Epidemiol. Infect. (2008), **136**, 391–394. © 2007 Cambridge University Press
doi:10.1017/S0950268807008734 Printed in the United Kingdom

SHORT REPORT
Cercarial dermatitis and lake eutrophication in south-central Chile

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(*Accepted 25 April 2007; first published online 7 June 2007*)

SUMMARY

Cercarial dermatitis is caused by exposure to the cercariae of schistosome species which have birds or mammals as their definitive hosts. A public alarm was raised in the summer of 2004 when this parasitic disease was observed for the first time in south-central Chile at Laguna Chica de San Pedro (36° 51′ S, 73° 05′ W). Swimmers at this eutrophic lake were surveyed in order to estimate the amount of cercarial dermatitis in the area; participants were observed during the summers of 2004 and 2005 for clinical signs of cercarial dermatitis and 25 *Chilina dombeyana* snails were collected monthly from Laguna Chica de San Pedro during one year and then examined for animal schistosome cercariae. We found that 3% of the swimmers had pruritic maculopapular rashes on their legs, arms, necks, or other body parts and that between 9·1% (May 2006) and 52·4% (November 2004) of the snails examined were infected with the bird schistosome cercariae *Trichobilharzia* sp.

Cercarial dermatitis is a parasitic disease with worldwide distribution. Dermatitis caused by the cercariae of animal schistosomes has been reported from many countries in Europe and America, but not from the southern end of South America [1–5]. This parasitic disease was first recorded in central Chile in the summer 2004 at the eutrophic lake Laguna Chica de San Pedro. The appearance of the parasite produced public alarm and seriously affected the recreational activities in this urban lacustrine area (population ~500 000 inhabitants), which has a Mediterranean-type climate with maximum summer temperatures between 25 °C and 32 °C (November–February). Many people (~1000–3000 per day) use this lacustrine system for swimming, sailing, and fishing activities in the summer. During this period, abundant freshwater snails, *Chilina dombeyana*, were observed in the shallow waters (0–3 m) and were found to have a high prevalence of digenean parasites associated with the system's high diversity and the abundance of wild ducks and swans. The endemic snail *C. dombeyana* serves as an intermediate host for many digenean species [6]. In south-central Chile, this snail may have an important impact on digenean abundance, as it is very frequent and widespread in freshwater systems and its large size enables the digenean parasites to produce very high numbers of cercariae for their transmission. Parasites may regulate host populations and digeneans, in particular, may have considerable effects on the population biology of their gastropod intermediate hosts [7]. The purpose of the present study was to determine (i) the temporal occurrence of cercarial dermatitis in humans and (ii) the prevalence of animal schistosome infection in *Chilina* snails and the level of cercarial shedding in relation to time of year and water temperature.

Laguna Chica de San Pedro (36° 51′ S, 73° 05′ W) was chosen for this study because it had the highest

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number of cercarial dermatitis cases. This small lake has an important local economy associated with water-dependent recreational activities (e.g. swimming, sailing, fishing). Valdovinos & Pedreros [8] recently published a complete limnological description of the lake. The system's surface temperature was recorded between December 2004 and November 2005.

Human cases of cercarial dermatitis in the summers 2004 and 2005 were determined monthly (December–March) by asking 1500 swimmers by season (voluntary respondents) at the University of Concepción's beach each year about the presence of itching and maculopapular rashes or eruptions on the body (especially legs, arms, and necks) after swimming.

To detect snails infected with animal schistosome cercariae, 25 *C. dombeyana* snails were collected monthly for one year (January 2004 to September 2005) and transferred to the EULA Environmental Research Centre ($n=300$). In typical sampling campaigns, 2–3 co-workers collected snails during the morning. The collectors waded in the shallow areas (water depth mostly 10–70 cm) along the banks and picked out the snails manually. In the laboratory, the snails were isolated in vials of 25 ml and cercarial emergence was stimulated by lighting for 24 h at 20 °C. The shed cercariae were determined and the cercarial prevalence recorded. Cercariae were collected and fixed in 5% hot formaldehyde and cleared in lactophenol or stained with azocarmine. Cercariae were identified by systematic key references [9, 10] and quantified under a stereomicroscope (expressed as number of cercariae per patently infected snail per day). Only older *C. dombeyana* with a shell height of at least 25 mm were collected.

In the summer of 2004 and 2005, 3% of the people surveyed reported cercarial dermatitis symptoms; i.e. a macular or papular rash, mainly on the legs, arms, and neck. The symptoms were widespread in children and appeared on the first author's legs and arms 20 min after collecting infected snails in the Laguna Chica de San Pedro. Of all the *Chilina* snails examined for animal schistosome cercariae, between 9·1% (April 2005) and 52·4% (November 2004) were infected with brevifurcate-apharyngeate distome cercariae, *Trichobilharzia* sp. (Fig. 1). The maximum prevalence was recorded in spring, prior to the foci of cercarial dermatitis (Fig. 2*a*), but was not significantly correlated with the water temperature of the lacustrine system (Pearson product moment correlation $R^2=0{\cdot}0001$, $P>0{\cdot}05$). However, there might be a

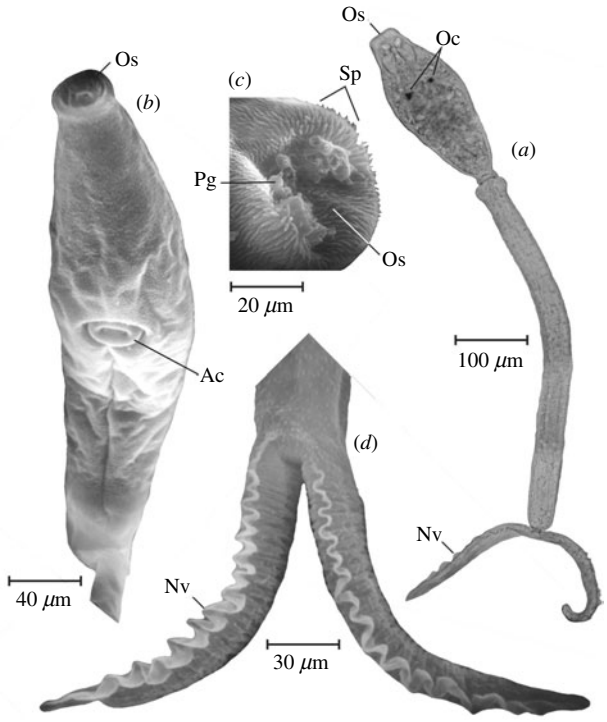

Fig. 1. Cercaria of *Trichobilharzia* sp. obtained from the *Chilina dombeyana* snail. (*a*) General view (optical microscopy), (*b*) head (SEM), (*c*) head organ (SEM), (*d*) bifurcated tail (SEM). Ac, Acetabulum; Nv, natatory velum; Oc, ocelli; Os, oral sucker; Pe, penetration grand; Sp, spines.

correlation between water temperature and patently infected snails which might be time displaced. We believe it will be worthwhile collecting more data during future research to confirm or abandon this hypothesis.

The maximum production of cercariae by infected snails was recorded in the summer seasons (Fig. 2*b*) and was significantly correlated with the water temperature of the lacustrine system ($R^2=0{\cdot}59$, $P<0{\cdot}05$).

Trichobilharzia spp. cause cercarial dermatitis when penetrating the skin [11]. There are no readily available, easy tests for cercarial dermatitis. Diagnosis is based on a history of exposure to water that may be contaminated with cercariae. This is the first record of cercarial dermatitis in Chile and in southern South America. Previous records have indicated this parasitic disease to be in the tropical and subtropical areas of South America [1–6]. In summer, south-central Chile's climate is temperate – warm with maximum temperatures ranging between 25 °C and 32 °C (November–February). During this period, people swim and play in freshwater systems where animal

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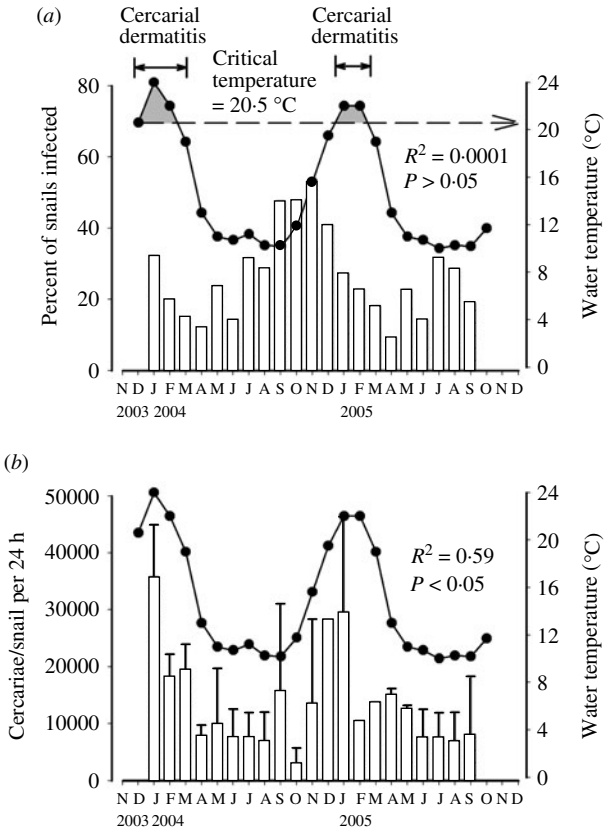

Fig. 2. (*a*) Seasonal variation in the prevalence of *Trichobilharzia* sp. infection in *Chilina dombeyana* snails (□) and water temperature (–●–). (*b*) Seasonal variation in the mean cercarial production by patently infected snails (□) and water temperature (–●–).

schistosome cercariae can readily penetrate the skin. The majority of cercarial dermatitis cases were observed as maculopapular rashes. According to the claims of infected individuals (and the first author's personal experience), a burning sensation appeared after water drops had dried on their skin and they had an itchy sensation on the skin. Symptoms started with erythema and itching, followed by maculopapular rashes that appeared several hours later. Cases were most frequent from November to February due to the shedding of cercariae and people bathing. Patients with severe reactions were referred to physicians for treatment with a cortisone cream (steroid) that decreased local swelling and itching [12]. *C. dombeyana* snails are abundant in lakes, ponds, rivers, and canals and live in different ecological habitats. They were observed at the oxygenated marginal water surface of the Laguna Chica de San Pedro. Various cercariae species, including strigeid, echinostome, monostome, and schistosome were obtained from *C. dombeyana* in the laboratory. Cercariae of animal schistosomes could be confused with strigeid cercariae; however, the former lack a pharynx. These cercariae belonged to non-human schistosomes, especially bird schistosomes, including *Trichobilharzia* spp. This bird schistosome was, with its total body length of $945{\cdot}6 \pm 163{\cdot}7$ μm (range 684–1212 μm), large and easy to distinguish with the naked eye. Good features for recognition were the bifurcated tail, eyespots, flame cells, and arrangement of penetration glands [5]. Two eyespots were found on the body, the pharynx and oral sucker were fused together into a head organ, and the intestinal system was reduced. The cercariae were strongly positively phototactic, i.e. they swam towards a light source and congregated there. The simultaneous occurrence of four phenomena – eutrophication of the freshwater ecosystem, bathing habits, colonization by *Chilina*, and settlement of many duck and swans colonies (both also associated with eutrophication and elevated macrophyte growth) – combined with the extended daylight and high temperatures of summer are responsible for most of the outbreaks of cercarial dermatitis observed in the area. Control of this condition is difficult, requiring strict maintenance of bodies of water and, if necessary, the use of molluscicides such as niclosamide. The use of praziquantel in baits for treating the definitive hosts appears to interrupt the natural cycle of the avian Schistosomatidae [11]. We believe that reducing the snail populations, limiting the inputs of phosphorus into the lake, and controlling eutrophication could be used as alternative treatments, in order to avoid controlling populations with more environmentally aggressive methods (e.g. niclosamide). In the last decade the numbers of *C. dombeyana* snails in the San Pedro lacustrine system have clearly increased [13, 14] and this may explain the foci of cercarial dermatitis observed in the last 2 years. The abundance of snails is positively associated with increased aquatic macrophytes produced by an accelerated eutrophication process derived from historic, intensive changes in land use (deforestation and urbanization) in the lacustrine system watershed [13, 15]. We believe that reducing aquatic macrophytes will limit snail populations and the transmission of cercariae, as macrophytes are fundamental for the recruitment and growth of these snails.

In a complementary way, it would be convenient to study the possibility of using cream formulations for the swimmers. Recently, nine water-resistant formulations were evaluated, by exposing the treated

https://doi.org/10.1017/S0950268807008734 Published online by Cambridge University Press

arms of volunteers to *Trichobilharzia szidati* cercariae [16]. Six formulations protected from cercarial invasion. However, after immersion of the treated skin in water (2 × 20 min), only two formulations still offered full protection: (*a*) Safe Sea?, a cream protecting against jellyfish, and (*b*) niclosamide in water-resistant sun-screen cream formulations at concentrations as low as 0·05%. In an *in vitro* system Safe Sea? and a 0·1% niclosamide formulation caused a high damage rate in *T. szidati* (92% and 99% after 5 min; only niclosamide with lethal effect) but not in *Schistosoma mansoni* (1% and 72%; both formulations with lethal effect). However, a 1% niclosamide formulation damaged *S. mansoni* sufficiently (100% after 5 min) and might offer full penetration protection.

We think that this incipient focus of cercarial dermatitis will expand to other geographic areas of Chile in the future, associated with the clear trend of eutrophication in freshwater ecosystems. Cercarial dermatitis could be a health problem in the eutrophic ecosystems of south-central Chile. *Trichobilharzia* sp. cause cercarial dermatitis due to the joint presence of patently infected snails and swimmers. Although the snails are infected all year round, cercariae prevalence and production are seasonal, increasing in the summer. Temperature is a good predictor of cercarial dermatitis; we consider a risk to exist when temperatures exceed 20·5 °C.

ACKNOWLEDGEMENTS

The authors thank the staff of the University of Concepción resort and Ilustre Municipality of San Pedro for their field facilities and statistics on cercarial dermatitis detection, especially Dr Alberto Arrizaga. We are most grateful to Dr Margarita Ostrowski from Nuñez, Buenos Aires (Argentina) and Luz María Sans, Viña de Mar (Chile) for their valuable help with the identification of cercarial species. We thank three anonymous reviewers for critical review of the manuscript. This study was supported by a grant from the Centre of Environmental Sciences EULA–Chile, University of Concepción and DIUC 203.310.036-1.0.

DECLARATION OF INTEREST

None.

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