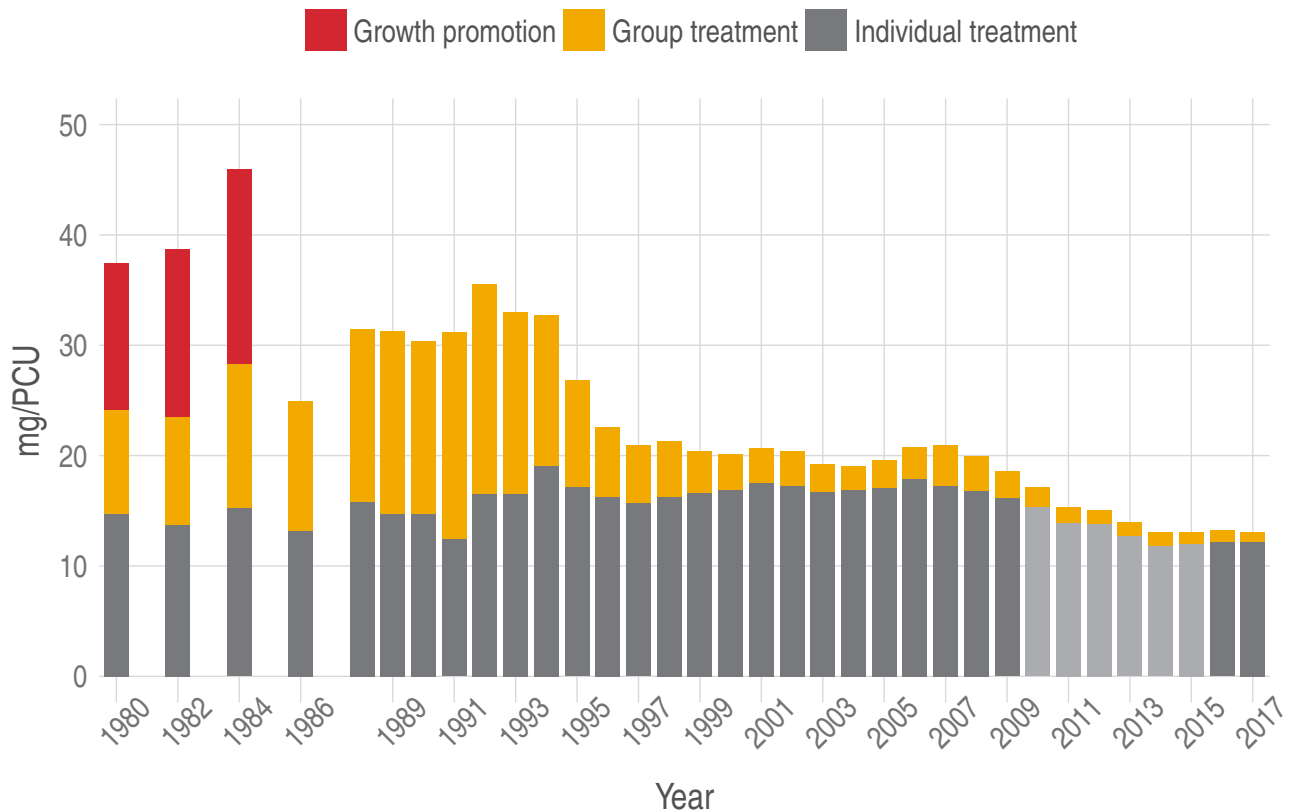


Figure 34: Sales of antibiotics for animals expressed as mg per population correction unit (PCU). Data from 2010-2015 are uncertain because of a lack of completeness mainly affecting injectable products (Indicated in a lighter grey). In the present figure, all products (including tablets) are included while in data presented in the European surveillance of veterinary antimicrobial consumption tables are excluded when calculating mg/PCU.

