Annual Report on Zoonoses in Denmark 1998

Ministry of Food, Agriculture and Fisheries

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Introduction

In August 1997, the fourth revision of the Danish plan for implementation of the Zoonosis Directive (hereafter called "the Danish plan") was submitted to the EU Commission. The plan describes the details of the different national programmes for control of zoonoses in Denmark. Thus information about the origin of the data presented in this report can be found in the Danish plan.

This report does not include the Faroe Islands and Greenland.

Demographic data

Total number of livestock and herds in Denmark, 1997:

	Livestock	Herds
Cattle	2,004,212	27,606
Pigs	11,383,181	18,829
Laying hens	3,993,000	7,625
Broilers	12,510,000	675
Sheep	142,408	3,865

Human Population in 1998:
5.3 million
0.8 million in rural areas
4.5 million in urban areas

Area of Denmark:
44,000 sq km

Source: The Statistical Yearbook 1998, Danmarks Statistik.

Approximate total number of animals slaughtered in 1998:

Cattle:	647,960
Pigs:	20.8 million
Broilers:	138 million

Source: Danish Veterinary and Food Administration, 7th. Department.

It should be noted that:
- 90% of the production of slaughter pigs takes place in 8,000 holdings
- the majority of the egg production takes place in 339 holdings
- nearly all of the broiler production takes place in 315 holdings

1. Salmonella

Feeding stuffs

All Danish feed compounders are routinely monitored for *Salmonella* by the Danish Plant Directorate. Monitoring includes routine sampling of compound feeds and during feed processing and from feed materials, including raw materials of animal origin. Table 1 shows the overall results of the monitoring in 1998.

Feeding stuffs

The Danish Plant Directorate collects samples of feeding stuffs from the production plants and retailers. The number of samples depends on the size of the production, but is increased if *Salmonella* is detected in samples other than raw materials.

The occurrence of *Salmonella* in compound feeding stuffs in 1998 is listed in Table 1. Compared to the previous years the good hygienic quality of compound feeding stuffs is stabilised at a very low level (Figure 1).

The proportion of *Salmonella* positive samples of feed materials has increased from 1997 to 1998 from 2.5% to 6.4%.

Feed processing

Process control is carried out by inspectors at least four times a year. Samples are collected for microbiological examination at the critical control points of the production process.

From compounders with heat treatment (more than 81°C) of the feeding stuff the samples are collected after the heat treatment at critical

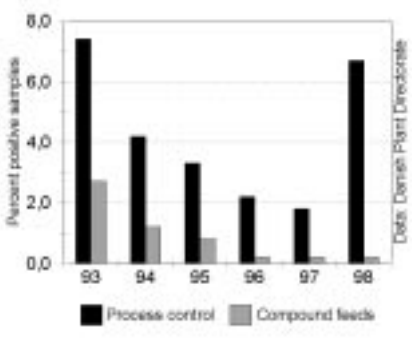

Figure 1. Percent Salmonella *positive samples of process control and compound feeds, 1993-1998. Rapeseed-oil crushers included in October 1997.*

control points. Where there is no heat treatment, the samples are being collected from CCP's along the entire process as well as from the feed materials.

The plants are inspected in order to check whether they comply with a national set of rules for good production hygiene, including control of the heat treatment, which is monitored every second hour during the process.

Additional inspection of the plants is carried out when *Salmonella* is detected in the samples or critical hygiene conditions are reported.

The incidence of *Salmonella* positive samples from the process control at the plants has increased from 1997 to 1998 from 1.8% to 6.7%, due to problems with *Salmonella* infected rapeseed meal (Figure 1). The rapeseed-oil crushers were included in the process control from the last quarter of 1997.

Serotypes

The serotypes found in the feeding stuffs and at the inspection of the feed processing are listed in Table 1. *Salmonella* Derby and *S.* 4.12:b:- constitutes an emerging problem. The serotypes are found mostly in rapeseed meal.

Summary

The results of the *Salmonella* control by the Danish Plant Directorate indicate that the good hygienic quality of compound feeding stuffs is stabilised. *Salmonella* is found only in a very small percentage of the compound feeding stuffs samples.

However, the results of the inspection of the feed processing and the increased incidence of *Salmonella* positive samples of feed materials has shown that *Salmonella* infected rapeseed meal is a serious risk for the contamination of the Danish feed compounders.

Rendering Plants

Control of hygiene at rendering plants is carried out by the animal health section of the Danish Veterinary and Food Administration. The products are routinely examined for *Salmonella*. In 1998, 3 (2%) of 137 pooled samples of the final products from rendering plants were found to be contaminated with *Salmonella*. The serotypes found were *S.* Liverpool, *S.* Tennessee and *S.* Oranienburg.

Table 1. Control of Salmonella *in compound feeds and feed processing in 1998.*

	Control of compound feeds			Process control		Control of feed materials	
	Pig feed		Cattle feed etc. 1)		Poultry feed			
Total number of samples	1,440		795		296	3,222	313	
Salmonella detected	1		3		0	217	20	
Percent positive	0.1%		0.4%		-	6.7%	6.4%	
Serotypes	S. Tennessee	1	S. Derby	1		S. 13.23:-:- (aphasic) 2	S. 4.12:b:-	4
			S. Mbandaka	1		S. 4.12:-:- (aphasic) 7	S. 4.12:-:- (aphasic)	1
			S. Welikade	1		S. 4.12:b:- 52	S. Agona	2
						S. 4.12:b:- (monophas) 1	S. Derby	3
						S. Agona 2	S. Infantis	1
						S. Anatum 2	S. Isangi	1
						S. Bredney 3	S. Livingstone	2
						S. Cerro 2	S. Oranienburg	1
						S. Derby 83	S. Senftenberg	1
						S. Havana 11	S. Tennessee	1
						S. Infantis 1	S. not serotyped	3
						S. Kentucky 2		
						S. Lexington 1		
						S. Liverpool 1		
						S. Livingstone 1		
						S. Mbandaka 4		
						S. Meleagridis 2		
						S. Montevideo 8		
						S. Newport 1		
						S. Poona 2		
						S. Potsdam 1		
						S. Putten 7		
						S. Senftenberg 3		
						S. Tennessee 6		
						S. Typhimurium 4		
						S. Urbana 2		
						S. Virchow 1		
						S. Yoruba 1		
						S. not serotyped 4		

Data: Danish Plant Directorate. 1) Includes feed for cattle, horses, sheep and rabbits.

Poultry and poultry products

In 1989, the Danish poultry industry initiated a control programme for *Salmonella* in the broiler production. In 1991, this programme was followed by another control programme for *Salmonella* in the table-egg production. Both of these programmes were voluntary and concentrated mainly on the top of the production system i.e. parent animal flocks.

In 1992, the Danish Ministry of Agriculture and Fisheries implemented the official Ante-Mortem examination of broilers. All broiler flocks were hereafter monitored for *Salmonella* prior to slaughter. At slaughter positive and negative flocks were slaughtered separately.

The Zoonosis Directive (92/117/EEC) was implemented in Denmark in January 1994 and in accordance with the Directive all parent-animal flocks within the broiler and table-egg production were tested for *S.* Enteritidis and *S.* Typhimurium.

In 1996, the Danish Ministry of Agriculture and Fisheries implemented a more intensive control programme including monitoring of *Salmonella* in the entire table-egg production. Serology on eggs was introduced and sero-positive flocks were followed by bacteriology. Breeder flocks found infected with *Salmonella* of any type, and rearing and commercial-layer flocks infected with *S.* Typhimurium or *S.* Enteritidis were slaughtered. Because more parent flocks than originally anticipated were found to be infected with *Salmonella*, the programme was discontinued in the rearing and layer flocks for a period from September 1997 to March 1998. Intervention then focused on the top of the production pyramid in an attempt to free this part from *Salmonella*. The serological monitoring of layer flocks continued during this period.

In the beginning of 1998, the situation in the breeder flocks had been brought under control, and a revised version of the original programme was implemented on the 2nd of March 1998 (Table 3), when four new governmental orders concerning *Salmonella* in Danish poultry were put into effect. The programme once more included all parts of the production system, but as something new, the intervention in rearing and layer flocks also included flocks infected with other types than *S.* Enteritidis and *S.* Typhimurium.

Layer flocks testing positive for *Salmonella* in routine samples were "suspected" of being infected with *Salmonella*. As a consequence, the district veterinary officer (DVO) took samples consisting of faecal material and dead chickens. If the second set of samples were positive, the flock was declared infected with *Salmonella* and consequently all eggs from the flock were heat treated (pasteurised).

During the summer of 1998, a few cases of human salmonellosis was caused by eggs from flocks suspected but not yet confirmed as being infected with *Salmonella*. To prevent such incidents the programme was adjusted once more by the implementation of a new governmental order in September 1998. Eggs from layer flocks suspected of being infected with *Salmonella* were hereafter sent to

Table 2. Number of establishments in the broiler production and the table-egg production in 1998.

	No. of establishments	No. of houses	No. of animals
	Broiler production		
Central rearing	19	92	1,200,000 purchased per year
Broiler breeders	66	210	
Broilers	342	785	134,000,000
	Table-egg production		
Central rearing	6	7	80,000 purchased per year
Layer breeders	12	23	
Hatcheries	6	55	-
Rearing	122	196	4,000,000
Layers	366	515	4,200,000

Data: Danish Veterinary and Food Administration.

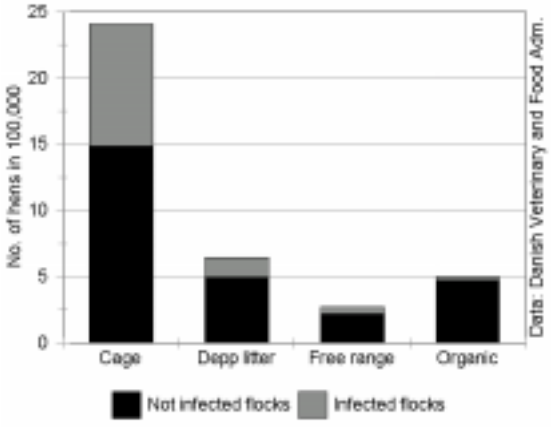

Figure 2. Number of hens from infected and not infected flocks according to type of table-egg production in 1998.

Table 3. Salmonella *surveillance of the broiler and table-egg sector after the 2nd of March 1998.*

Age or Frequency	Samples taken after the 2nd of March 1998.
	CENTRAL - REARING STATIONS Broiler and table-egg sector
Day-old chickens	10 samples of cratematerial, 20 dead/destroyed chickens [a]
1 week	40 dead chickens
2 weeks	20 dead chickens
4 weeks	30 dead chickens and 60 faecal samples [a]
8 weeks	60 faecal samples
2 weeks prior to moving	12x5 faecal samples and 60 blood samples [a] [b]
	BREEDERS (HATCHING-EGG PRODUCTION) Broiler and table-egg sector
Every 2 weeks	50 dead chickens or meconium from 250 chickens taken from the hatchery [a] [c]
Every 4 weeks	60 faecal samples and 60 samples of blood or eggs taken from the flock [d]
	HATCHERY
Every week	Wet dust
	REARING - TABLE-EGG PRODUCTION
Day-old chickens	10 samples of cratematerial and 20 dead chickens
Every 3 weeks	60 faecal samples
Every 12 weeks	12x5 faecal samples and 60 blood samples [b]
	TABLE-EGG PRODUCTION
Every 9th week for eggs sold to authorized egg - packing centres	60 faecal samples and 60 egg samples
Every 6 months for eggs sold at barnyard sale	Faecal and egg samples

a) Requirements of the EU Zoonosis Directive (92/117/EEC).
b) Samples taken by the district veterinary officer.
c) Samples taken by the district veterinary officer every 8 week.
d) Samples taken by the district veterinary officer every 3 months.

heat treatment until the confirmatory test results were available.

Due to the fact that the serological test for *Salmonella* has a higher sensitivity than the bacteriological test, another important change was made. Laying flocks could now be declared infected with *Salmonella* on the basis of two consecutive positive serological tests.

Table-egg production

In 1998, no central-rearing or layer-breeder flocks were found infected with *Salmonella*. A total of 11 out of 375 rearing flocks examined were found infected with *Salmonella*. Of these, 10 flocks were infected with S. Enteritidis and 1 flock with other serotypes (Table 4).

In flocks producing table-eggs for authorised egg-packing centres, 193 flocks out of 770 flocks examined were put "under suspicion" and 105 flocks were confirmed as being infected with *Salmonella*. Of these, 91 flocks were infected with *S.* Enteritidis, 6 flocks were infected with *S.* Typhimurium and 6 flocks were infected with other serotypes. In 4 flocks, more than one serotype was found. In 2 sero-positive flocks the serotype was not determined (Table 4).

Table 4. Occurrence of Salmonella *in the table-egg production in 1998.*

	Central rearing		Layer breeders		Rearing		Table-egg production	
	Examined flocks	Positive flocks (%)	Examined flocks	Positive flocks (%)	Examined flocks	Positive flocks (%)	Examined flocks	Positive flocks (%)
Salmonella spp.	21	0	42	0	375	11(2.9)	770	[a]105(13.6)
S. Enteritidis	-	0	-	0	-	10(2.7)	-	91(11.8)
S. Typhimurium	-	0	-	0	-	0	-	6(0.8)
Other serotypes	-	0	-	0	-	1(0.3)	-	6(1.0)

Data: Danish Veterinary Laboratory and Danish Veterinary and Food Administration.
a) 2 flocks found infected exclusively based on serological confirmation.

In flocks producing table eggs for barnyard sale, 33 out of 400 examined flocks were put “under suspicion” and 15 were later confirmed as being infected with *Salmonella*.

Broiler production

In 1998, *Salmonella* was not isolated from any central-rearing flocks. Among the broiler breeders (hatching-egg production), 2 (0.6%) flocks were found infected with *Salmonella* (Table 5).

Salmonella was monitored continously by ante-mortem examination of all broiler flocks. Three weeks prior to slaughter, five pair of so-called "sock-samples" were collected from each flock. A "sock-sample" consist of 15 cm pieces of tube gauze mounted on the footwear during inspection of the house. This method has been shown to have superior sensitivity to 60 faecal samples and the actual sampling is easier to perform. The percentage of positive flocks ranged from 3.9% to 13.7% per month with a mean of 6.5% (Table 5, Figure 3). The most frequently encountered serotypes were *S.* Enteritidis and *S.* Typhimurium, which were found in 24.5% and 18.2% of the infected flocks, respectively. The sero- and phage-type distributions are shown in Tables 15, 16 and 17.

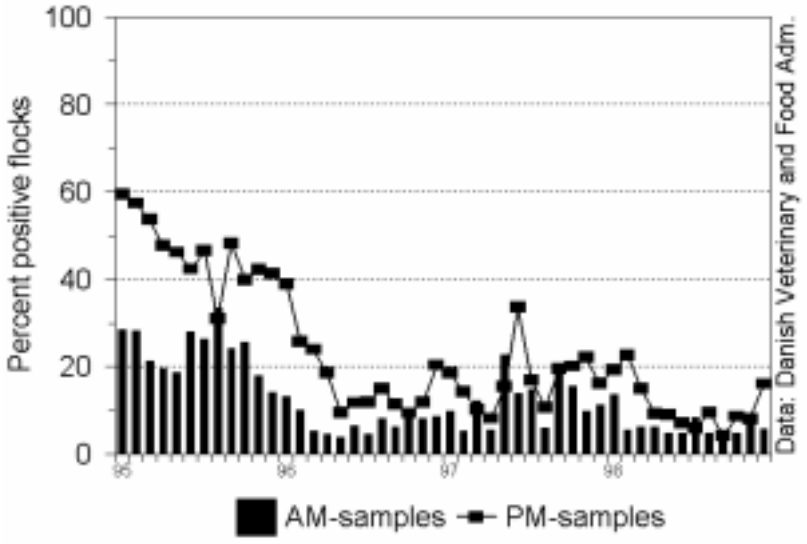

Figure 3. Percent Salmonella *positive broiler flocks detected as part of the mandatory ante-mortem and post-mortem inspection, 1995-98.*

Salmonella was detected in a total of 11.1% of the flocks after slaughter by examination of 5 pooled samples each consisting of 10 neck-skin samples from each slaughter flock (Table 5, Figure 3).

Turkey production

Salmonella was detected in 34 of 366 flocks investigated by the mandatory ante-mortem examination. Of these, 2 flocks were infected with *S.* Enteritidis, 1 flock with *S.* Typhimurium and 31 flocks with other serotypes. The most frequently occurring serotype was *S.* Derby found in 14 (41%) of the infected flocks (Table 15). The percentage of positive flocks ranged from 0.0% to 24.2% per month with a mean of

Table 5. Occurrence of Salmonella *and* Campylobacter *in the broiler production in Denmark in 1998.*

	Flock level				Slaughterhouse		Retail - broilers and products of broiler meat				
	Broiler breeders		Broiler flocks		Neck skin		Not heat treated		Heat treated		
Zoonotic pathogen	Flocks examined	% positive flocks	Flocks examined	% positive flocks	N	% positive flocks	N	% positive samples	N	% positive samples	Note:
Salmonella spp.	344	0.6	4,166	6.5	4,985	11.1	283	10.6	158	0	a
S. Enteritidis	-	0.3	-	1.6	-	-	-	1.4	-	-	-
S. Typhimurium	-	0	-	1.2	-	-	-	0.7	-	-	-
Other serotypes	-	0.3	-	3.7	-	-	-	8.5	-	-	-
Campylobacter spp.	-	-	5,943	47.1	-	-	819	28.0	-	-	b
C. jejuni	-	-	-	40.1	-	-	-	-	-	-	-
C. coli	-	-	-	5.2	-	-	-	-	-	-	-
C. lari	-	-	-	0.3	-	-	-	-	-	-	-
Other species	-	-	-	1.5	-	-	-	-	-	-	-

Data: Danish Veterinary Laboratory and Danish Veterinary and Food Administration

a) Parent flocks examined by samples of droppings every 4th week. Broiler flocks monitored by "sock-samples" 2-3 weeks prior to slaughter and by 50 neck-skin samples at slaughter.

b) Flocks investigated by cloacal swabs collected at slaughter, ten chickens per flock were examined.

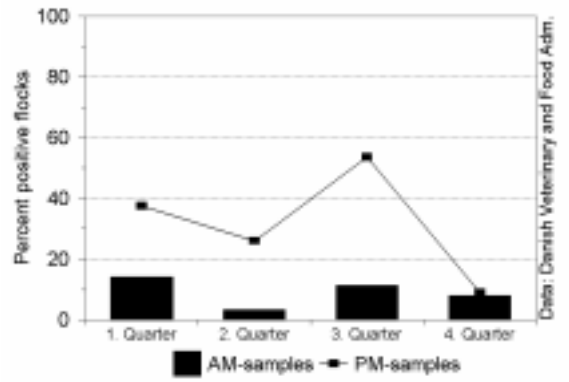

Figure 4. Percent Salmonella *positive turkey flocks detected as a part of the mandatory ante-mortem and post-mortem inspection, 1998.*

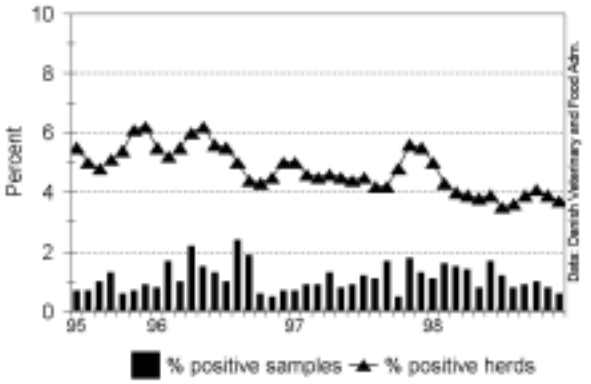

Figure 5. Percent Salmonella *positive samples of fresh cuts of pork and percent positive herds (Level 2 and 3 herds), 1995-98.*

9.3% (Table 6, Figure 4).

Salmonella was detected in a total of 109 (32.1%) out of 340 flocks examined after slaughter (Table 6, Figure 4).

Pigs and pork

A serological surveillance programme for detection of *Salmonella* infection in slaughter-pig herds was implemented in the beginning of 1995. All herds producing more than 100 pigs for slaughter per year are monitored by serologically testing meat juice. The herds are assigned to one of three levels based on the proportion of samples with a serological reaction. Level 1: a herd with no or very few reactors where intervention is not required; Level 2: a herd with a higher proportion of reactors and where the owner is required to seek advice on how to reduce the prevalence of *Salmonella*; Level 3: the proportion of reactors in the herd is unacceptably high and the owner is required to seek advice and in addition slaughter of pigs from the herd has to be carried out under special hygienic precautions. From August 1996, the requirements to the herds in Level 2 and 3 were increased by an order issued by the Danish Veterinary and Food Administration. These requirements made it mandatory to collect a sufficient number of pen faecal samples in order to clarify the distribution of *Salmonella* in the herd. Based on the results, an intervention plan must be prepared by the farm advisors.

As described in the 1997 report, an independent group of experts evaluated the plan for control of *Salmonella* in pigs and pork products. In particular, the group suggested adjustments in the top of the breeding pyramid. These adjustments have been implemented in the plan as follows:

- Breeding and multiplying herds are obliged to collect pen-faecal samples if a specific cut-off level in the monthly serological tests is reached. If serological reactions exceed a specific high

Tabel 6. Occurrence of Salmonella *and* Campylobacter *in the turkey production in Denmark in 1998.*

	Flock level		Slaughterhouse		Retail - cuts and products of turkey meat				
	Turkey flocks		Neck skin		Not heat treated		Heat treated		
	Flocks examined	% positive flocks	N	% positive flocks	N	% positive samples	N	% positive samples	Note:
Salmonella spp.	366	9.3	340	32.1	525	4.0	72	0	a
S. Enteritidis	-	0.5	-	-	-	0.0	-	-	-
S. Typhimurium	-	0.3	-	-	-	0.2	-	-	-
Other serotypes	-	8.5	-	-	-	3.8	-	-	-
Campylobacter spp.	-	-	-	-	411	14.0	-	-	-

Data: Danish Veterinary Laboratory and Danish Veterinary and Food Administration

a) Flocks monitored by "sock-samples" 2-3 weeks prior to slaughter and by 50 neck-skin samples at slaughter.

level, all movement of livestock from the herd is stopped.

- Sow herds producing piglets for slaughter-pig herds placed in level 2 or 3 are also obliged to collect pen-faecal samples in order to determine the distribution of *Salmonella* within the herd, and to clarify a possible transmission of *Salmonella* from the sow herd to the slaughter-pig herd.

At the end of 1998, 96.3% of the herds fell within Level 1, 2.7% within Level 2 and 1.0% within Level 3. Compared to 1997, there has been a reduction in the proportion of *Salmonella* positive herds (Figure 5).

A continuous programme for monitoring of *Salmonella* in pork at the slaughterhouses was initiated in July 1993. Approximately 2,250 samples are analysed every month. For each slaughterhouse the number of samples collected is determined by the actual number of animals slaughtered, as described in the Danish plan. In 1998, the number of *Salmonella* positive cuts of pork varied between 0.5% and 1.7% with a mean of 1.1%, which is at the same level of contamination as in 1997 (Table 7, Figure 5). The reduction of *Salmonella* positive slaughter-pig herds did apparently not result in a similar reduction of *Salmonella* level in pork. This is mainly explained by *S.* Infantis contamination of the slaughter equipment at a few slaughterhouses. These so-called "house-strain" infections resulted in an increase of positive cuts of pork with this particular serotype. With exception of *S.* Infantis, the distribution of *Salmonella* serotypes and phage types in pork at the slaughterhouses largely reflects the distribution of types in the herds (Tables 15 and 17).

Clinical salmonellosis was recorded in 51 herds (Table 8). This figure was determined by the number of herds submitting material from clinically affected animals to the laboratory. Of these, 37 herds were placed under official veterinary supervision by the district veterinary

Table 8. Isolation of Salmonella *from outbreaks of clinical disease in pig and cattle herds in 1997 and 1998.*

Serotype	Pig herds		Cattle herds	
	1997	1998	1997	1998
Agona	-	1	-	-
Brandenburg	-	-	-	1
Derby	2	4	-	5
Dublin	-	-	94	52
Enteritidis	-	-	2	1
Infantis	2	4	-	-
Ohio	1	-	-	-
Orion 15var	1	-	-	-
Saint Paul	-	-	-	1
Typhimurium	68	39	26	20
Typhimurium/Derby	-	1	-	-
Typhimurium/Indiana	1	-	-	-
1.4.12:d-	1	-	-	-
4.5.12:-:-	-	-	1	-
4.12:b:-	1	1	-	-
9.12:-:-	-	-	3	2
Unknown	-	1	-	1
Total	77	51	126	83

Data: Danish Veterinary and Food Administration.

Table 7. Occurrence of zoonotic pathogens in pigs and pork in Denmark 1998.

	Herd level			Slaughterhouse				Retail				
	Examined			Cuts of pork		Offal		Not heat treated		Heat treated		
Zoonotic pathogen	Herds	Animals	% positive herds	N	% positive samples	N	% positive samples	N	% positive samples	N	% positive samples	Note:
Mycobacterium bovis	18,829	20.8 mill	0	-	0	-	0	-	0	-	0	a
Brucella abortus	-	-	-	-	-	-	-	-	-	-	-	b
Trichinella spp.	18,829	20.6 mill	0	-	0	-	0	-	0	-	0	c
Salmonella spp.	16,756	648,791	3.7	17,846	1.1	9,091	2.7	2,660	0.7	2,311	0.08	d
S. Enteritidis	-	-	-	-	0	-	0	-	0.04	-	0.04	-
S. Typhimurium	-	-	-	-	0.6	-	1.6	-	0.2	-	0	-
Other serotypes	-	-	-	-	0.6	-	1.1	-	0.46	-	0.04	-
Campylobacter spp.	318	318	68.6	-	-	-	-	-	-	-	-	e
C. jejuni	-	-	4.1	-	-	-	-	-	-	-	-	-
C. coli	-	-	63.2	-	-	-	-	-	-	-	-	-
C. lari	-	-	1.3	-	-	-	-	-	-	-	-	-
Y. enterocolitica O:3	-	-	-	-	-	-	-	600	0.2	-	-	

Data: Danish Veterinary Laboratory and Danish Veterinary and Food Administration

a) All slaughter pigs are examined in connection with meat inspection.
b) Boars examined on admission to semen collection centres and before leaving the station. No cases found in 1998.
c) All pigs slaughtered at export slaughterhouses are examined in connection with meat inspection
d) Herds are monitored by serological testing. Herds belonging to Level 2 and 3 are defined as Salmonella positive.
e) Herds investigated by caecal samples from one animal per herd collected at slaughter.

Screening for multiresistant *S.* Typhimurium DT104

Occurrence of DT104 in the primary production

During the period from December 1996 to March 1999, 31 domestic animal herds (17 swine herds, 3 cattle herds and 11 combined cattle- and swine herds) were found infected with multiresistant *Salmonella* Typhimurium DT104 (DT104). In addition, DT104 was found in imported swine held in quarantine. DT104 has not been found in Danish poultry.

Background for the DT104 screening

In May 1998, the Danish Veterinary and Food Administration implemented a programme with the objective to reduce or eliminate DT104 in herds of domestic animals. The aims of the programme was to protect consumers from the health risks associated with the presence of DT104 in food and to prevent DT104 from spreading among herds.

As part of the programme, it was decided to carry out a screening to estimate the prevalence of DT104 in swine and cattle herds.

The primary purpose of the screening was to obtain an overall picture of the current prevalence of DT104 infected herds in Denmark and hereby make it possible to work out a future strategy for controlling DT104. Secondarily, the screening would shed light on the current distribution of other *Salmonella* types. Finally, the screening was to be used as a tool to evaluate the effect of the *Salmonella* control programme for swine, by comparing the bacteriological results with the results from a preliminary screening carried out in 1993/94, where 1,519 finishing-pig herds were tested.

Results

The screening for DT104 in 1998 included 366 multiplier and breeding pig herds, 305 piglet producing herds and 1,962 finishing herds. The main conclusions were:

- DT104 was found in 1 of 1,962 finishing herds, resulting in a herd prevalence of 0.5 per thousand. DT104 was not found in any of the 366 multiplying and breeding herds, nor in any of the 305 tested piglet-producing herds.
- *S.* Typhimurium is the most commonly found serotype in swine herds in Denmark. Thirty-two other serotypes were found, *S.* Derby, *S.* Infantis and *S.* Livingstone being the most common among these.
- The *Salmonella* control programme for swine implemented in 1995 has been successful. The prevalence of *Salmonella* in swine herds has been reduced by almost 50% from 1993/1994 to 1998. In 1993/94, *S. enterica* was found in 22.2% of the tested finishing herds, compared to 11.4% in 1998. Results from the screening in 1998 showed that the prevalence of *S. enterica* in multiplier/breeding herds and piglet-producing herds was 11.7% and 16.7% respectively.

A total of 265 cattle herds were included in the screening for DT104 in 1998. *S.* Typhmurium DT104 was not isolated from any of these herds.

Screening of imported products

In July 1998, a screening for the content of DT104 in EU meat and third country meat was initiated. From July until December the following fresh meat samples were examined (most samples originate from EU-countries, some from countries outside the EU):

- 1,339 samples of poultry meat, 436 (53%) positive for Salmonella, 11 (0.8%) samples positive for DT104
- 427 samples of pork, 44 (10%) positive for Salmonella, 7 (1.7%) samples positive for DT104
- 700 samples of beef, 3 (0.4%) samples positive for Salmonella, 1 (0.1%) sample positive for DT104

Table 9. Occurrence of zoonotic pathogens in cattle and beef in Denmark 1998.

	Herd level			Slaughterhouse				Retail				
	Examined			Cuts of beef		Offal		Not heat treated		Heat treated		
Zoonotic pathogen	Herds	Animals	% positive herds	N	% positive samples	N	% positive samples	N	% positive samples	N	% positive samples	Note:
Mycobacterium bovis	-	-	0	All	0	All	0	-	0		0	a
Brucella abortus	-	-	0	-	-	-	-	-				b
Salmonella spp.	286	286	0	2,145	0.3	1,026	1.2	2,600	0.5	745	0.13	c
S. Enteritidis	-	-	0	-	0	-	0	-	0.1	-	0	-
S. Typhimurium	-	-	0	-	0	-	0.2	-	0.07	-	0.13	-
S. Dublin	-	-	0	-	0.2	-	0.8	-	0	-	0	-
Other serotypes	-	-	0	-	0.1	-	0.2	-	0.33	-	0	-
Campylobacter spp.	85	85	47.0	-	-	-	-	-	-	-	-	c
C. jejuni	-	-	42.4	-	-	-	-	-	-	-	-	-
C. coli	-	-	3.5	-	-	-	-	-	-	-	-	-
C. lari	-	-	1.2	-	-	-	-	-	-	-	-	-
E. coli O157 (VT+)	248	248	0.4	-	-	-	-	-	-	-	-	c

Data: Danish Veterinary Laboratory and Danish Veterinary and Food Administration.
a) Bulls at semen collection centres are examined by TB test. Notifiable disease. No cases diagnosed in 1998.
b) Bulls examined on admission to semen collection centres and annually after entry. Clusters of abortions are notifiable. Notifiable disease in cattle.
c) Herds were investigated by caecal samples from one animal per herd collected at slaughter.

officer. *Salmonella* Choleraesuis is not present in Danish pig herds.

Cattle and beef

Herds of cattle are investigated for *Salmonella* on clinical indications and as part of a continous monitoring programme of zoonotic bacteria. Salmonellosis was diagnosed in 83 (0.3%) cattle herds in 1998 (Table 8). Of these, 22 herds were placed under official veterinary supervision by the district veterinary officer. The predominant serotypes isolated from clinical cases in cattle in 1998 were *S.* Dublin (63%) and *S.* Typhimurium (24%) (Tables 8 and Table 15). As part of the surveillance programme, 286 caecal samples were collected at slaughterhouses. One animal per herd was sampled and no positive samples were found (Table 9).

At slaughterhouses, approximately 270 samples in total are collected each month from a representative sample of the beef cuts and the offal. The number of positive samples of beef cuts per month has ranged from 0.0% to 1.3% during 1998 with a mean of 0.3% (Table 9), which is comparable with 1997 (0.4%). The predominant serotype was *S.* Dublin (68%) (Table 15).

Products from retail outlets

The Municipal Food and Environmental Laboratories collect samples for routine surveillance of meat and meat products at the retail level.

A total of 441 samples of broilers and broiler products, 597 samples of turkey cuts and turkey products, 4,971 samples of pork and pork products, and 3,345 samples of beef and beef products have been examined in 1998. In not heat-treated samples the prevalences were 10.6%, 7.0%, 0.7% and 0.5%, respectively. The prevalences in heat-treated products were less than 0.2% (Tables 5, 6, 7 and 9).

Salmonellosis in humans

In 1998, the registered number of human salmonellosis caused by zoonotic serotypes was 3,880 (73 cases per 100,000 inhabitants). Thus, the incidence in 1998 fell by 23% compared with 1997 (5,015 cases), but was higher than the incidence in 1996 where 3,250 salmonella-cases were found (Figure 6, Table 11).

The decrease in 1998 compared with 1997 was mainly due to a lower number of *S.* Enteritidis cases (2,607 compared with 3,674 in 1997, i.e., a 29% reduction). However, the incidence of *S.* Enteritidis remains high compared with the years before 1997, e.g. 1,771 cases in 1996 and 2,070 cases in 1995. Table 16 shows the phage-type distribution of 218 human isolates of *S.* Enterti-

dis. The major types were PT8 (40%), PT6 (29%) and PT4 (11%). Whereas more than 95% of PT8 and PT6 cases were domestically acquired, 50% of the cases of PT4 had a history of foreign travel. In addition, PT1 was associated with travel.

Figure 7 compares the age-specific incidence of *S.* Enteritidis in 1998 with 1997. It appears, that the decreased incidence was most pronounced at the extremes in age, consistent with the fact that the decrease was mainly related to a lower number of domestically acquired cases. Figure 9 shows the geographical distribution of the *S.* Enteritidis. The incidence was high in some of the counties in Zealand and in the county of Ribe in Jutland. The high incidence in Ribe county was related to an outbreak of *S.* Enteritidis PT6 associated with cross-contamination of shrimps.

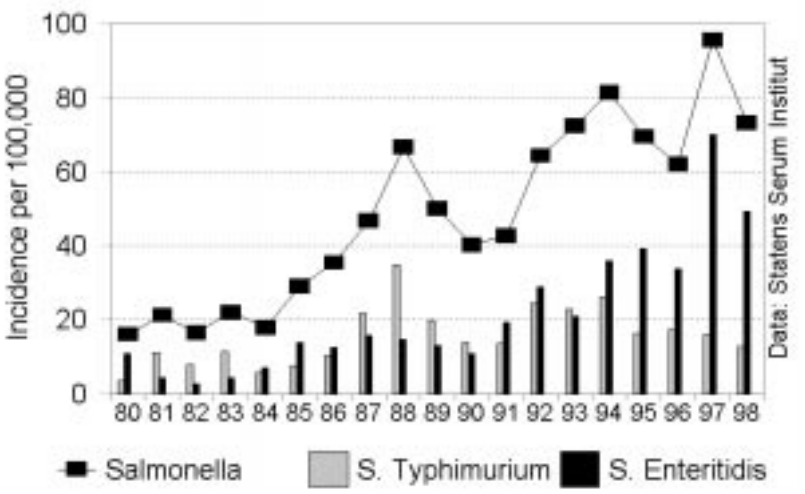

Figure 6. Registered cases of human salmonellosis in Denmark 1980-98.

It is estimated that approximately 85% of *S.* Enteritidis infections are domestically acquired.

There was a 20% reduction in the number of *S.* Typhimurium cases compared with 1997 (678 cases versus 841). Hence, the incidence of sporadic cases of *S.* Typhimurium in Denmark has gradually declined since 1994. Table 17 shows the phage-type distribution of 474 human isolates. DT12 (43%) is still the major phage type, but DT104 has increased and now accounts for 13% of *S.* Typhimurium phage types compared with 7% in 1997. This

Table 11. Zoonoses in humans 1998 - incidence and trends of 5 and 10 years

	1998		Five years trend					10 years	
Agent	Cases per 100.000 inh.	Registered cases	1997	1996	1995	1994	1993	1988	Note:
Mycobacterium bovis	0.2	8	11	11	9	5	7	8	a
Brucella abortus/melitensis	0	0	0	0	0	0	0	0	a
Trichinella spiralis/nativa	0	0	0	0	0	0	0	0	a
Salmonella spp.	73.3	3,880	5,015	3,259	3,654	4,276	3,802	3,495	b
S. Enteritidis	49.2	2,607	3,674	1,771	2,070	1,876	1,093	711	
S. Typhimurium	12.8	678	841	907	848	1,363	1,193	1,826	
Other serotypes	11.2	595	500	581	736	1,037	1,516	898	
C. coli/jejuni	63.7	3,372	2,666	2,973	2,601	2,196	1,776	1,445	
E. multilocularis/granulosus	0	0	0	0	0	0	0	0	c
Listeria monocytogenes	0.8	41	33	39	29	23	27	37	d
Rabies	0	0	0	0	0	0	0	0	e
Toxoplasma gondii	-	-	-	-	-	-	-	-	f
Yersinia enterocolitica	8.8	464	430	532	779	643	710	1,015	
Escherichia coli (VTEC)	0.6	34	33	5	2	10	4	3	
O157 (VTEC)	0.1	6	12	3	2	3	1	1	

Data: Statens Serum Institut.

a) Notification not mandatory. Cases of tuberculosis due to reactivation of latent infections in elderly or imported disease.
b) Only first isolations registered.
c) Notification not mandatory. A few imported cases occur.
d) Notification mandatory from 1986.
e) Notification mandatory. No domestical or imported cases.
f) Notification not mandatory. Approximately 1% of the population seroconvert annually.

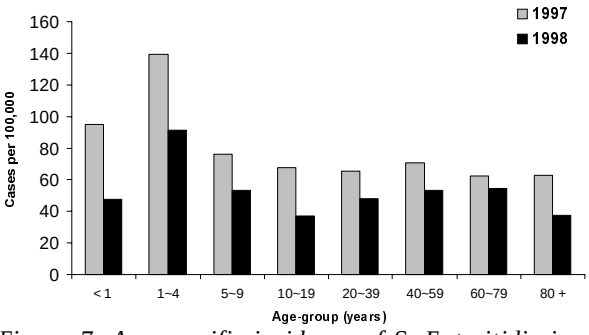

Figure 7. Age-specific incidence of S. *Enteritidis in 1997 and 1998. Data: Statens Serum Institut.*

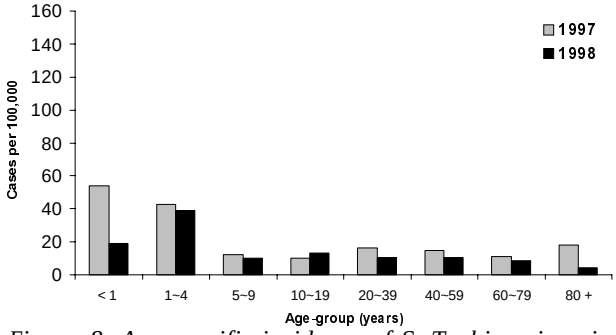

Figure 8. Age-specific incidence of S. *Typhimurium in 1997 and 1998. Data: Statens Serum Institut.*

increase is explained by the first community outbreak of *S.* Typhimurium DT104. The outbreak included 25 culture-confirmed cases and was traced back to pork of Danish origin.

The organism involved in this outbreak showed the classical penta-resistance pattern, but was also resistant to a quinolone, nalidixic acid. This resistance pattern had not previously been found in Danish food animals or food, and only on two occasions in humans. This unusual resistance pattern from the patients corresponded to that found in isolates from a slaughterhouse in Zealand, as well as in isolates collected by the Municipal Food and Environmental Laboratories in Copenhagen and Roskilde. All had the same DNA-fingerprinting pattern.

A connection between the finding of nalidixic acid resistant *S.* Typhimurium DT104 both in fresh pork and in these patients was further supported by patient interviews, which revealed that patients had bought and eaten pork from shops that had been supplied by the slaughterhouse in question. In addition, two swine herds that had sent animals for slaughter at the plant were identified, and *Salmonella* isolates from the herds were identical to isolates from the slaughterhouse, the pork, and the patients.

It is estimated that approximately 87% of *S.* Typhimurium infections are domestically acquired.

Figure 8 compares the age-specific incidence of *S.* Typhimurium in 1998 with 1997, and Figure 10 shows the geographical distribution of this serotype. The incidence was high in South Jutland County (83 cases in 1998 compared with 33 in 1997). The increased incidence in this county was mainly related to *Salmonella* pro-

Figure 9. Geographical distribution and incidence of human cases of S. *Enteritidis in 1998. Data: Statens Serum Institut.*

Figure 10. Geographical distribution and incidence of human cases of S. *Typhimurium in 1998. Data: Statens Serum Institut.*

Table 12. Laboratory based surveillance of outbreaks of food-borne zoonotic diseases diagnosed by Statens Serum Institut, 1998.

Zoonotic pathogen	No. of outbreaks	No. of patients involved	Suspected source
S. Enteritidis	4	5-40	Buttermilk dish (3), meat balls (1)
S. Typhimurium	2	27-30	Pork
S. Infantis	1	139	Chicken or pork meat
S. Manhattan	1	39	Smoked fillet of pork
Campylobacter	1	4	Cake
ETEC	1	21	Vegetables ?
Shigella sonnei	1	app. 80	Imported baby maize
Unknown	1	20	Homemade icecream

Data: Statens Serum Institut.

blems in a local pig slaughterhouse.

The remaining 595 zoonotic *Salmonella* cases were distributed over more than 100 different serotypes. Among these were *S.* Hadar (61 cases), *S.* Manhattan (44 cases), *S.* Infantis (35 cases), *S.* Virchow (30 cases), and *S.* Agona (30 cases). Table 15 shows the distribution of major serotypes. In 1997, a total of 500 "exotic" *Salmonella* serotypes were registered. The increase were mainly due to an outbreak caused by *S.* Manhattan which occurred in January 1998.

Salmonella Manhattan is rarely found in humans in Denmark, usually isolated between 0 and 3 times each year. From the first week of 1998 the incidence increased, with cases occurring throughout Denmark, predominantly in adults. A case-control study showed that ten out of 16 cases had eaten cured and smoked ready-to-eat fillet of pork in the three days before becoming ill, compared with 4 out of 45 matched controls (odds ratio 17, $p<0.0001$). The fillet was traced back to a particular slicing plant. The Danish Veterinary and Food Administration was informed about the results of the investigation and the product was withdrawn from shops on February 17. A week later *S.* Manhattan was isolated from a packet of smoked fillet. From April 98, only two cases of *S.* Manhattan were registered.

Table 12 summarises outbreaks diagnosed by Statens Serum Institut in 1998, whereas Table 13 summarises the number of suspected food-borne infections as reported to Statens Serum Institut by the general practitioners.

Only in case of outbreaks of probable food-borne disease (defined as two or more cases associated with the same potential source of infection),

Table 13. Suspected food-borne zoonotic infections reported to Statens Serum Institut, 1998.

	Infections acquired outside the home		Household infections	
Zoonotic pathogen	No. of reported infections	Suspected source	No. of reported infections	Suspected source
S. Enteritidis	32	Homemade ice cream, buttermilk dish, smoked fillet of pork, roasted piglet, cheese cake, poultry	6	Buttermilk dish , smoked eel, sausages, raw egg
S. Typhimurium	10	Minced veal and pork , home-smoked lamb, roasted piglet, hamburgers	4	Egg, sausages
Campylobacter	10	Chicken, pork, sausages, poultry, hamburgers	3	Poultry
Others a)	18	Turkey, meat balls, chicken, minced beef, pork	4	Poultry, egg
Unknown	28	Egg, paté of goose, buttermilk dish, smoked fillet of pork, sausages	3	Egg, veal, paté, ice cream, buttermilk dish, stew of pork, minced beef

Data: Statens Serum Institut. a) Other zoonotic Salmonella spp. and Yersinia enterocolitica O:3.

Eggs, Humans and *S.* Enteritidis

In 1997, the incidence of human salmonella-infections due to *S.* Enteritids more than doubled compared with 1996, and thereby reached a historical hight. Surveillance in layers, epidemiological typing of bacterial isolates from different sources, and evidence from outbreak investigations suggested that the increasing incidence of *S.* Enteritidis was due to increased levels of contamination of layers and shell eggs. This evidence was further corroborated from a case-control study of sporadic cases which suggested that in 1998, raw eggs and food containing raw egg was the major risk factor for domestically acquired *S.* Enteritidis infections.

The decreased incidence in 1998 is probably related to several factors.

As described earlier, a plan to control *Salmonella* in layers was implemented in 1996 with further adjustments added in March and September 1998. The continuously monitoring of all flocks and the destruction of infected breeder and rearing flocks has resulted in a decreasing prevalence of *Salmonella* in the table-egg producing flocks in 1998. Further, the plan ascertains that eggs from production flocks found serological or bacteriological positive for *Salmonella* are referred to heat-treatment. Consequently, the risk to the consumers has been reduced considerably.

There is therefore little doubt that the plan contributed to the reduction of the incidence of *S.* Enteritidis. However, factors affecting consumer habits may also have an effect. Attention from the press and other public media, as well as a cold summer of 1998, may have reduced the use of raw eggs in dishes that are not heat treated, e.g. home-made icecream. It is difficult to disentagle effects of control plans at the farm level from behavioural changes at the consumer level.

the Municipal Food and Environmental Laboratories will be requested to identify a possible common source. In 1998, 25 outbreaks caused by *Salmonella* were investigated (Table 14). A total amount of 306 patients were involved in the outbreaks. In 12 outbreaks (general outbreaks), the suspected foodstuff was prepared by commercial

Table 14. Outbreaks of food-borne salmonellosis registered by the Municipal Food and Environmental Laboratories in 1998.

General outbreaks					Family outbreaks				
Zoonotic agent	No. of out-breaks	No. of patients involved	Suspected source	Confirmed by culture (+/-)	Zoonotic agent	No. of out-breaks	No. of patients involved	Suspected source	Confirmed by culture (+/-)
S. Enteritidis	7	2-21	Steak of veal (1)	-	*S.* Enteritidis	12	2-15	Buttermilk dish (7)	+ (3), - (4)
			Roast chicken (1)	-				Cake dough (1)	-
			Cheesecake (1)	+				Egg yolk Cheesecake (1)	+
			Shrimps with eggs, salmon (1)	+				Dessert with egg whites (1)	-
			Herring, shrimps with eggs (1)	-				Salmon, spinach, eggs (1)	+
			Beef, marinated chicken (1)	+					+
			Mashed potatoes (1)	-					
S. Typhimurium	3	3	Grilled pork (1)	+	*S.* Kottbus	1	2	Turkey	+
			Sausages (1)	+					
			Unknown (1)	-					
Others*	2	4-139	Turkey (1)	+					
			Chicken (1)	-					

Data: Danish Veterinary and Food Administration. * *S.* Hadar and *S.* Infantis.

retailers, wholesalers and manufactures. In 13 outbreaks (family outbreaks), the suspected foodstuff was produced in private homes. Use of raw eggs in desserts was, like in 1997, a major source of food-borne outbreaks, especially in family outbreaks. Cross-contamination and undercooked food were other contributory causes.

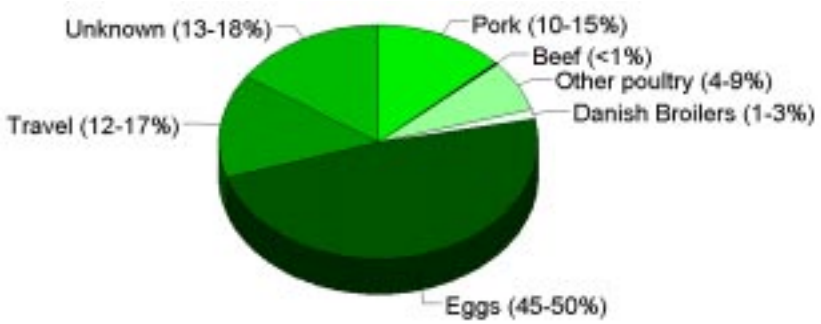

Figure 12. Estimated sources for human salmonellosis in Denmark in 1998. Other poultry includes turkey, duck and imported poultry of various kinds. Data: Danish Zoonosis Centre.

Risk assessment of sources of human salmonellosis

As described in this and previous issues of this report, all major food animals and food of animal origin are monitored continuously for *Salmonella*. The resulting collection of 10-20,000 *Salmonella* isolates per year is serotyped and isolates of *S.* Typhimurium and *S.* Enteritidis are phage typed. In addition, a sub-sample of the strains is typed by antibiogram typing and molecular methods, primarily pulsed-field gel electrophoresis.

A comparison of *Salmonella* types isolated from food animals and food with isolates from humans, makes it possible to produce estimates of the number of human cases attributable to certain animal sources. It is prerequisite that some of the predominating *Salmonella* types are found almost exclusively in a single animal reservoir or food stuff. *Salmonella* types that are found in several reservoirs, may then be distributed in proportion to the occurrence of these so-called "typical" types, assuming that the pathogenicity of the different types is equal.

This rather crude assessment has been shown to render results that are useful in monitoring the dynamics in the changing sources of human salmonellosis in Denmark. Figure 11 shows that Denmark has experienced three waves of human salmonellosis, where the majority of cases has been caused by three distinct sources: broilers in the late 80'ies, pork in the mid 90'ies and eggs in the mid/late 90'ies. At each peak, a new control programme has been implemented and resulted in a reduction of human cases attributable to that particular source.

In 1998 in Denmark, the estimated number of human cases pr. 100,000 inhabitants that could be attributed to various animal sources, was as follows: eggs: 35; travel: 10; pork: 10; Danish produced broilers: 1; other poultry (turkeys, ducks and imported poultry of various kinds): 5; beef: 0.2. Approximately 600 cases (11 per. 100,000) could not be associated with any specific source, but some of these infections are probably related to pet animals (Figure 12).

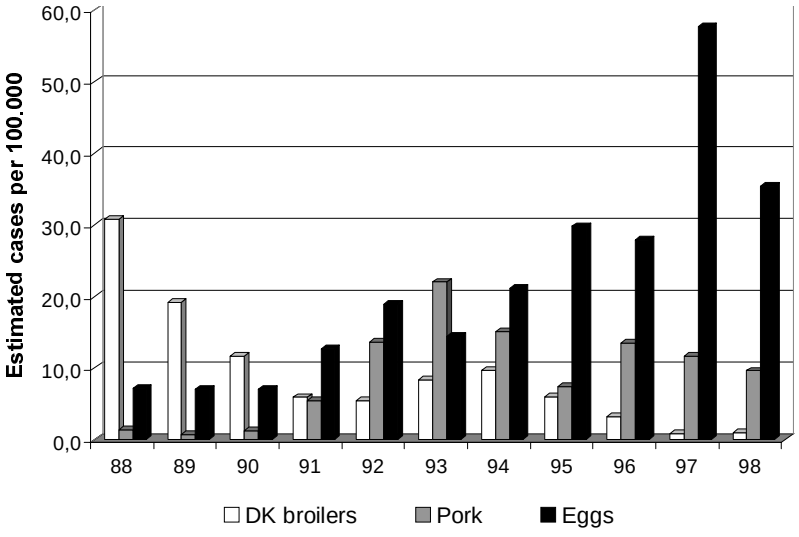

Figure 11. Estimated major sources for human salmonellosis in Denmark, 1988-98. Data: Danish Zoonosis Centre.

Table 15. Serotype distribution of Salmonella *from animals, meat at slaughterhouses and humans in Denmark, 1998.*

Serotype	Humans	Pig a) herds	Pork b)	Cattle herds	Beef b)	Broiler c) flocks	Layer d) flocks	Turkey c) flocks	Duck e)
S. Enteritidis	67.2	0.9	0.0	1.2	0.0	24.5	85.4	5.9	60.0
S. Typhimurium	17.5	78.6	54.0	24.1	10.5	18.2	6.8	2.9	0.0
S. Hadar	1.6	0.2	0.0	0.0	0.0	3.7	0.0	8.8	30.0
S. Manhattan	1.1	0.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0
S. Infantis	0.9	3.7	17.2	0.0	0.0	17.5	4.9	0.0	0.0
S. Virchow	0.8	0.0	0.2	0.0	0.0	0.4	0.0	0.0	0.0
S. Agona	0.8	0.1	0.0	0.0	0.0	1.1	0.0	14.7	0.0
S. Derby	0.6	7.1	6.3	6.0	10.5	1.1	0.0	41.2	0.0
S. Newport	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. Java	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. Stanley	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. Braenderup	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. Bovismorbificans	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. Glostrup	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
S. Heidelberg	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0
S. Saintpaul	0.3	0.0	0.0	1.2	0.0	0.0	0.0	0.0	10.0
S. Dublin	0.3	0.1	0.2	62.7	68.4	0.0	0.0	0.0	0.0
Others incl. not typable	6.1	9.0	21.9	4.8	10.5	30.5	2.9	26.5	0.0
Total	100	100	100	100	100	100	100	100	100
Number typed	3,880	898	448	83	19	269	103	34	10

Data: Danish Veterinary Laboratory, Danish Veterinary and Food Administration and Statens Serum Institut.

a) Isolates obtained from sampling in slaughter-pig herds placed in Level 2 or 3.
b) Representative meat samples from the surveillance programme at slaughterhouses.
c) Representative faecal or sock samples from the mandatory ante-mortem inspection.
d) Representative samples from the surveillance programme in production flocks.
e) Screening of Danish poultry products carried out between Nov. 97 - May 98.

Table 16. Phage-type distribution (%) of S. Enteritidis from humans and poultry, 1998.

Phage type	Humans	Layers	Broilers
8	39.9	59.1	30.6
6	28.9	22.7	48.0
4	11.0	4.6	14.3
1	4.1	1.1	2.0
21	4.1	6.8	0.0
6a	1.8	0.0	1.0
29	1.4	0.0	0.0
1b	0.9	0.0	0.0
21b	0.9	0.0	0.0
25	0.9	2.3	0.0
34	0.9	0.0	0.0
17	0.9	0.0	0.0
Others incl. not typable	4.1	3.4	4.1
Total	100	100	100
Number typed	218	88	98

Data: Danish Veterinary Laboratory, Danish Veterinary and Food Administration and Statens Serum Institut.

Table 17. Phage-type distribution (%) of S. Typhimurium from humans, animals and meat at slaughterhouses, 1998.

Phage type	Humans	Pigs	Pork	Cattle	Beef	Broilers	Layers
12	43.3	48.2	42.6	53.9	0.0	15.2	14.3
104	13.1	0.9	0.3	11.5	0.0	0.0	0.0
66	4.9	6.1	10.2	11.5	0.0	15.2	0.0
U288	3.8	2.4	1.5	0.0	0.0	0.0	0.0
135	3.6	2.8	1.2	0.0	0.0	2.2	14.3
193	3.4	3.2	5.7	3.9	0.0	2.2	28.6
17	2.1	6.7	7.2	3.9	0.0	6.5	0.0
120	1.7	0.9	1.5	0.0	0.0	2.1	0.0
302	1.7	1.1	0.6	0.0	0.0	0.0	0.0
10	1.1	1.3	3.6	3.9	0.0	0.0	0.0
107	0.8	1.6	1.8	7.7	0.0	0.0	0.0
177	0.8	1.1	1.2	0.0	0.0	4.4	0.0
110	0.6	2.1	0.9	0.0	50.0	34.8	14.3
41	0.4	0.1	0.0	0.0	0.0	4.4	28.6
15a	0.4	2.4	3.0	0.0	0.0	0.0	0.0
Others incl. not typable	18.4	19.1	18.6	3.9	50.0	13.0	0.0
Total	100	100	100	100	100	100	100
Number typed	474	749	333	26	2	46	7

Data: Danish Veterinary Laboratory, Danish Veterinary and Food Administration and Statens Serum Institut.

2. Campylobacter jejuni/coli

Poultry, pigs and cattle

As part of a continuous surveillance programme of zoonotic bacteria in broilers, pigs and cattle, caecal contents/cloacal swabs were sampled at slaughterhouses and examined for thermotolerant *Campylobacter*. One animal per herd and ten birds per flock were sampled. In broilers the prevalence was 47.1% (Table 5), in pigs 68.6% (Table 7) and in cattle 47% (Table 9). In broilers a distinct seasonal variation is observed (Figure 13). This seasonal variation coincides with human campylobacteriosis in Denmark. However, the increase in broilers seems to appear slightly later than the increase in humans.

Products from retail outlets

The nationwide surveillance programme of thermotolerant *Campylobacter* in foods from the retail outlets established in 1996 as a co-operation between the Danish Veterinary and Food Administration and the Municipal Food and Environmental Laboratories was continued in 1998. The foods represented in the survey in 1998 included raw and lightly processed products (not heat treated) of chicken, turkey and other birds. The samples represent both imported products and products of Danish origin. In total 1,500 samples have been analysed. The results for chicken and turkey are shown in Tables 5 and 6, respectively. In the group of other birds (incl. ducks, pigeons, quails and ostriches), the prevalence was 21% (N=293) in 1998 compared to 26% (N=285) in 1997.

Campylobacteriosis in humans

The incidence of human *Campylobacter* infections increased from to 2,666 in 1997 to 3,372 cases in 1998 (64 cases per 100,000 inhabitants). This is the highest registered incidence in Denmark (Figure 14, Table 11). There are no apparent explanations for the emergence of *Campylobacter* which remains a major cause of concern for public health. It is estimated that approximately 80% of the *Campylobacter* infections are domestically acquired.

Figure 15 shows the age-specific incidence of *Campylobacter* in the counties of Bornholm, Frederiksborg, Fyn, Ribe, Roskilde, Storstrøm, Vestsjælland, and Århus, 1997 and 1998. Figure 16 shows the geographical distribution of infections with *Campylobacter*. There is no straigtforward explanation for the considerable geographical variation.

Case-control study on sporadic campylobacteriosis

From May 1996 to May 1997, a case-control study was conducted to identify risk factors and routes of infection for sporadic campylobacteriosis in Denmark. Using a combination of mailed questionnaire and telephone interviewing, the effect of travelling, exposure to different foods, animal

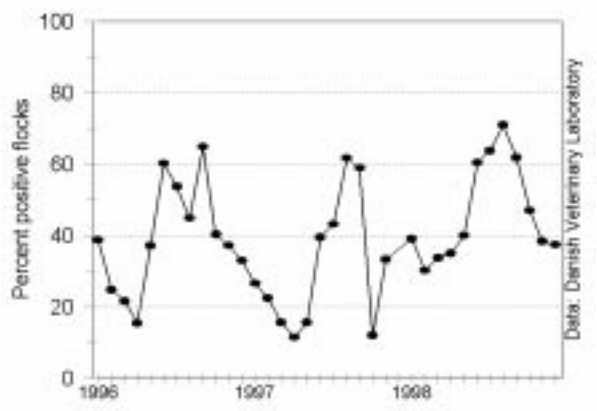

Figure 13. Percent Campylobacter *positive broiler flocks, 1996-98.*

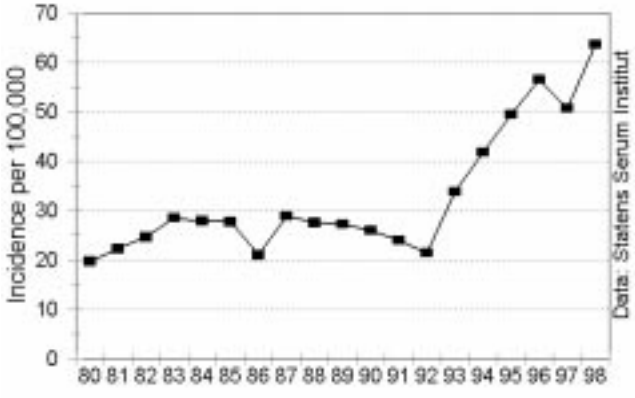

Figure 14. Incidence per 100,000 of human campylobacteriosis in Denmark 1980-98.

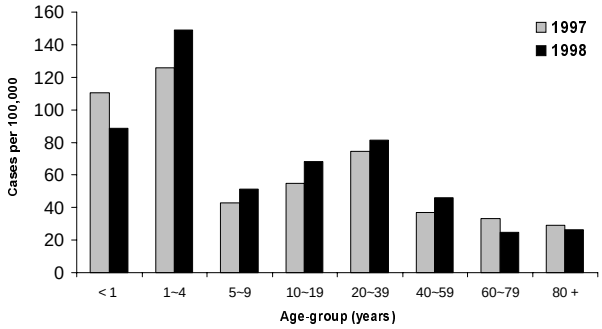

Figure 15. Age-specific incidence of Campylobacter *in the counties of Bornholm, Frederiksborg, Fyn, Ribe, Roskilde, Storstrøm, Vestsjælland, and Århus, 1997 and 1998. Data: Statens Serum Institut.*

Figure 16. Geographical distribution and incidence of human campylobacteriosis in 1998. Data: Statens Serum Institut.

contact and type of water supply was evaluated. Of 282 cases and 319 sex, age and municipality matched controls, 219 cases and 240 controls had not been travelling within the last 4 weeks prior to illness onset/interview. Travelling to a foreign country was found to be associated with an increased risk of infection and from the multivariate analysis the following risk factors were found to be independently associated with infection: eating undercooked poultry, eating meat (beef, pork or veal) prepared at a barbecue, consuming drinking water with a bad taste or smell from private well, contact with a cat with diarrhea, daily contact with a cat younger than 6 month and daily contact with pigs.

Serotyping of *Campylobacter*

Isolates of *C. jejuni* and *C. coli* were serotyped using the Penner serotyping scheme (heat-stable antigens). Among human isolates, serotype O:2 was the dominating serotype accounting for 36% of the *C. jejuni* isolated in 1998, which is an increase compared to earlier years (26% of *C. jejuni* were O:2 in 1996-97). However, it must be stressed that serotyping in 1998, in contrast to the previous two years, exclusively has been performed on domestic acquired cases. Other important human serotypes were O:4-complex, O:1,44, O:11, O:5 and O:6,7 (4-19% each). Other serotypes each accounted for 3% or less (Table 18). In broilers and cattle, serotype O:2 was also the most common serotype and showed an increased proportion compared to 1996-97. In general, broilers, poultry

Table 18. Serotype distribution (%) of Campylobacter jejuni *from human patients, animals and poultry product in 1998.*

Serotype	Human	Broilers	Cattle	Pigs	Poultry retail level
1,44	9	18	8	0	8
2	36	26	30	9	18
3	2	5	0	0	4
4-complex*	19	7	22	18	14
5	4	4	0	0	8
6,7	4	6	3	0	8
11	6	1	0	9	1
12	3	2	3	0	3
19	2	1	6	0	11
21	2	1	0	0	1
23,36	0	1	14	27	1
27	0	4	0	0	1
29	1	1	6	0	0
31	3	4	0	0	3
35	2	0	8	27	0
57	0	5	0	0	3
Others	4	9	0	8	7
Not typable	3	5	0	0	9
Number typed	128	82	36	11	74

Data: Danish Veterinary Laboratory. * 4-complex: Reaction with one or more of the following antisera: 4, 13, 16, 43, 50, 64, 65.

Table 19. Serotype distribution (%) of Campylobacter coli *from human patients, animals and poultry products in 1998.*

Serotype	Human	Broilers	Pigs	Poultry retail level
5	17	7	15	0
24	17	7	9	0
30	33	13	16	33
34	17	0	8	8
46	0	20	20	0
54	0	7	1	17
59	0	20	6	33
Others	17	20	19	8
Not typable	0	6	6	0
Number typed	6	15	101	12

Data: Danish Veterinary Laboratory.

products and to a lesser extent cattle showed a serotype distribution with large overlap with the human isolates. A few serotypes that were rare in humans and broilers were fairly common in cattle, e.g. O:23,36, O:19 and O:35 (Table 18). *C. coli* is the dominant *Campylobacter* species in pigs, whereas less than 10% of the campylobacters in most other sources are *C. coli*. The most common *C. coli* serotypes in pigs i 1998 were O:46, O:30 and O:5 (Table 19).

3. Yersinia enterocolitica

Pigs and cattle

The vast majority of Danish slaughter-pig herds are assumed to harbour *Y. enterocolitica* O:3. A serological survey in 1993, showed that 90% of herds and 75% of slaughter-pigs were seropositive. In addition, several bacteriological investigations have shown a herd prevalence of approximately 80%.

In 1998, 4 cattle herds were found to be infected with *Y. enterocolitica* O:9, which only rarely causes infections in humans in Denmark.

Products from retail outlets

During 1998, a survey of human pathogenic bacteria in ready-to-eat meat products was performed as a collaboration between the Municipal Food and Environmental Laboratories and the Danish Veterinary and Food Administration. The products consisted of smoked, salted or cured products, that were not heat treated. The pork products were analysed for the occurrence of human pathogenic strains of *Yersinia enterocolitica*. Out of 600 samples of pork products analysed, only one sample was found to harbour the human pathogenic serotype O:3.

Yersiniosis in humans

A total of 464 cases of infections with *Yersinia enterocolitica* was registered in 1998 (Table 11, Figure 17). Most cases (459) were serotype O:3. In 1997, 426 cases of *Yersinia enterocolitica* O:3 were registered. In other words, the situation remains stable. The

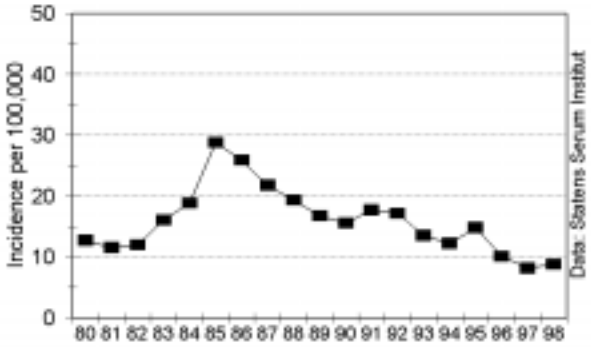

Figure 17. Incidence per 100,000 of human yersiniosis in Denmark, 1980-98.

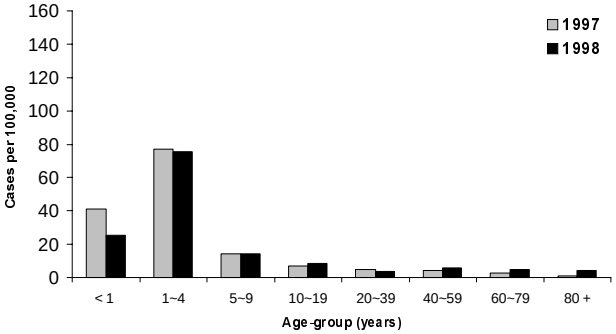

Figure 18. Age-specific incidendence of yersiniosis in the counties of Bornholm, Frederiksborg, Fyn, Ribe, Roskilde, Storstrøm, Vestsjælland, and Århus, 1997 and 1998 Data: Statens Serum Insitut.

primary source of yersinosis is assumed to be porcine.

Figure 18 shows the age-pecific incidence of *Y. enterocolitica* infections in the counties of Bornholm, Frederiksborg, Fyn, Ribe, Roskilde, Storstrøm, Vestsjælland, and Århus, 1997 and 1998. Approximately 50% of the cases are among children less than five years of age, and more than 90% are domestically acquired. Figure 19 illustrates the geographical distribution of infections with *Y. enterocolitica*.

Figure 19. Geographical distribution and incidence of human yersionosis in 1998. Data: Statens Serum Institut.

4. Listeria monocytogenes

Products from retail outlets

Data from 1998 on the incidence of *Listeria monocytogenes* in foods at retail level in Denmark was reported continuously by the Municipal Food and Environmental Laboratories.

According to the Danish rules, investigations of the level of *L. monocytogenes* in foods are to be performed on certain ready-to-eat products. The results of these routine examinations are reported to the Danish Veterinary and Food Administration (Table 20).

Table 20. Percentage distribution of the number of Listeria monocytogenes *in selected foods, sampled at retail level in Denmark by the Municipal Food and Environmental Laboratories in 1998.*

	Number of samples	Percent of samples with cfu<10 per g	Percent of samples with cfu between 10-100 per g	Percent of samples with cfu>100 per g
Heat treated meat products handled after heat treatment	3629	89.9	9.6	0.5
Preserved, not heat treated or slightly heat treated meat products	225	83.6	14.7	1.8
Gravad, smoked, salted, not heat treated or slightly heat treated fish products	177	78.5	21.5	0.0
Sprouts or sliced vegetables	168	64.9	34.5	0.6
Meat or vegetable mayonnaise	2172	95.3	4.2	0.5
Cheese or cheese products	36	100.0	0.0	0.0
Ready-prepared dishes	1296	94.6	5.4	0.0

Data: Danish Veterinary and Food Administration.

Listeriosis in humans

In 1998, 41 sporadic cases of Listeria monocytogenes were registered (Table 11). This is the highest number of registered cases in Denmark since 1986 (Figure 20). The patients were geographically spread throughout the country and no type predominated as judged by ribotyping, PFGE or RAPD. Thus, no outbreak seems to have occurred. Twenty-three strains belonged to serogroup 1, 16 to serogroup 4 and two strains were non-typable.

Table 21 shows the age distribution of the 41 cases.

Table 21. Incidence of listeriosis by age in Denmark, 1998.

Age group (years)	Number of cases
0	3
1-9yrs	0
10-19yrs	1
20-39yrs	1
40-59yrs	6
60-79yrs	20
80+yrs	10
Total	41

Data: Statens Serum Institut.

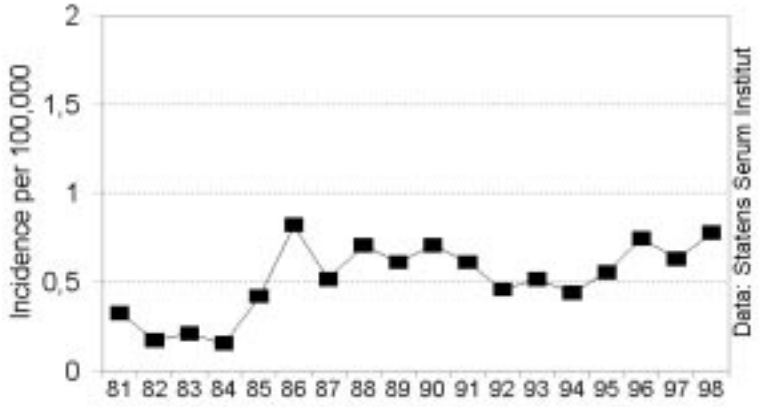

Figure 14. Incidence per 100,000 of human listeriosis in Denmark, 1981-98.

5. Escherichia coli (VTEC)

Cattle

A small-scale surveillance programme to monitor the occurrence of verotoxigenic *Escherichia coli* O157 (VTEC O157) in Danish cattle was initiated by the Danish Veterinary Laboratory in June 1997. In 1998, VTEC O157 was found in 1 (0.4%) out of 248 feacal sample from cattle (Table 9).

Human infections

The problem of zoonotic *E. coli* infections remains low in Denmark, and no domestically acquired food-associated outbreaks have been identified. Before 1997, VTEC was only looked for rarely in humans. In 1997, laboratories examining more than 2/3 of the stool cultures performed in Denmark changed their diagnostic practice and started to look for VTEC in all stools from patients with grossly bloody diarrhoea and in all stools from patients 4 years of age or less with a history of bloody diarrhoea. Additionally, stools from patients evaluated for travellers or persistent diarrhoea have been cultured for VTEC. The methods used were a combination of colony hybridisation using probes for verotoxin and *eae*A genes, and live slide agglutination of suspect colonies with O-antisera against the most common VTEC serotypes. This approach resulted in the identification of a total of 34 VTEC infections in 1998 compared with 33 in 1997. Before 1997, approximately 5 cases were diagnosed annually. Six of the 34 cases were infected with O157 strains, and two of these patients had haemolytic uraemic syndrome (HUS). Other VTEC serogroups included O103 (six cases), O26 (four cases) and O145 (two cases, including one patient with HUS). There were no cases of VTEC O111.

6. Mycobacterium bovis

In accordance with Commission Decision 97/76/EEC, Danish cattle herds are declared officially free from bovine tuberculosis (TB) since 1980. TB in cattle is a notifiable disease in Denmark. Monitoring is performed by meat inspection, which means that all slaughter animals are examined for lesions indicative of TB. Bulls at semen collection centres are subject to pre-entry and annual intradermal tuberculin testing. The last case of TB in cattle was diagnosed in 1988.

In 1988-89, 13 deer farms were found infected with bovine tuberculosis, and until 1994 another 3 farms were found affected. Eradication measures were taken and restrictions have now been lifted on all 16 farms. All deer farms were surveyed through tuberculin testing of animals more than 1 year old or through meat inspection of slaughtered animals. After December 1994, bovine tuberculosis has not been diagnosed in deer in Denmark.

In 1998, 8 cases (0.15 cases per 100,000 inhabitants) of human tuberculosis caused by *M. bovis* were registered. All were diagnosed in elderly Danish patients. These cases are regarded as reactivation of a latent infection acquired before the eradication of bovine TB in cattle. Bovine tuberculosis is no longer a notifiable disease in Denmark.

7. Brucella abortus/ melitensis

In accordance with Commission Decision 97/175/EEC Denmark has been regarded officially free from brucellosis in cattle since 1979. Brucellosis is a notifiable disease, and clusters of abortions are notifiable. Monitoring is performed by examination of abortion material. Bulls are subject to serological testing before entering bovine semen collection centres. After entry they are examined annually for brucellosis. Boars at porcine semen collection centres are likewise subject to pre-entry testing, followed by testing at least every 18 months and before they leave the centre.

No domestically acquired human cases but a few imported cases occur each year. The infection in humans is not notifiable in Denmark.

8. Trichinella spiralis/ nativa

All pigs slaughtered at Danish export slaughterhouses are examined for *Trichinella spp.* in accordance with Council Directive 64/433/EEC, Annex 1, Chapter VIII. Trichinella has not been found in Danish pigs since 1930. During 1998, 20.6 mill. pigs were examined by the digestion method at slaughter, all with a negative result (Table 7).

A national programme for screening of *Trichinella* infection in wild foxes was initiated in 1995. In 1997 and the two first months of 1998, a total of 4,366 forelegs of foxes were collected by hunters across the country. Approximately 700 forelegs was examined for *Trichinella*, all with a negative result. The screening was terminated by the end of February 1998.

No domestically acquired cases of human trichinosis were recorded in 1998. A few imported cases occur annually. The infection in humans is not notifiable.

9. Echinococcus granulosus/multilocularis

Echinococcus granulosus infections in all animals are reportable. Surveillance for *Echinococcus* is performed through meat inspection. In 1998, no cases of *Echinococcus* infections were reported.

No domestically acquired human cases but a few imported cases occur annually. The infection in humans is not notifiable.

10. Toxoplasma gondii

Toxoplasmosis in humans is not a notifiable disease in Denmark, and the incidence of toxoplasmosis in humans is unknown. It is estimated that approx. 1% of the human population seroconvert annually.

11. Cryptosporidium parvum

Cryptosporidiosis is not a notifiable disease in Denmark. It is estimated that approximately 180 human cases are diagnosed in Denmark annually. Most of these are acquired abroad.

12. Rabies

Rabies is a notifiable infection in both humans and animals. In 1998, 12 bats were found infected with European bat lyssavirus and infection with that virus type was diagnosed in 3 sheep. Three of the infected bats had bitten children. No domestically acquired cases were reported in 1998, but 39

people were treated by prophylactic vaccination after exposure to bat bites or other animals suspected of being infected. Sylvatic rabies (genotype 1 lyssavirus) was not found in domestic animals, pet animals or wildlife in 1998.

Antimicrobial resistance

For information on antimicrobial resistance in zoonotic bacteria we refer to the yearly report: "DANMAP - Consumption of antimicrobial agents and occurrence of antimicrobial resistance in bacteria from food animals, food and humans in Denmark". The 1998 report will be available at:

http://www.svs.dk

or can be ordered from the Danish Zoonosis Centre (sca@svs.dk) by the end of June 1999.