CURRENT STATUS OF FOOD-BORNE PARASITIC ZOONOSES IN WEST GERMANY

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Abstract. The present status of food-borne parasitic zoonoses in West Germany is characterized by a relatively high frequency of toxoplasmosis, sarcocystosis and *Taenia saginata* infections. From empirical data it can be estimated that 4% of the German population become infected per year by *Toxoplasma gondii* as well as by *Sarcocystis* species (*S. hominis, S. suihominis*). The number of *T. saginata* infected persons is reckoned at 900,000, which is equal to an average prevalence of 1.5%. Due to meat inspection and to modern methods of breeding and keeping pigs trichinellosis and *Taenia solium* infections have become rare diseases. According to eating habits there are only sporadic cases of fascioliasis and anisakiasis. Whether *Diphyllobothrium latum* and *Opisthorchis felineus* are still endemic, is unknown; it seems that the influx of refugees from areas of high endemicity never created new foci in West Germany.

INTRODUCTION

Before World War II food-borne parasitic zoonoses were mainly endemic in the then eastern and central parts of Germany and in parts of Hesse, Lower Saxony, and Northrhine Westphalia. This was due to the eating habits in these areas where, to some extent, meals containing raw or undercooked beef, pork and fish belonged to the normal diet. Since the end of the war, the situation has changed considerably. About 13.5 million refugees left their homes in the east (Opitz, 1988), and most settled in West Germany. To this figure, nearly 4 million refugees from the former German Democratic Republic and 4.5 million foreign laborers have to be added, resulting in a total influx of an estimated 15 to 18 million people during the last 45 years. As a consequence, some food-borne parasitic zoonoses may have spread to parts of the country where, hitherto, they were unknown or of low endemicity. Furthermore, with the beginning of the 1960s, millions of Germans per year spend their holidays either in other parts of the country or in foreign countries, and others migrate for occupational reasons. All these migratory events are the reason for the present country-wide distribution of some food-borne parasites. The following ten species have to be dealt with, namely three sporozoa (*Toxoplasma gondii, Sarcocystis hominis, S.suihominis*), two trematodes (*Opisthorchis felineus, Fasciola hepatica*), three cestodes (*Diphyllobothrium latum, Taenia saginata, T. solium*) and two nematodes (*Anisakis simplex, Trichinella spiralis*).

Toxoplasmosis

Toxoplasma gondii is one of the most frequent and widespread food-borne parasites in West Germany. Several surveys revealed seroprevalence rates of between 45% and 70% (Kudicke and Pohlig, 1954; Piekarski, 1960; Schassan and Kaskara, 1971; Hinz, unpublished). Although it is not exactly known, which part is food-borne and which one can be traced back to ingestion of oocysts from cat feces, the food-borne route of infection is thought to play the major role (Braveny *et al*, 1982). But it is beyond question that pork is the only source for food-borne infections, because living *Toxoplasma* have never been detected in beef (Rommel *et al*, 1982) and mutton is never consumed in a raw or undercooked condition by the German population. According to several authors (eg , Boch *et al*, 1964; Grossklaus *et al*, 1965; Hellmann and Tauscher, 1967) 9% to 12% of pork samples contain living parasites. The yearly total of pigs slaughtered being 37.5 million (Statistisches Bundesamt, 1989), this suggests that up to 4.5 million of them harbor infective stages of *T.gondii*

The seropositivity rates found in humans depend on sex and age. Kudicke and Pohlig (1954) obtained seroprevalence figures of 71.6% in females and of 58.1 in males, the higher rates in females most probably due to food (pork) preparation. Regarding age differences, the incidence can be calculated from the seroprevalence in the different age groups. From empirical seroprevalence data Berger (1973) came to the conclusion that an average of 4% of the West German population ingest infective stages of *T.gondii* per year (Fig 1), thus leading to seropositivity rates of approximately 100% in older age groups. It has to be kept in mind, however, that it is not known to what extent the food-borne route of infection contributes to these figures.

Sarcocystosis

Knowledge of human sarcocystosis in West Germany is limited. It has been found that 7 . 3% of 300 patients excreted oocysts of *Sarcocystis hominis* (Janitschke, 1975), and 86.8% of 304 sera gave positive reactions with *Sarcocystis* antigen in the indirect fluorescent antibody test (IFAT) (Aryeetey and Piekarski, 1976). Out of these sera, 233 specimens could be grouped according to age. In children up to 12 years, a seroprevalence of 58.9% was found, whereas in the older age groups, 97.9% of the sera reacted positively. From these results it can be concluded that, on the average, everyone in West Germany gets infected at least once during lifetime by *S.hominis* and/or *S. suihominis*.

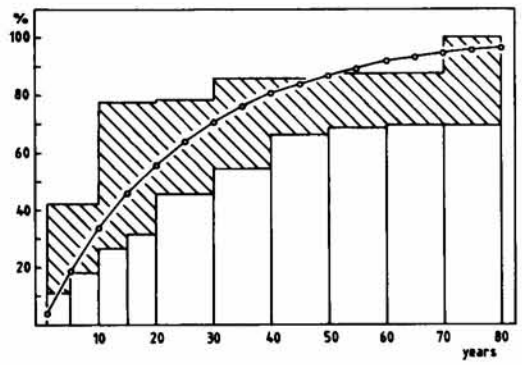

Fig 1–Human toxoplasmosis in the Federal Republic of Germany: seroprevalence by age groups (hatched area: empirical rates; curve: theoretical seroprevalence with an estimated incidence of 4% per year).

The high infection rates in humans are attributable to the high prevalence of *Sarcocystis* in cattle and pigs. Examination of cattle from 11 slaughter-houses in southern Germany revealed a *S.hominis* prevalence rate of 62.8% (Boch *et al*, 1978a), whereas in the western parts of the country it reached only 40.5%. A similar difference was also found in *S.suihominis* infections of pigs: 11.3% were positive in the south and 3.6% in the west (Boch *et al*, 1978b). Another survey (Heydorn *et al*, 1978) in the northern and western parts of West Germany revealed even lower prevalence rates, namely 0.2% in fattened pigs and 1.7% in sows. The reasons for these differences await clarification.

Opisthorchiasis

Human infections with the cat liver fluke (*Opisthorchis felineus*) were formerly confined to the then German area of the Neman (Nemunas) delta. Prevalence rates there were as high as 8% in the village populations (Vogel, 1929) and 87.8% in cats (Erhardt, 1934). Outside this area, metacercariae and adults of *O.felineus* have been found only very sporadically, eg, in tenches (*Tinca tinca*) and domestic cats near Hamburg (Erhardt *et al*, 1962) and in red foxes (*Vulpes vulpes)* near Berlin (Schmidt-Hoensdorf and Saar, 1957). No infections (neither human nor animal) have been reported for more than 30 years.

Fascioliasis

Despite high infection rates in domestic and wild herbivores, human infections with *Fasciola hepatica* are rarely diagnosed (Ehlers and Knüttgen, 1949; Minning and Vogel, 1950; Mohr *et al*, 1951; Grote, 1955; Ahrens and Berning, 1968; Wahn and Mehlhorn, 1984; Maier *et al*, 1987; Schleppi *et al*, 1987; Wessely *et al*, 1987, 1988). In our laboratory we have diagnosed only one *Fasciola*-infected patient since 1975. This is due to the fact that aquatic or semi-aquatic plants are usually not consumed by the population. Thus, fascioliasis can be regarded as a negligible food-borne parasitic zoonosis in West Germany.

Diphyllobothriasis

Similar to opisthorchiasis, human diphyllobothriasis was endemic mainly in the east, especially in the former province of East Prussia,

where locally up to 46% of the population was affected (Zschucke *et al*, 1932). Outside this area *Diphyllobothrium latum* was found sporadically only in areas around Lake Constance and some Alpine lakes and plerocercoids were detected in fish from waters near Hamburg (Kuhlow, 1953). In the recent literature there exists only one finding of *Diphyllobothrium* sp. in red foxes (*Vulpes vulpes)* from Württemberg (Loos-Frank and Zeyhle, 1981). Thus it is not possible to decide whether *D.latum* is still endemic in West Germany or not. Its apparent disappearance may be due to the increasing pollution of lakes and rivers by industrial and household wastes during the last decades, making these waters poor in oxygen and, consequently, unsuitable for the development of fish tapeworm coracidia.

Taenia saginata infections

Infection with the beef tapeworm (*Taenia saginata*) is the most frequent food-borne helminthiasis in West Germany. However, this statement depends nearly totally on our knowledge about cysticercosis in cattle, which has been well documented for about 90 years. Before World War II the average prevalence rates in cattle fluctuated between 0.14% and 0.44%. After the war it increased in West Germany to a maximum of 2.24% in 1963, followed by a gradual decline with a rate of 0.52% in 1988 (Fig 2). But there were considerable variations between the results of different slaughter-houses for the period under review, resulting in figures of nearly 10% in some areas (Fähnle and Strauch, 1978).

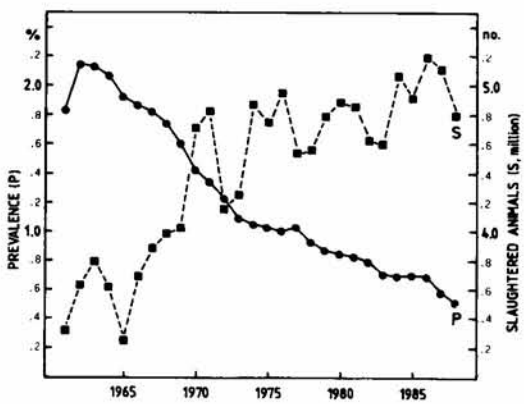

Fig 2–Cysticercosis in cattle and number of cattle slaughtered and inspected in the Federal Republic of Germany, 1961-1988.

Despite the decrease of cysticercosis in cattle *T. saginata* infections in humans seem to have kept a rather constant level. The average prevalence rate has been estimated to be nearly 1% (Hörchner, 1983) or even higher. According to Zimmermann (1985) there are about 900,000 people infected in West Germany, which equals a rate of 1.5%. But as with cysticercosis in cattle, in certain areas and population groups *T. saginata* infections show a much higher frequency than in others. For instance in West Berlin 10% of pregnant women (Hörchner, 1983) and 11.1% of female Turkish guest-laborers (Oguz, 1976) have been found infected. From these results it can be concluded, that meat inspection as a single measure is insufficient to eradicate *T. saginata*.

Taenia solium infections

In 19th century Germany, parts of the country, especially Prussia, were highly affected by *Taenia solium* infections and human cysticercosis as well; eg, in the 1860s approximately 2% of autopsies done in Berlin revealed metacestodes of the pork tapeworm (Braun, 1908). However, since no exact reports on human *T. solium* infections are available, the situation may be described indirectly on the basis of cysticercosis in pigs, on which reliable data exist.

In Prussia, infection of pigs amounted to 3,279 per million for the period from 1876 to 1882. As a result of meat inspection this figure decreased to 476 in 1899, and to 189 in 1919 for all Germany. This trend has continued since: In 1922 for the first time the infection rate came to less than 100 per million, and in the following 1920s and 1930s it fluctuated between 8 and 96. After World War II a further reduction took place in West Germany with 51 pigs infected out of 37.5 millions slaughtered in 1988, ie with an infection rate of 1.4 per million only (Fig 3). But the low figures for the last decades cannot be attributed solely to meat inspection, but also to altered methods of breeding and keeping pigs, which prevents them from getting infected. Interestingly, there is a south to north gradient with a maximum rate of 10.8 per million in Bavaria and 0.3 per million only in Schleswig-Holstein (Fig 4). This gradient reflects different methods of breeding and

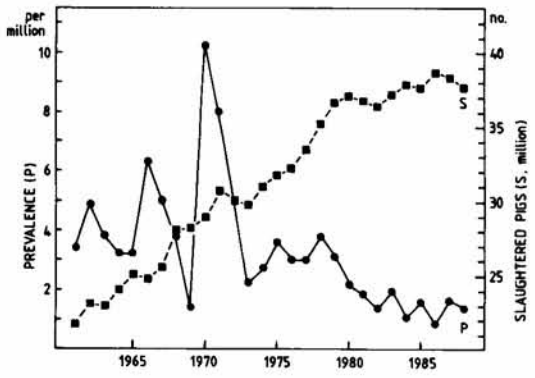

Fig 3–Cysticercosis in pigs and number of pigs slaughtered and inspected in the Federal Republic of Germany, 1961-1988.

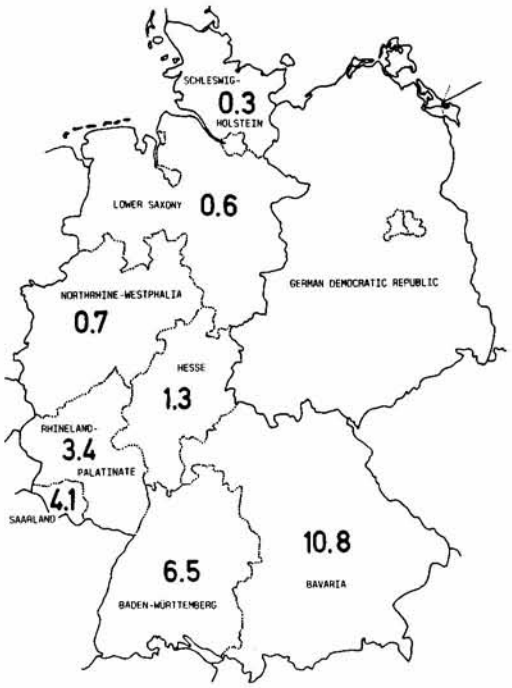

Fig 4–Cysticercosis of pigs in the different states of the Federal Republic of Germany (rate per million; 1961-1988 average).

keeping, which will be discussed elsewhere (Hinz, 1991).

From the changes mentioned, it can be deduced that human *T. solium* infections must have decreased almost parallel to cysticercosis in pigs, but no data are available. However, the fact that *T. solium* is still endemic in West Germany is not only demonstrated by metacestode infections in pigs but also by reports on cases of human cysticercosis (Pilz and Müller, 1972; Baas *et al*, 1982, 1983; Gerken *et al*, 1986; Rodiecker *et al*, 1987; Thie *et al*, 1987).

Anisakiasis

In West Germany, herring worm disease, caused by *Anisakis simplex* and related species, has been diagnosed in only a few humans (Schaum and Müller, 1967; Dumke and Janitschke, 1981; Mravak *et al*, 1986; Möller and Schröder, 1987; Poggensee *et al*, 1989). Nevertheless, high infection rates of 70-100% in herring (*Clupea harengus*) from the North Sea (Reimer and Jessen, 1972) led to the legislation of strict control measures in the fish processing industry (Bundesgesundheitsblatt, 1988). Whether these measures will completely protect humans from anisakiasis or not, remains to be seen.

Trichinellosis

In 19th century Germany, human trichinelliasis represented an important medical problem. Due to meat inspection and other reasons the number of infections decreased gradually, in man as well as in reservoir hosts (Hinz, 1991). However, even after World War II several epidemics occurred, the latest in 1982 with more than 400 cases (Stein, 1983).

DISCUSSION

Changes in the composition of the population by influx of refugees and foreign laborers, increasing mobility of the people, legislative control measures and changes in breeding and keeping domestic animals are the most significant factors the combination of which determine the distribution pattern and frequency of food-borne parasitic zoonoses in West Germany. The central point of the control measures is represented by the meat inspection law, now called meat hygiene law, last amended on February 24, 1987. The present wording of §1 of this law is only slightly different from the first version of June 3, 1900; its translation runs as follows: "Cattle, pigs, sheep, goats, other even-toed

ungulates, horses, other odd-toed ungulates, rabbits, kept as domestic animals, are subject to an official meat inspection before and after slaughter, if their meat is assigned for food consumption by humans; this applies also to game, if slaughtered ...game killed otherwise (by hunting) is only subject to meat inspection..." Regarding parasites meat inspection is restricted to cysticercosis, hydatidosis, trichinellosis and sarcocystosis.

The decrease of trichinellosis (cf Hinz, 1991), *T. solium* infections and human cysticercosis is not only the result of meat inspection, however. Modern methods of breeding and keeping pigs indoors in large scale farms with a rather high standard of hygiene contributed much to this decline. It is different with *T. saginata* infections. Keeping cattle partly outdoors on pasture is one reason for their relatively high infection rates with metacestodes of this tapeworm species. How cattle become infected, however, is still an open question. It has been suspected that areas around highways are contaminated by travellers who defecate in the open, thus leading to infection of grazing animals. Yet there is no proof of this supposition. However, the high *T. saginata* prevalence rates in the human population can be explained only by false negative results of meat inspection and, consequently, by the fact that a considerable amount of metacestode-infected beef is still put on the market. Furthermore, the rising living standard in West Germany led to an increase in beef consumption, especially of raw "minced beef", thus contributing to the relatively high frequency of *T. saginata* infections.

Examination of slaughtered animals for *T. gondii* infections are not included in the law, and *Sarcocystis* is only detected in cases of macroscopically visible meat alterations. As a consequence, meat inspection cannot contribute to a decline of human toxoplasmosis and sarcocystosis. In this context it has to be mentioned that there are no educational campaigns to teach people about food-borne parasitosis and how to prevent it. Only pregnant women are advised to avoid raw meat because of congenital toxoplasmosis.

It is not known whether *O. felineus* and/or *D. latum* are still endemic in West Germany. Obviously refugees from the former areas of high endemicity near the shores of the eastern Baltic Sea did not give rise to new foci. Despite high prevalence rates in cattle, human fascioliasis is a rare disease in West Germany, mainly because people do not collect and do not eat aquatic or semi-aquatic plants. Only sporadic cases of anisakiasis are reported in the German population. Raw sea-fish is not consumed in Germany and there is compulsory inspection of such fish for nematode larvae.

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