GENERAL INTRODUCTION AND EPIDEMIOLOGY OF TRICHINELLOSIS

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Abstract. All studies on trichinellosis have been based on the assumption that there is only one cosmopolitan agent of human and animal trichinellosis; *Trichinella spiralis* (Owen, 1835). In the past, swine and only a few synanthropic animals were considered reservoirs, and the presence of the parasite in sylvatic animals was considered rare. Breeding experiments before, and then biochemical approaches (isoenzymes and DNA analysis), showed the presence of a high genetic variability inside this genus, suggesting it be considered as polyspecific. At present, eight gene pools, named from T1 to T8, have been identified in the genus *Trichinella*. T1 (*T. spiralis* s str) is the etiological agent for the domestic cycle, with a cosmopolitan distribution related to swine breeding and human habits. However, in some areas this parasite passes from domestic to sylvatic animals and vice versa. Six gene pools are the agents for the sylvatic cycle at different latitudes, mainly in carnivores. T2 (*T. nativa*) is present in terrestrial mammals and seldom in sea mammals of arctic and subarctic regions. T3, T5, and T8 are present mainly in Canidae (T3), Ursidae (T5), Hyaenidae and Felidae (T8) of temperate-subtropical areas of Palearctic, Nearctic and South African regions, respectively. T6 is present in carnivores in the subarctic-temperate area of the Nearctic region; and T7 (*T. nelsoni*) in Hyaenidae and Felidae of Equatorial Africa. Only T4 (*T. pseudospiralis*) can infect both mammals and birds, and it shows a cosmopolitan distribution. Probably trichinellosis is present worldwide, but unknown in those areas where it has not been sought.

INTRODUCTION

Trichinella was described for the first time in 1835 by Owen. It is one of the most studied nematode parasites, not only for its role as a pathogen of humans and animals, but also because it can be easily maintained in the laboratory. The hundreds of papers on studies of the different aspects of trichinellosis in humans and animals, ie, immunology, epidemiology, biology, clinics, pathology, biochemistry, up to 1972 were based on the assumption that there was only one cosmopolitan agent of human and animal trichinellosis, namely *Trichinella spiralis*. Swine and only few synanthropic animals were considered reservoirs, and the presence of the parasite in sylvatic animals was considered rare. During the last 30–40 years it was shown that trichinellosis was a common parasitic disease in sylvatic carnivorous and omnivorous mammals, and the biology was different among parasites obtained from different hosts and regions. At present there is strong evidence that the *Trichinella* biomas are greater in sylvatic than in domestic animals. Since 1972, genetic, biological and biochemical studies have suggested that the genus *Trichinella* is polyspecific. Studies on the biological and biochemical aspects of more than 150 *Trichinella* isolates collected worldwide, suggested the presence of at least eight gene pools in the genus *Trichinella* (Pozio *et al*, 1989; La Rosa *et al*, 1989; Zarlenga and Murrell, 1989; Rossi *et al*, 1990). The main epidemiological concepts on the eight gene pools are reported here. The eight gene pools are labeled with T-designations from T1 to T8.

Trichinella spiralis sensu stricto (T1)

T1 is the etiological agent of domestic trichinellosis, and shows a cosmopolitan distribution. Its life cycle can be maintained between

domestic (ie, swine-swine), domestic and synanthropic (ie, swine-rat), domestic and sylvatic (ie, swine-fox), synanthropic and sylvatic (ie, rat-fox), and sylvatic hosts (ie, fox-fox). The distribution overlaps the distribution of domestic pigs, and human habits have certainly influenced its dispersion. Infection can be controlled in domestic animals, but the same control approaches are not always possible for synanthropic animals, and are absolutely impossible for sylvatic animals. This parasite does not survive freezing and this method can be used to make meat safe to eat. The main sources of infection for humans are domestic swine and wild boar, and occasionally bear, horse and fox meat. Only T1 can produce infections in rats. Infected rats can spread the infection, but the epidemiological role of rodents is less important now than in the past, as there is scientific evidence that this host cannot maintain the life cycle of the parasite for a long time unless it consumes additional infected flesh. Human infections are well known, and numerous fatal cases have been reported especially in the past.

Trichinella nativa (T2)

The etiological agent of sylvatic trichinellosis in arctic and subarctic areas of the Oloarctic region is *Trichinella nativa*. The southern border of distribution is influenced by the environmental temperature during the cold season, which seems to be the isotherm –5° C in January. Numerous carnivores belonging to the Canidae, Felidae, Mustelidae, Ursidae, and Odobenidae families are hosts of this parasite. The polar bear, *Ursus maritimus*, seems to play a very important role as a reservoir in the Arctic region. The main biological characteristic of this parasite is its resistance to freezing. Human infections occur in Eskimos and other people who eat wild animals. According to Bohm and van Knapen (1989), Inuit people (Greenland) acquire the infection early in life and are constantly reinfected, becoming seronegative and parasite-free by the age of 50. Bear and walrus flesh are the main sources of infection for man. *T. nativa* infections in humans are characterized by a long incubation period, and serious intestinal symptomatology. Fatal cases have been reported. Imported horse meat infected with T2 caused a human epidemic in France in 1985. T2 infected polar bears were detected in the Bern Zoo (Switzerland) and in the Antwerp Zoo (Belgium). The importation of infected animals can represent a new source of infection in countries where *Trichinella* parasites resistant to freezing were not previously present.

Trichinella sp. (T3)

The etiological agent of sylvatic trichinellosis in the temperate area of the Palearctic region is T3. The northern border of distribution is influenced by the environmental temperature during the cold season, which seems to be the isotherm –6° C in January. In the area between the isotherms –5° C and –6° C, T3 lives sympatrically with T2. The southern border has yet to be established in Asia, while in Africa it seems to be the Sahara region. Soviet scientists considered this parasite to be *T. nelsoni*. The fox (*Vulpes vulpes*), jackal (*Canis aureus*), and wolf (*C. lupus*) seem to be the main reservoirs, but the parasite can also infect wild boars, horses, free-ranging swine, and only in circumstantial situations rats. Human infections are caused by the consumption of wild boar, fox, free-ranging swine and horse meat. This parasite can infect domestic animals, but does not maintain a domestic cycle. T3 human infections are characterized by a mild symptomatology, with a long incubation period and an absence of intestinal symptoms and signs. Fatal cases are unknown. T3 larvae in fox and wolf muscle show resistance to freezing at lower temperatures than T2 and T6.

Trichinella pseudospiralis (T4)

The etiological agent of bird-related trichinellosis, *T. pseudospiralis*, shows a cosmopolitan distribution in Palearctic, Nearctic and Oceania regions. Birds of prey, omnivores, and mammalian hosts belonging to the Order Marsupialia, Rodentia, and Carnivora were found infected with T4. The main biological characteristics are absence of nurse cells around muscle larvae, and a wide spectrum of hosts due to its ability to survive at temperatures ranging from 36° C to 42° C. The difficulty in detecting infections, due to the absence of nurse cells, is probably the cause of very few reports of this parasite.

Human infections are unknown, but experimental infections in primates show this parasite to be a potential pathogen for man.

Trichinella T5

The etiological agent of sylvatic trichinellosis in temperate areas of the Nearctic region is T5. Very few isolates have been examined, and the southern and northern borders of distribution are presently unknown. This gene pool shows biological, epidemiological and biochemical characteristics very similar to T3, so T5 could be considered a variant of T3 in the Nearctic region. The main biological characteristics are a low reproductive capacity index in laboratory mice and no resistance to freezing. The bear (*Ursus americanus*), coyote (*Canis latrans*), red fox (*V.vulpes*), racoon (*Procyon lotor*), and mink (*Mustela vison*) are reservoirs in Pennsylvania and Indiana in the United States. Human infections are unknown, but probably some human cases in the United States, due to the consumption of wild animal meat, were caused by this parasite.

Trichinella T6

The etiological agent of sylvatic trichinellosis in the northern temperate area of the Nearctic region is T6. Very few isolates were examined, and the southern and northern borders of distribution are presently unknown. This gene pool shows biological, epidemiological and biochemical characteristics intermediate between T2 and T5. The main biological characteristic is resistance to freezing at temperatures lower than T2 but higher than other gene pools. The bear (*Ursus arctos horribilis*), mountain lion (*Felis concolor*), wolverine (*Gulo luscus*), wolf (*C. lupus*), and gray fox (*Urocvon cinereo-arqenteus*), were found to be infected in Montana and Pennsylvania. Human infections are unknown, but probably some human cases due to the consumption of wild animal meat were caused by this parasite.

Trichinella nelsoni (T7)

The etiological agent of sylvatic trichinellosis in equatorial Africa is *T. nelsoni*. Only two isolates from a spotted hyena (*Crocuta crocuta*) and a warthog (*Phachochoerus aethiopicus*) originating from Kenya and Tanzania were examined. Epidemiological studies on this parasite were carried out by Nelson and coworkers (Nelson, 1970). The main biological characteristics are low pathogenicity for man and animals, a long period (between 34 and 60 days post infection) in developing nurse cells, and no resistance to freezing. Less than 100 human infections have been reported in Kenya, Tanzania, Senegal, and Ethiopia.

Trichinella T8

The etiological agent of sylvatic trichinellosis in South Africa is T8. Only two isolates from a spotted hyena and a lion (*Panthera leo*) originating from the Kruger National Park (South Africa) were examined. The main biological and biochemical characteristics of T8 are very similar to the T3 and T5 gene pools. Human infections are unknown.

DISCUSSION

A polyspecific point of view allows us to explain many questions in epidemiology as well as in immunological, biological, biochemical, clinical and pathological aspects. An obvious factor of epidemiological importance for most of the parasitic zoonoses, is host specificity. On the contrary, we do not observe a well-marked host specificity for *Trichinella* species, but the different gene pools are correlated with the fauna present at different latitudes. Probably trichinellosis is present worldwide, and it is considered unknown in those areas where it has not been sought. The clinical and pathological aspects in humans also change among the different gene pools, probably because of different immunogenicity levels and numbers of larvae produced per female.Control is possible for *T. spiralis* s.str. having domestic cycles, but the control of strains having sylvatic cycles is dependent on food preparation and consumption habits which should be changed to prevent transmission of meat-borne diseases. Moreover, there is a need to prevent contact between domestic and wild or synanthropic animals and to ensure a more rigorous meat control.

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