



Alaria spp. mesocercariae in Eurasian badger (*Meles meles*) and wild boar (*Sus scrofa*) from the Białowieża Forest, north-eastern Poland

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Abstract

Alaria spp. mesocercariae are commonly found in wild boar and other omnivorous mammals. In Europe, the number of cases presenting *Alaria* mesocercariae infections has been on the rise in the last years. From October to December 2016, samples of muscle from tongue, neck, and mandibular regions were collected from 1 Eurasian badger (*Meles meles*) and 14 wild boars (*Sus scrofa*) hunted in the Białowieża Forest, north-eastern Poland. Using the *Alaria* migration technique (AMT), *Alaria* mesocercariae were isolated and morphologically identified in one badger and one wild boar. To the authors' knowledge, this is the first report of *Alaria* mesocercariae in paratenic hosts from the Białowieża Forest.

Keywords *Alaria* spp. · Badger · *Meles meles* · *Sus scrofa* · Białowieża Forest

Introduction

Alaria spp. are parasitic trematodes of wild and domestic carnivores. The life cycle comprises one final host and two intermediate hosts: snails and amphibians in that order. The addition of a paratenic host can occur at the mesocercarial stage through predation of infected amphibians. In Europe, *Alaria alata* is the endemic species for the genus. In the last years, there has been an increase in reports of *Alaria alata* mesocercariae in some game animals from several European

regions such as France, Eastern Germany, Southern Austria, Hungary, and Poland (Portier et al. 2011; Paulsen et al. 2013; Riehn et al. 2012; Riehn et al. 2014; Rentería-Solís et al. 2013; Berger and Paulsen 2014). However, there is still a lack of information regarding the parasite ecology and epidemiology of *Alaria alata* in broader regions of Europe.

The Białowieża Forest, located within the border of Poland and Belarus, is one of the last remaining primeval forests of Europe. Intestinal parasite diversity in this forest has been rarely studied (Górski et al. 2006, Szczesna et al. 2008). Most of the studied species, badger (*Meles meles*) included, inhabiting the area are infected with intestinal helminths. This also includes domestic species such as cats and dogs (Górski et al. 2006).

Alaria alata is known to be present in the Białowieża region. Eggs of this parasite were reported in several carnivores (Górski et al. 2006). However, cases of mesocercarial infection and most common paratenic host species have not been published.

This study presents the first report of *Alaria* spp. mesocercariae in Eurasian badger and confirms the presence of the parasite in wild boar from the Białowieża Forest.

Material and methods

From October to December 2016, 1 badger and 14 wild boars were hunted and collected in the Białowieża Forest in north-

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eastern Poland, close to the border of Belarus. Carcasses were submitted for a necropsy to the Mammal Research Institute, Polish Academy of Sciences in Białowieża. Samples of muscle from tongue, neck, and mandibular regions were collected from each animal for *Alaria* mesocercaria examination. *Alaria* spp. mesocercariae were isolated from muscle following the *A. alata* mesocercaria migration technique (AMT) developed by Riehn et al. (2010). Briefly, 30 g of muscle were cut into small cubes of around 1 cm. They were placed on a plastic sieve supported on a glass funnel, which was filled with warm tap water (48 °C) completely covering the meat sample. After a 60-min incubation period, 20 ml of liquid were run-off and examined under the stereoscope. *Alaria* mesocercariae were identified based on morphological features according to Odening (1961).

Results and discussion

Details of each collected animal can be found in Table 1. *Alaria* mesocercariae were successfully isolated and identified in one badger and one wild boar (Table 1). In the badger, 28 mesocercariae were found in 150 g of sample material, analyzed in rounds of 30 g each. Separately, ten mesocercariae were isolated from around 100 g of sample material, analyzed in three rounds of 30 g each, from the wild boar. The parasite morphology and motility was consistent with the one described in the literature (Odening 1961; Riehn et al. 2010). As side finding, the badger also presented severe sparganosis with around 400 spargana collected during necropsy (Kołodziej-Sobocińska, unpubl. data).

This is the first report of *Alaria* spp. mesocercariae in paratenic hosts from the Białowieża Forest. Górski et al. (2006) investigated intestinal helminth diversity in several carnivore species, including badgers, from the Białowieża Forest. During this study, eggs of *Alaria alata* were identified in wolf (*Canis lupus*), fox (*Vulpes vulpes*), lynx (*Lynx lynx*), otter (*Lutra lutra*), and mink (*Mustela vison*). This data confirmed the parasite is successfully maintaining its cycle in the region. However, data regarding the mesocercarial stage of *Alaria* was still missing.

Only one previous report of mesocercariae in badger has been produced in Europe. Takeuchi-Storm et al. (2015) successfully isolated *Alaria alata* mesocercariae from six badgers in Denmark. In this study, the authors identified the species through molecular biology techniques. Since the mesocercariae isolated in this study were immediately used for further investigations, no identification of the species was possible. Regarding *Alaria* occurrence in wild boars from Poland, preliminary results of a single study that reported 6% occurrence for the north-eastern part of the country have been reported (Michalski and Wiszniewska-Łaszczych 2016). Also in Poland, *Alaria alata* mesocercariae were found in all the samples collected from three frog species (*Rana temporaria*, *Rana esculenta*, and *Rana arvalis*) (Wójcik et al. 2002). Separately, the badger in this study presented severe sparganosis. *Spirometra* spp. has been reported in badgers and wild boars from the Białowieża Forest (Kołodziej-Sobocińska et al. 2014; Kołodziej-Sobocińska et al. 2016). No samples for *Alaria* detection were taken during those studies. Both *Alaria* spp. and *Spirometra* spp. use amphibians as intermediate hosts, which most likely are the source of both infections. Whether there is a further co-relation between both

Table 1 Information and testing results of examined animals in the Białowieża Forest

Animal number	Species	Date of collection (day.month.year)	Sex	Age	AMT results
1	Badger (<i>Meles meles</i>)	17.10.2016	Male	Adult	Positive
2	Wild boar (<i>Sus scrofa</i>)	17.10.2016	Female	Adult	Positive
3	Wild boar	26.11.2016	Male	Juvenile	Negative
4	Wild boar	28.11.2016	Male	Unknown	Negative
5	Wild boar	02.12.2016	Female	Juvenile	Negative
6	Wild boar	02.12.2016	Male	Juvenile	Negative
7	Wild boar	02.12.2016	Male	Juvenile	Negative
8	Wild boar	02.12.2016	Female	Unknown	Negative
9	Wild boar	02.12.2016	Female	Juvenile	Negative
10	Wild boar	16.12.2016	Female	Unknown	Negative
11	Wild boar	16.12.2016	Female	Unknown	Negative
12	Wild boar	16.12.2016	Female	Unknown	Negative
13	Wild boar	19.12.2016	Male	Unknown	Negative
14	Wild boar	19.12.2016	Male	Unknown	Negative
15	Wild boar	19.12.2016	Male	Unknown	Negative

parasitic infestations, e.g., the presence of one facilitates the infection degree of the other, is still unknown.

The wild boar has been the most studied paratenic host for *Alaria mesocercariae* in Europe (Sailer et al. 2012; Riehn et al. 2012; Riehn et al. 2014). This might be due to its popularity as game and human consumption of its meat. In Germany, Riehn et al. (2012) reported 11.5% of occurrence in wild boars from the eastern part of the country. Lower numbers were found during a study in the Czech Republic with 6.8% occurrence (Paulsen et al. 2013). Portier et al. (2014) investigated wild boars from the Rhine valley, Eastern France. They reported an overall occurrence of 0.6% with numbers rising up to 12% in certain areas from the valley where hunting was intensively practiced.

Initial findings of *Alaria mesocercariae* in Europe were accidentally produced during *Trichinella* routine examinations in game meat (Möhl et al. 2009; Riehn et al. 2010; Portier et al. 2011). Riehn et al. (2010) developed a simple and practical technique for the sole identification of *Alaria mesocercariae* in meat (AMT). The technique triggered the rise of the parasite detection throughout Europe (Sailer et al. 2012; Paulsen et al. 2013; Rentería-Solis et al. 2013; Riehn et al. 2012; Riehn et al. 2014; Takeuchi-Storm et al. 2015). Additionally, it brought insight into the mesocercariae distribution in paratenic hosts in the continent, particularly their presence in game animals. The implementation of AMT in further studies in the Białowieża Forest would bring a panorama regarding *Alaria* ecology and epidemiology in the area. Moreover, the data presented in this study would aid future studies in this forest regarding parasite diversity in such important biotope.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

References

- Berger EM, Paulsen P (2014) Findings of *Alaria alata* mesocercariae in wild boars (*Sus scrofa*, Linnaeus, 1758) in west Hungary (Transdanubia regions). *Wiener Tierärztliche Monatsschrift* 101: 120–123
- Górski P, Zalewski A, Łakomy M (2006) Parasites of carnivore mammals in Białowieża Primeval Forest. *Wiad Parazytol* 52:49–53
- Kołodziej-Sobocińska M, Tokarska M, Kowalczyk R (2014) The first report of sparganosis (*Spirometra* sp.) in Eurasian badger (*Meles meles*). *Parasitol Int* 63:397–399
- Kołodziej-Sobocińska M, Miniuk M, Ruczyńska I, Tokarska M (2016) Sparganosis in wild boar (*Sus scrofa*)—implications for veterinarians, hunters, and consumers. *Vet Parasitol* 227:115–117. <https://doi.org/10.1016/j.vetpar.2016.08.001>
- Michalski MM, Wiszniewska-Laszczych A (2016) Preliminary data on the incidence of *Alaria alata* mesocercariae in wild boars (*Sus scrofa*, Linnaeus, 1758) in North-eastern Poland. *Ann Parasitol* 62
- Möhl K, Große K, Hamedy A, Wüste T, Kabelitz P, Lücker E (2009) Biology of *Alaria* spp. and human exposition risk to *Alaria mesocercariae*—a review. *Parasitol Res* 105:1–15
- Odening K (1961) Zur Kenntnis des Exkretionssystems einiger Digenetischer Trematoden (Unterordnungen Plagiorchiata, Brachylaemata, Strigeata). *Zeitschrift für Parasitenkunde* 204:440–456
- Paulsen P, Forejtek P, Hutarova Z, Vodnansky M (2013) *Alaria alata* mesocercariae in wild boar (*Sus scrofa*, Linnaeus, 1758) in south regions of the Czech Republic. *Vet Parasitol* 197:384–387
- Portier J, Vallé I, Lacour SA, Martin-Schaller R, Ferté H, Durand B (2014) Increasing circulation of *Alaria alata* mesocercariae in wild boar populations of the Rhine Valley, France, 2007–2011. *Vet Parasitol* 199:123–129
- Portier J, Jouet D, Ferté H, Gibout O, Heckmann A, Boireau P, Vallée I (2011) New data in France on the trematode *Alaria alata* (Goeze, 1792) obtained during *Trichinella* inspections. *Parasite* 18:271–275
- Rentería-Solis ZM, Hamedy A, Michler F-U, Michler BA, Lücker E, Stier N, Wibbelt G, Riehn K (2013) *Alaria alata* mesocercariae in raccoons (*Procyon lotor*) in Germany. *Parasitol Res* 112: 3595–3600
- Riehn K, Hamedy A, Grosse K, Wüste T, Lücker E (2012) *Alaria alata* in wild boars (*Sus scrofa*, Linnaeus, 1758) in the eastern parts of Germany. *Parasitol Res* 111:1857–1861
- Riehn K, Lalkovski N, Hamedy A, Lücker E (2014) First detection of *Alaria alata* mesocercariae in wild boars (*Sus scrofa* Linnaeus, 1758) from Bulgaria. *J Helminth* 88:247–249
- Riehn K, Hamedy A, Große K, Zeitler L, Lücker E (2010) A novel detection method for *Alaria alata* mesocercariae in meat. *Parasitol Res* 107:213–220
- Sailer A, Glawischning G, Irschik I, Lücker E, Riehn K, Paulsen P (2012) Findings of *Alaria alata* mesocercariae in wild boar in Austria: current knowledge, identification of risk factors and discussion of risk management options. *Wiener Tierärztliche Monatsschrift* 99: 346–352
- Szczęśna J, Popiołek M, Schmidt K, Kowalczyk R (2008) Corpological study on helminth fauna in Eurasian lynx (*Lynx lynx*) from the Białowieża Forest in eastern Poland. *J Parasitol* 94:981–984
- Takeuchi-Storm N, Al-Sabi MNS, Thamsborg SM, Enemark HE (2015) *Alaria alata* mesocercariae among feral cats and badgers, Denmark. *Emerg Infect Dis* 12:1872–1874
- Wójcik AR, Grygnon-Frankiewicz C, Żbikowska E (2002) Current data of *Alaria alata* (Goeze, 1782) according to own studies. *Medycyna Wet* 58:317–519 [Article in Polish]