TRICHINELLOSIS AND TRICHINELLOSIS CONTROL IN GERMANY

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Abstract. In nineteenth century Germany, trichinellosis was a relatively frequent disease. From 1861 to 1890 more than 12,500 cases, with an average mortality rate of 5%, were reported. As a consequence, trichinoscopy was made compulsory for the kingdom of Prussia in 1877, and a respective law was issued on June 3, 1900, for Germany as a whole. This measure led to a considerable decrease in human trichinellosis, reaching a minimum of only 49 cases for the period 1931–1940. The decrease in human cases was correlated to a constant decline of prevalence in pigs. However, after World War II, ten epidemics of human trichinellosis occurred with a total of about 2,000 cases. Sources of infection were illicitly slaughtered pigs, minced pork and sausages of partly unknown origin, and uninspected wild boars (*Sus scrofa*). Today, besides pigs, wild boars can be regarded as main sources of human infections. During the last two decades, two positive wild boars have been detected every year, thus demonstrating that a sylvatic cycle still exists.

Measures to control trichinellosis in Germany have been limited to meat inspection. Before 1978 the only method allowed was trichinoscopy of compressed muscle samples. Then the pooled sample digestion technique and the magnetic stirrer method were introduced, which was later improved and automatized by use of the Foss Electric Trichomatic 35 and of the GMP 50 as a sampling device.

INTRODUCTION

In the second half of the nineteenth century research in the field of parasitology, and especially helminthology, went through a period of blooming in Germany. Thus, the elucidation of the life cycle of *T.spiralis*, the recognition of trichinellosis as a disease, and the initiation of control measures are closely connected with the names of three German scientists: Rudolf Leuckart (1822–1898), Friedrich Albert von Zenker (1825–1898), and Rudolf Virchow (1821–1902). Since their basic work, the frequency and distribution of trichinellosis in Germany have been well documented and reviewed repeatedly (Stiles and Hassall, 1901; Hanspach, 1928; Lehmensick, 1970). It is the purpose of this paper to give a brief account of the situation during the last century and to describe the development up to the present time.

FREQUENCY OF HUMAN TRICHINELLOSIS

During the period from 1861 to 1890 there were more than 100 epidemics with more than 30 cases each and with an average mortality rate of 5%. With about 12,500 cases, the average incidence amounted to more than 400 infections per year. Frequency reached its peak with 828 documented cases in 1874. However, for the last decade of the 19th century the positive effect of trichinoscopy (compulsory for the kingdom of Prussia since 1877) can be demonstrated: The total frequency decreased by 75% to about 100 cases per year. This tendency continued as a consequence of the meat inspection law, issued June 3, 1900, for all Germany, and led to a minimum of only 49 cases reported for the period 1931–1940. Again, after World War II, sporadic epidemics occurred with an increase of trichinellosis to 2,000 cases (Fig 1). Sources of infection were uninspected wild boars, illicitly slaughtered pigs, minced pork and sausages of partly unknown origin.

GEOGRAPHICAL DISTRIBUTION OF HUMAN TRICHINELLOSIS

Until the end of World War I, the kingdoms of Prussia and Saxony were the areas of highest endemicity (Fig 2). From 1861–1890 about 60%

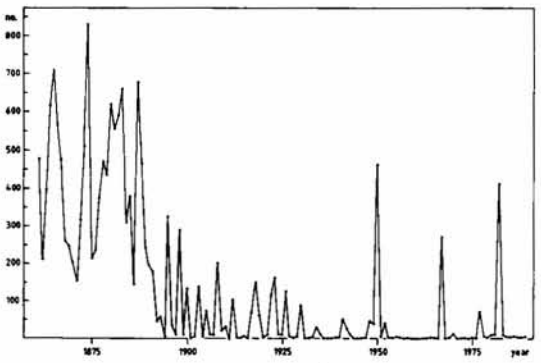

Fig 1 – Cases of human trichinellosis in Germany, 1861-1989.

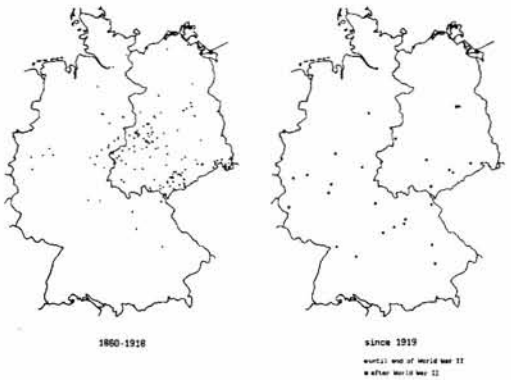

Fig 2 – Human trichinellosis in Germany: localities with at least one epidemic of ten cases or more.

of all cases were in Prussia and 26% in Saxony. In the other parts of the country, now belonging to the federal states of Rhineland-Palatinate, Saarland, Baden-Württemberg, to western Lower Saxony and southern Bavaria, only single cases were reported during that period. Even smaller epidemics (up to 10 cases) were never observed in those areas up to World War I. This distribution pattern changed considerably in later years. At present, human trichinellosis is no longer restricted to the former kingdoms of Prussia and Saxony. This development is closely correlated to the eating habits of the population. While in former times the custom of eating raw or undercooked pork and pork products had mainly been observed in Prussia and Saxony, since World War II this habit has spread with people migrating to all parts of the country.

FREQUENCY AND GEOGRAPHICAL DISTRIBUTION OF TRICHINELLOSIS IN DOMESTIC ANIMALS

Among domestic animals, pigs play the predominant role as reservoirs of *T.spiralis* and sources of human infections. After the introduction of trichinoscopy in Prussia, between 1878 and 1890 a total of 28,160 (0.05%) out of 56,703,401 slaughtered and inspected pigs were found positive for trichinae (Table 1). This figure decreased to 15,508 (0.006%) for the years 1901–1911. Between World Wars I and II only about 10 pigs per million were found infected in all Germany; and after World War II there was a further decrease in West Germany from 2.2 in the 1950s to 0.1 per million in the 1980s (with a yearly average of 37.5 million pigs slaughtered) (Statistisches Bundesamt, 1982–1989).

Infected pigs could be found in all parts of West Germany, but there is a clear south to north gradient (Fig 3). While the infection rate per 10 million pigs is as high as 17.9 in Bavaria in the south, it is only 0.4 in the northernmost federal state of Schleswig-Holstein. These differences are mainly correlated to differences in the methods of pig breeding and keeping. While in the north (with 208 pigs per holder) pigs are bred and kept mainly indoors, smallholdings (with an average of 36 pigs) prevail in the south, and pigs are sometimes allowed to roam about. In Schleswig-Holstein only 19% of the holders own less than ten pigs, whereas the respective figure for Bavaria is 56% (Statistisches Bundesamt, 1989). Modern methods of breeding and keeping prevent pigs from eating infected rats and avoid the feeding of wild animal meat to pigs. These factors and the decrease of trichinellosis in wild animals (see below) contributed greatly to the general decline of the prevalence in pigs. They are responsible for the south to north gradient as well.

In the past dogs also played a role as a source of human infections. Dogs, therefore, were also subject to meat inspection. For instance, between 1904 and 1912 out of 55,749 dogs slaughtered and examined in all Germany,

Table 1
Trichinellosis of pigs and wild boars in Germany.

Area	Period	No. inspected	No. positive	Rate per million	Infected: non-infected
			Pigs		
Prussia	1878–1890	56,703,401	28,160	496.6	1 : 2,014
Prussia	1891–1900	78,137,913	15,508	198.5	5,039
Prussia	1901–1911*	114,664,547	7,367	64.2	15,569
Germany	1927–1936	186,535,243	1,758	9.4	106,107
Bavaria	1951–1960	32,401,962	281	8.7	115,309
W Germany	1951–1960	165,757,159	370	2.2	447,992
W Germany	1961–1970	252,003,769	81	0.32	3,111,158
W Germany	1971–1980	327,624,099	20	0.06	16,381,205
W Germany	1981–1988	300,230,897	38	0.13	7,900,813
			Wild boars		
W Germany	1962–1970	?	1193	?	?
W Germany	1971–1980	330,256	65	196.8	5,081
W Germany	1981–1988	398,169	26	65.3	15,314

* No data for the year 1904 available

Fig 3 – Trichinellosis of pigs in the different states of West Germany (rate per 10 million; 1951-1988 average).

126 (0.23%) were found positive for trichinae (Gruber, 1926). Twice as many (0.51%) were observed in Saxony for the years 1901–1923, when 532 infected dogs were detected (out of 104,967 inspected). Compared with 741 trichinous pigs (out of 21.5 million) found during the same period in Saxony, the importance of dogs is evident. Since then customs have changed considerably. Today dogs are not slaughtered and dog meat is no longer consumed in Germany. Therefore, dogs will not be listed in the meat hygiene law.

FREQUENCY AND GEOGRAPHICAL DISTRIBUTION OF TRICHINELLOSIS IN WILD ANIMALS

Among wild animals only the wild boar (*Sus scrofa*) is of importance today as a source of human trichinellosis. The statistics reveal that from 1962–1988 there were 1,284 *T.spiralis* positive boars (as compared with 125 domestic pigs) (Table 1) (Statistisches Bundesamt, 1963–1989). Thus, wild boars far surpass the epide-

miological significance of domestic pigs. Furthermore, Wagner *et al* (1988) reported that the yearly bag outnumbers the inspected animals by 20%. This would mean that during the period mentioned about 250 infected boars must have been consumed without having been examined for trichinae. However, the prevalence in wild boars decreased considerably during the last three decades (as it is the case with domestic pigs) and amounted to only three positive animals per year during the 1980s. Thus, at present there is the possibility of only one infected wild boar among the non-inspected animals.

In the past, it was the red fox (*Vulpes vulpes*) which contributed most to maintain the sylvatic cycle of *T.spiralis* in Germany. This was mainly because their carcasses were exposed on so-called "carrion-places" to lure predatory animals. Thus, from 1938 to 1943 the prevalence of 5.8% (83/1,500 foxes) was rather high. Between 1958 and 1965 it decreased to 1.9% (24/1,259) and later (1969–1988) to 0.1% (7/6,464) (Lehmensick, 1970; Wagner *et al*, 1988). The reason for this decline is supposedly related to the predominant role of the red fox as a rabies reservoir and - as a consequence - the destruction of their carcasses. By this means, an important link in the chain of sylvatic trichinellosis has been eliminated.

Being an euryxenous helminth, *T.spiralis* parasitizes other species of wild animals, among which the badger (*Meles meles*) showed infection rates similar to those of the red fox (Schoop and Schade, 1939; Lehmensick, 1970). But today neither badgers nor other wild mammals seem to play a role in maintaining the *Trichinella* cycle. Among 2,426 such animals (including 73 badgers), none was found positive (Wagner *et al*, 1988).

TRICHINELLOSIS CONTROL

In 1862, Nikolaus Friedreich, professor of clinical medicine at the University of Heidelberg, was the first to call for control measures. That year the city of Brunswick made meat inspection compulsory, and others followed. Owing to Virchow's efforts, a law was issued for the kingdom of Prussia in 1877 which became the basis for the meat inspection law of June 3, 1900, for all Germany. However, the enforcement of the law was left to the states and, for example, it did not become effective in Bavaria until 1935. Only the amendment of April 15, 1937, made trichinoscopy compulsory for all parts of Germany. The translation of paragraph 1 (3) of the last amendment on September 28, 1981, is as follows: "Pigs and dogs, if assigned for food consumption, are subject to inspection for trichinae after slaughter. Furthermore, wild boars, bears, foxes, nutrias, badgers, and other carnivores which can harbor trichinae are also subject to meat inspection after killing, if their meat is assigned for food consumption." Six years later the meat hygiene law of February 24, 1987 (which replaced the meat inspection law) showed one important omission – dogs were no longer mentioned.

The regulations of the respective laws include exact details on the training and qualifications of the meat inspectors, on the equipment of the laboratories, and the execution of the inspection, etc. Until now, measures have been limited to examination of defined muscle samples. Serological tests for proof of specific antibodies are not accepted. Until 1978 the only method allowed was trichinoscopy (compressor slide technique). Then the pooled sample digestion method and the magnetic stirrer technique were introduced, the last being the main diagnostic procedure since 1986. Later improvements amounted to automatization: in the federal states of Baden-Württemberg, Bavaria and Lower Saxony now the Foss Electric Trichomatic 35 and the GMP 50 as a sampling device are widely used (Krutsch, 1989). This method allows the examination of up to 35 animals within 15 to 20 minutes. Most probably it will soon be preferred in all Germany.

Measures to control trichinellosis in Germany are still limited to only meat inspection. Of course, this measure has contributed greatly to the reduction of human trichinellosis, but it could not influence the prevalence in domestic and wild mammals. The decrease of trichinellosis in these animals is due to other reasons.

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