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Increasing circulation of *Alaria alata* mesocercaria in wild boar populations of the Rhine valley, France, 2007–2011

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ABSTRACT

The presence of the mesocercarial stage of *Alaria alata* (Goeze, 1792) in wild boar meat represents a potential risk for human, but little is known about the circulation of mesocercaria in wild boar populations. Routine Trichinella inspection, mandatorily performed in wild boar in France, also allowed detecting mesocercaria. We analyzed the results of this detection in the carcasses of 27,582 wild boars hunted in 2007–2011, in 502 hunting areas of the Rhine valley. Prevalence was globally low (0.6%), but 12% of the hunting areas were affected. These were clustered in lowlands of the Rhine valley, and prevalence strongly decreased with increasing elevation. In the lowlands, prevalence doubled between 2007 and 2011. This time trend and the geographic aggregation of positive wild boars suggest risk management measures based on targeted surveillance, control and prevention.

1. Introduction

Emerging or reemerging zoonoses are often considered to originate from wildlife and helminth parasites are not an exception (Jones et al., 2008; Woolhouse and Gowtage-Sequeria, 2005). In Europe, one of the latest emerging trematodes is the digenean trematode *Alaria* sp. (Möhl et al., 2009). The specificity of this parasite lies in the fact that the infectious stage for humans is the mesocercarial stage (Freeman et al., 1976), as for many paratenic hosts.

For the completion of this parasite's cycle, two intermediate hosts are necessary: a Planorbid snail (cercarial stage) (Ruszkowski, 1921) and an amphibian host (mesocercarial stage) (Ruszkowski, 1921; Skrjabin, 1965). The definitive hosts are canids, foxes being often described as the most suitable (Skrjabin, 1965). Paratenic hosts can enter the cycle: mesocercaria from amphibians can survive in many mammalian, avian and reptile species and reenter the cycle when these hosts are eaten by canids (Skrjabin, 1965). Paratenic hosts can also infect each other. Among other species, wild boars (*Sus scrofa*) are paratenic hosts to *Alaria alata* (Dollfus and Chabaud, 1953).

In Europe, the mesocercarial stage of *A. alata* has been known to infect wild boars since the late 19th century and many descriptions have been made of its presence in Germany at that time (Duncker, 1896; Leuckart, 1879) and later in France (Dollfus and Chabaud, 1953). According to the current European regulation, all wild boar carcasses entering commercial circuits should be submitted

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to *Trichinella* inspection by a method based on the pepsic digestion of meat samples from predilection muscles (EU-Commission, 2005). Though this method was originally designed for the control of *Trichinella* sp. in meat, *A. alata* mesocercaria can also be detected during the process. The implementation of a systematic *Trichinella* inspection has led to numerous discoveries of wild boar carcasses bearing *A. alata* mesocercaria in the European Union (Grösse and Wüste, 2006; Jaksic et al., 2002; Mileševic et al., 2004). The French area that has been most confronted to the problem posed by *A. alata* mesocercaria in wild boars is the Bas-Rhin department in the East of France. In this particular area, more than 40 cases of infected carcasses are reported since 2008 and this number increases steadily each year (Portier et al., 2011).

Such repeated discoveries raise concerns about the public health risk presented by *A. Alata* mesocercaria in boars' meat. Only one publication reports suspected human cases of alariosis due to the presence of *A. alata* mesocercaria in wild boars' meat and this paper does not give indication regarding the number of cases or the means used for the diagnosis of alariosis (Prokopowicz et al., 2005). However, several published and documented cases of alariosis due to American species have been reported with dramatic outcomes (Fernandes et al., 1976; Freeman et al., 1976). Symptoms reported by Prokopowicz et al. (2005) are fever, inflammation, edema and difficulty to breathe. Human alariosis due to *Alaria marcianae* include retinitis and neuroretinitis, respiratory symptoms (McDonald et al., 1994; Walters et al., 1975). One fatal case with massive invasion of several organs including the lungs has been reported (Fernandes et al., 1976; Freeman et al., 1976). Most of these cases were linked with the ingestion of frog meat. Prokopowicz et al. (2005) gives insufficiently cooked wild boar and goose meat as sources of infection for *A. alata*. Considering *A. alata* in Europe, rats and mice were successfully infected with *A. alata* mesocercaria isolated from wild boars (Dollfus and Chabaud, 1953). Moreover, Odening (1963) obtained a massive infection in a Rhesus monkey (*Macaca mulatta*) with *A. alata* mesocercaria found in several vital organs including the heart. Several other species (hens, geese, falcons and owls) were experimentally infected in the former Union of Soviet Socialist Republics (Skrjabin, 1965). Few studies have been devoted to *A. alata* mesocercaria in wild boar. A new detection method was designed (Riehn et al., 2010, 2011) and resistance to freezing has been tested (Portier et al., 2011). Though wild boars are not an obligatory host to *A. alata* mesocercaria and their suspected sources of infection (amphibians) are not the heart of their diet, high prevalence and heavy parasite burdens have been observed in different European landscapes (Mileševic et al., 2004; Möhl et al., 2009; Riehn et al., 2012). Infection by *A. alata* mesocercaria does not seem to have an impact on the health of wild boars, but the presence of *A. alata* mesocercaria in this species represents a potential risk for human because of new cooking methods (barbecuing increasingly used for game meat), suspected cases of alariosis due to *A. alata* (Prokopowicz et al., 2005) and confirmed cases of alariosis due to mesocercaria of American *Alaria* species in the USA and Canada (Fernandes et al., 1976; Freeman et al., 1976; McDonald et al., 1994).

The objective of this study was to evaluate the prevalence of *A. alata* mesocercaria in wild boars hunted in the Bas-Rhin area and to analyze its variations according to time (season, year), space, and to wild boars' individual characteristics (age, sex).

2. Materials and methods

2.1. Data collection

All wild boars hunted in the Bas-Rhin department are submitted to systematic *Trichinella* inspection in meat, which also allows *A. alata* detection. Laboratory results and individual-level data (including age, sex, weight, date and hunting area) are routinely collected in a database. We analyzed a subset of this database, corresponding to 27,582 wild boars hunted between April 2007 (as no wild boar bearing *A. alata* mesocercariae was detected in this area before April 2007) and September 2011, in a study area bounded in the East by the Rhine river and in the West by the Vosges mountains (Fig. 1).

Age was coded in 3 classes (<1 year; 1–2 years and >2 years) according to general aspect and dentition. The <1 year age class was further subdivided into two age classes (<6 months and 6 months–1 year) using weight: wild boars weighing less than 21 kg (full body) or less than 16 kg (without offals) were considered <6 months old. For each wild boar, the place where the animal had been killed was given by the hunting area: areas managed by local hunting societies and defined by specific boundaries. The Bas-Rhin department contains 1502 hunting areas, of which 502 were considered in this study. Hunting area boundaries were obtained from the departmental direction of territories. For each hunting area, elevation of the area centroid was computed using the ASTER global digital elevation model (ASTER GDEM is a product of METI and NASA).

2.2. Mesocercariae detection

A. alata mesocercariae were detected in wild boar according to the method used for *Trichinella* meat inspection. The samples used for this method were chiefly tongue and diaphragm. If a second analysis was necessary (for individual carcass analysis and/or confirmation of positive result), the remainder of these tissues was used, as well as, if no more tongue or cheek was available, tissues of the anterior limb. At least 5 g of meat without grease and connective tissues were used per animal. The artificial digestion method was used as described in EC regulation 2075/2005 (EU-Commission, 2005). This method relies on a pepsin–hydrochloric acid (HCl) artificial digestion with a magnetic stirrer. Samples for one analysis must weigh 100 g and can be composed of one individual or be a pool of up to 20 individuals.

Analyses were performed by the local veterinary diagnostic laboratory. Individuals from positive pools were routinely retested to identify the positive animal(s). When no positive animal had been identified, the whole pool was excluded from the dataset.