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RESEARCH ARTICLE

Cercarial Dermatitis in Schleswig-Holstein Distribution of Cercariae in Public Swimming Lakes

Frauke Elbnik¹ and Regina Fölster-Holst^{2*}

¹Christian-Albrechts University, Kiel, Germany

²Department of Dermatology, University clinics of Schleswig-Holstein, Campus Kiel, Germany

ABSTRACT

Cercarial dermatitis is a neglected zoonotic disease with distribution all over the world's temperate zones. It is caused by cercariae, a larval stage of parasitic blood flukes of the genus *Trichobilharzia* that is a parasite of waterfowl. When cercariae burry into human skin, they trigger an allergic reaction that leads to severely itching papules. Goal of this research was to get an overview over the distribution of cercariae in the bathing places of Schleswig-Holstein, the most northern state of Germany. Therefore, all public bathing places were visited and searched for fresh water snails that are the potential intermediate hosts of cercariae. Water snails of different families and genera were collected and examined for the presence of cercariae. Water samples were taken and examined for cercariae via a microscope. Additionally slime samples of the water snails were taken to test a new, time saving method of detection. In total 8 different kinds of water snails were collected and examined, of which the families of Lymnaeidae and Planorbidae proved to be the most common hosts of cercariae. In total, the results indicate a spatial distribution of cercariae shedding snails all over Schleswig-Holstein.

*Corresponding author

Regina Fölster-Holst, Department of Dermatology, University clinics of Schleswig-Holstein, Campus Kiel, Germany

Tel: +49-431-500-211-60

E-mail: rfoelsterholst@dermatology.uni-kiel.de

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INTRODUCTION

Cercarial dermatitis is a neglected zoonotic disease with distribution all over the world's temperate zones. It is caused by the larvae of parasitic blood flukes of the family *shistosomatidae* that parasitize wild waterfowl [1]. Those larvae are released by freshwater snails, its intermediate hosts and then try to penetrate the skin of waterfowl as potential regular hosts. Occasionally people with contact to infested water are infested and so the penetration of the human skin leads to the typical symptoms of cercarial dermatitis which is the development of allergic red rashes and severe itching [2-4].

In Schleswig-Holstein the most common cause of cercarial dermatitis are Cercariae of the genus *Trichobilharzia* that include *T. szidati*, *T. regent* and *T. franki* [5]. They appear mainly in warm summer months in stagnant freshwater and show a typical appearance with a forked tail, two eye spots and are shown in figure 1 [6,7].

In just one day, one water snail can release 100.000 cercariae [8]. These then swim around actively and search for a compatible host. When cercariae find a fitting skin surface they start the penetration by emptying secretion glands to etch the stratum corneum [9-12]. Once inside the skin the cercariae seek for blood vessels to enter. After reaching the bloodstream cercariae travel to the digestive organs and the liver (*T. szidati* and *T. franki*) or the central nervous system (*T. regenti*) [5]. Here the larvae develop to adult worms and begin to produce eggs, that are dispersed into water. Once in the water, ciliated larval forms hatch and search for a suitable freshwater snail. After the penetration of the snail's skin it becomes the new alternate host

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Figure 1 Schematic drawing of a cercaria (Butenschön 2016).

[12,13]. Searching for a fitting host, cercariae can come in contact with humans and penetrate their skin [9–11]. Once inside the human skin, cercariae get stuck because they are in a wrong host. Typically at first the penetration of the skin causes tingling or burning sensations that are replaced by severely itching maculae and papulae. The skin reaction is the correlate of an allergic reaction and gets more severe with the rising number of infections by cercariae in terms of an allergic sensitisation. As long as there is no desquamation of the skin, the dead cercariae are stuck and keep the allergic reaction active. This can last for several weeks [4,14].

In central Europe cercarial dermatitis occurs mainly from May to August. In this time the bathing season as well as the numbers of cercariae are at their peaks [7]. A special risk factor for cercarial dermatitis is the prolonged stay in shallow water. This is a natural habitat for freshwater snails and therefore the number of cercariae, is high. Especially, children are infested by cercariae because they most often play in the warm and shallow water of the shores [15].

The goal of the research was to determine the distribution of cercariae all over Schleswig-Holsteins freshwater bathing places. Therefore the parasites alternate hosts were collected and examined for infestation at all official bathing places. Additionally, a new method for detecting cercariae was developed and tested.

MATERIALS AND METHODS

To overview the documented cases of cercarial dermatitis data about cases of the past years were provided by health offices of every administrative district. Unfortunately, the submitted information was fragmentary, so freshwater snails were collected by hand or net systematically at each bathing place in a definite time range. After the first snail was found the search was continued for exactly 15 minutes. If no snail was found in 30 minutes the search was classified as not successful. All snails were kept in labeled plastic bags containing water from the corresponding bathing place,

a sufficient air circulation was ensured. Such bags were kept in shade and at environmental temperature to keep conditions as realistic as possible. Snails that were kept over several days were given lettuce and customary forage for fish. Every water snail was examined and its genus and species were determined using data provided by Jekel and Zick [16], Sturm [17] and Zettler [18]. After that the snails were put into a glass bowl with a diameter of 7 cm filled with 25°C warm tap water [modified after 19]. The bowls were placed in daylight for 15 minutes to provoke the shedding of cercariae [modified after 6]. Then a water sample was taken examined through a microscope. Cercariae were classified according to research results of Walter Neuhaus [12], Ilse Jekel and Daniela Zick [16] as well as Anna Faltynkova [3,20]. A detailed classification of cercariae was impossible due to the distinct similarities of the species. They were classified by the existence of eye spots (e.g. *T. szidati*) and shape of the tails. Cercariae that are a typical cause for dermatitis in humans show two eye spots and a classically forked tail. In consequence only water samples containing such cercariae were labeled positive.

Since the conventional method of detecting cercariae takes quite some time, additionally a new method was tried. As soon as water snails begin to move they produce slime to glide on. As in the common test for cercariae, snails were put in tap water under equal conditions for 15 minutes. The shed slime was taken with a pipette at the same time as the conventional sample to keep both methods comparable. The slime sample was put on an object slide and was examined under a microscope. As soon as one living cercaria with eye spots and a forked tail was found, the sample was labeled positive.

RESULTS

According to data from Public Health Services and the Department for Social Services Kiel bathing places from all rural districts were registered (Figure 2). Table 1 gives an overview of the distribution of bathing places in all districts.

Figure 2 Shows the occurrence of cercariae in different rural districts.

According to modified data of Geobasisdaten of Landesvermessungsamt Schleswig-Holstein: overview of the occurrence of cercariae in different rural districts (Butenschön 2014).

Table 1: Distribution of bathing places.

District	Number of lakes	Number of bathing places
Herzogtum Lauenburg	13	21
Neumünster	2	3
Nordfriesland	2	2
Ostholstein	13	15
Pinneberg	3	3
Plön	12	31
Rendsburg-Eckernförde	24	35
Schleswig-Flensburg	10	11
Segeberg	17	26
Steinburg	3	3
Stormarn	5	5
Total	104	155

Samples were taken at a total of 155 bathing places. Cercariae were found at 85 bathing places equaling 55%. At 7 bathing places no water snails could be found.

Altogether 2311 freshwater snails were collected at all bathing places. Cercariae with eyespots and forked tails were found in 341 (14.8%) water snails. Correspondingly 1970 water snails were tested negative for cercariae. The collected snails belonged to the family of Lymnaeidae with the genera

Lymnaea sp. and *Radix* sp. the family of Planorbidae with the genera *Planorbarius* sp. and *Planorbis* sp., the families of Bithynidae, Viviparidae and Physidae as well as the family of Nerthidae with the genus *Theodoxus* sp.

Most common were snails of the genus *Lymnaea* sp. that contributed 931 specimens to the collected water snails. In total they were 40.3% of all water snails found. 249 (26.8%) of the *Lymnaea* sp. were shedding cercariae. So this genus of snails is the most common host for cercariae in this survey. 682 (73.2%) of the *Lymnaea* sp. were found to shed no cercariae.

487 specimens of snails of the genus *Radix* sp. were found equaling 21.1% of all found water snails. 69 (14.2%) of the tested *Radix* sp. shed cercariae what makes this kind of snail the second leading genus in being host to cercariae. 418 (85.5%) of the collected *Radix* sp. did not shed cercariae.

Snails of the genus *Planorbarius* sp. were occasionally found. In total 127 specimens were collected equaling 5.5% of all water snails. 18 (14.2%) of the *Planorbarius* sp. shed cercariae. In 109 (85.8%) no cercariae could be found.

Also 127 snails of the genus *Planorbis* sp. were found occasionally equaling 5.5% of all found water snails. No *Planorbis* sp. shed any cercariae.

Another commonly found snail belonged to the family of Bithyniidae. In total 475 specimens could be found equaling 20.6% of all found water snails. None of these Bithyniidae was found to shed cercariae.

111 snails of the genus *Theodoxus* sp. were found equaling 4.8% of all snails. No *Theodoxus* sp. was positive for cercariae.

A rarely found snail belonged to the family of Physidae. In total 38 specimens were found equaling 1.6% of all water snails. No specimen shed cercariae.

Other rarely found snails belonged to the family of Viviparidae. In total 15 specimens were found which equals 0.7% of all snails. 5 (33.3%) of the found Viviparidae shed cercariae. 10 snails shed no cercariae.

The results were found using the detection method described earlier. Sample collected with this method often contained only few cercariae in the water on the object slide. So it was important to search the whole object slide. Additionally cercariae tend to swim around actively which makes the detection of a specimen even more difficult. There is quite a risk to label a sample negative if there are just few swimming cercariae. If a living cercaria is to be observed for a period of time the position of the object slide has to be corrected frequently to follow its movement. The new tested method of examining the slime of snails sometimes proved to be more efficient. Partially large quantities of cercariae were found in the slime. Those cercariae often were stuck and so could be observed easily as shown in figure 3. Stuck cercariae permanently tried to free themselves from the slime by abrupt movements of their tails. Despite of fierce movement some cercariae were immobilized for more than 20 minutes in slime so they could be observed thoroughly.

Table 2 shows several test results exemplarily comparing the common detection method for cercariae with the tested

method of examining the slime. Whenever cercariae with eyespots and forked tails were found they were always present in small numbers. Besides this type of cercariae, other cercariae which are not pathogenic for humans were found. Samples containing the other types of cercariae were not labeled positive. The most common type of cercariae found showed no eyespots but a forked tail. This type was present in great numbers, sometimes several hundred cercariae could be found in a single sample. Other forms of cercariae were found less often and when found were present in a small number of individuals.

CONCLUSION

Purpose of this research was to get an overview of the distribution of cercariae as a potential cause for cercarial dermatitis in freshwater lakes used as bathing places in Schleswig-Holstein. Therefore, all official bathing places at freshwater lakes were visited and tested for cercariae. For this purpose different freshwater snails serving as alternate hosts were collected. The snails with most frequent occurring of cercariae were from the family of Lymnaeidae with the genera of *Lymnaea* sp. and *Radix* sp. as well as the family of Planorbidae with its genus *Planorbarius* sp. [2,3]. Besides those species other water snails found were collected as well to see if there was also an occurrence of cercariae. –for examination, conventional methods of Graham [6], Sluiter, et al. [19] and Talpos and Elliott [21] were modified and used as a basis. The modification affected the amount of time for examining a single sample which was shortened and the light used. In this research only natural light was used to imitate natural conditions in a lake. In recited articles artificial sources of light were used [6,19,21]. The longer periods of time and artificial light in other studies were used to acquire as many cercariae as possible. In this study a single cercaria was enough to label a sample positive.

Figure 3 (Butenschön 2014).
a. single cercaria swimming freely.
b. multiple cercariae caught in slime.

Table 2: Comparison of different detecting methods.

Examined water snails	Number of cercariae in slime immediately after excretion	Number of cercariae in a water sample after 15 minutes
<i>Lymnaea</i> sp.	4	0
<i>Lymnaea</i> sp.	2	1
<i>Lymnaea</i> sp.	3	1
<i>Lymnaea</i> sp.	1	1
<i>Lymnaea</i> sp.	> 100	3
<i>Lymnaea</i> sp.	48	5
<i>Lymnaea</i> sp.	4	1
<i>Radix</i> sp.	14	0
<i>Radix</i> sp.	4	1
<i>Radix</i> sp.	1	2
<i>Radix</i> sp.	1	0
<i>Planorbarius</i> sp.	11	1

So these aspects could be changed without falsifying the results. Besides the modified but proven methods used, a new experimental approach in finding cercariae was tested. Here the slime produced by the snails was examined directly for cercariae. This method proved sufficient to check for cercariae in an even shorter amount of time. Additionally found cercariae stuck in slime can be observed for a longer period of time without constantly moving the object slide to follow swimming cercariae. This could be used in further examinations e.g. to determine species more easily. It should be tested though how sensitive the new method is for false negative results because of the short amount of time used to acquire samples and to detect further advantages and disadvantages.

The examination of the samples showed that there are different water snails in Schleswig-Holstein that serve as alternate hosts. Most often the detection of cercariae was possible in snails of the genera *Lymnaea* sp. and *Radix* sp. making a total of 1418 specimens (62, 5.5%) of all found snails. This is supported by other scientific works. Especially snails of the family of Lymnaeidae are known to be host to many kinds of cercariae [3,22]. This is one reason why those snails are often used in laboratories to produce cercariae [4]. In different surveys of *Lymnaea* sp collected from natural water bodies an average infestation rate was at 14.1% to 26.3% [3,12,23]. So the found infestation rate of 26.8% seems to be high but quite realistic since there have been measured infestation rates of 44,9% in single cases [22]. Also the genera of *Radix* sp. and *Planorbarius* sp. showed infestation in 14.2% of the specimens. Water snails of the families Physidae and Bithyniidae showed no cercariae in the results of this research. In other surveys both species proved to be hosts to cercariae [23].

For almost all bathing places visited, a considerable number of water snails could be found. Especially the bigger species such as *Lymnaea* sp. and *Radix* sp. seem to occur on

a regular basis and have a widespread distribution over all bathing places. Also often those snails are host to cercariae so a comprehensive appearance of cercariae all over Schleswig-Holstein can be supposed. Even at bathing places without findings of cercariae a general appearance cannot be excluded for there were a limited number of snails tested. Also environmental influences like e.g. the occurrence of blue algae at some bathing places were reasons for negative results. Such external influences were isolated cases. Further the number of cercariae depends greatly on time of the year and temperature and there is a deviation of the number of cercariae in different years [22]. So the results are just an extract not to be taken sweepingly. But it shows that in general the appearance of cercariae at many bathing places is possible.

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