Parasitology International 68 (2019) 92–94

Contents lists available at ScienceDirect

Parasitology International

journal homepage: www.elsevier.com/locate/parint

Letter to the Editor

Pleurolophocercous and parapleurolophocercous types of cercariae: Revisiting concepts

Dear Editor

An important milestone in the study of larval trematodes found in molluscs was the creation of the system of classification of cercarian types by Lühe (1909) [1], later modified and complemented by various authors [2–5]. This system considers morphological traits of cercariae that are easily visualized by optical microscopy, including the presence and disposition of suckers, types of tail, and presence of structures such as collar of spines, stylet, eyespots, finfolds and glands, among others. Although it is not necessarily related to formal taxonomic categories based on morphology of adults, the determination of the cercarian type can provide relevant information regarding the pattern of transmission of the species and other groups of hosts involved in the respective life cycles [6–8].

Among the various groups of trematodes transmitted by molluscs worldwide are the members of the superfamily Opisthorchoidea. These flukes parasitize various groups of piscivorous vertebrates [9], and several members of the families Opisthorchiidae and Heterophyidae are fish-borne zoonotic agents that infect millions of people, mainly in Asia [10–12]. These parasites have prosobranch snails as first intermediate hosts, in which single-tailed cercariae are produced. These larvae are morphologically characterized by most authors as belonging to the types Pleurolophocerca and Parapleurolophocerca. Both terms were originally coined in the magnificent work of Sewell (1922) [3] that dealt with the fauna of cercariae from India, describing several species of cercariae and creating new morphological groups. Although these two cercarian types have been widely present in the parasitological literature for almost a century, a recent consultation of Sewell's work revealed that most authors have since diverged from the original proposal of these terms, as discussed below.

The history related to these cercarian types began when Sewell (1922) [3] described the cercarian type Pleurolophocerca to accommodate three new monostome larvae (*Cercariae Indicae III*, *Cercariae Indicae VII* and *Cercariae Indicae VIII*, Fig. 1A-C) characterized by a set of morphological traits, including the presence of a pair of eyespots, absent ventral sucker and tail with well-developed finfolds. *Cercaria pleurolophocerca* Sonsino, 1896, and *Cercaria lophocerca* Lebour, 1907 were the other two larvae known at that time that were classified by Sewell (1922) [3] as belonging to this cercarian type. Some pages later in this same work, another cercarian type named Parapleurolophocerca was proposed to accommodate two distome larvae (*Cercariae Indicae XXXI* and *Cercariae Indicae L*, Fig. 1D-E), both distinct from all larvae known at that time. As the name suggests, this cercarian type resembles Pleurolophocerca, however, according to Sewell (1922) [3], it differs from the latter primarily by the presence of an evident ventral sucker. Another important difference verified between these two types of cercariae is the disposition of tail finfolds: in Parapleurolophocerca, they extend throughout each margin of the tail, while in Pleurolophocerca the tail can presents just a dorsal or a dorso-ventral finfold, or a combination of lateral (located in the anterior part of the tail) and dorso-ventral finfolds. Given several morphological similarities, the possibility that these two cercarian types can be produced by closely-related groups of trematodes was already considered in the original description.

Since then, some authors have debated without reaching consensus regarding the probable evolutive relationship between the species of trematodes that produce these types of cercariae. A probably inaccurate description of *C. pleurolophocerca,* in which Langeron (1924) [13] characterized the larva as bearing a ventral sucker, was considered at that time to be an additional indication of the relation between the cercariae of types Pleurolophocerca and Parapleurolophocerca. It was suggested by some authors that there were insufficient grounds for separating these cercarian types, and the merging of these cercarian types, under the name Pleurolophocerca, was previously suggested [14–17].

The fact is that the beginning of this discussion appears to have generated confusion regarding the interpretation and use of the term Parapleurolophocerca in most studies related to larval trematodes. This name was used, without clear justification, to name cercariae with general morphology similar to those known today to the members of the subfamily Haplorchiinae (e.g. [6,18–20]). The cercariae known to the members of this subfamily differs from that of Parapleurolophocerca as described by Sewell (1922) [3]. Rather, they have general characteristics similar to those described for larvae considered by this author as belonging to the type Pleurolophocerca.

When this nomenclatural mistake occurred for the first time is difficult to determine, however, this inconsistency is present in the work by Rothschild (1938) [15], in the first revision of the superfamily Opisthorchoidea by Price (1940) [21] as well as in the classical book on trematodes by Dawes (1946) [6]. I believe that the presence of the mistake in parasitological books and reviews can be related to its propagation and the later use over time. After performing a search of scientific literature, I verified that the term Parapleurolophocerca was applied in most cases to larvae morphologically related to Haplorchiinae. Between the exceptions to this rule, perhaps because of the ease of obtaining the Sewell's work, are works of some authors studying the fauna of cercariae of India (e.g. [22]). In this sense, it is important to emphasize that, according to the original proposal by Sewell (1922) [3], the larvae with general morphology similar to those currently known to be representatives of the superfamily Opisthorchioidea (most members of the families Opisthorchiidae, Cryptogonimidae and Heterophyidae) are all morphologically characterized as the type Pleurolophocerca, including the members of Haplorchiinae. Exceptions are the some species of heterophyids that produce larvae of the types Zygocercous and Magnacercous.

In relation to the larvae of the type Parapleurolophocerca, similar to the original description, i.e. presenting an evident ventral sucker and tail with lateral finfolds throughout its length, reports are less common.

https://doi.org/10.1016/j.parint.2018.09.001
Received 18 July 2018; Received in revised form 29 August 2018; Accepted 4 September 2018
Available online 06 September 2018

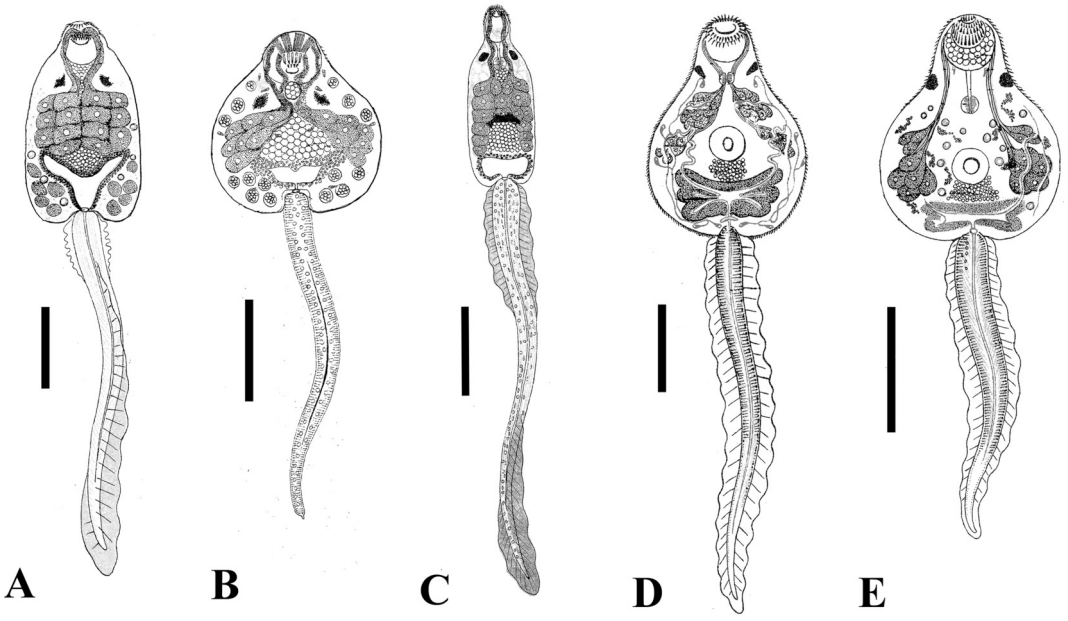

Fig. 1. Cercariae of type Pleurolophocerca (A: *Cercariae Indicae III*, B: *Cercariae Indicae VII*, C: *Cercariae Indicae VIII*) and Parapleurolophocerca (D: *Cercariae Indicae XXXI*, E: *Cercariae Indicae L*) described by Sewell (1922) from India. Scale bar: 100 μm. Modified from Sewell (1922) [3].

Among these we can include *Cercaria beatifica* found in China [23], *Cercaria melanoides* in South Africa [24], unidentified larvae found in Japan and China [25], *Cercariae atomica* from Belgian Congo [26], *Cercaria atomica kivuensis* reported in Democratic Republic of the Congo [16] and *Cercariae* sp. IV Kerala. reported in India [27]. To the best of my knowledge, none of these cercariae were linked with their respective adult parasites. A cercaria of Parapleurolophocerca type associated with the life cycle of the plagiorchioid *Astiotrema monticelli* Stossich, 1904 (see in [28]) was a doubtful report, given several biological inconsistences, as discussed by Besprozvannykh et al. (2015) [29]. Currently, a definitive confirmation that larvae of the type Parapleurolophocerca are produced by members of the superfamily Opisthorchioidea is lacking. However, the morphology of the rediae described for some of these larvae, as well as similarities with larvae of the type Pleurolophocerca, suggest that this relationship is probable, and this can be confirmed by future experimental life cycle or molecular phylogenetic studies.

Aiming to standardize parasitological terms and scientific communication related to larval trematodes, I suggest that use of the term Parapleurolophocerca be discontinued, especially for larvae of the subfamily Haplorchiinae. Instead, the use of the name Pleurolophocerca is here encouraged for the cercarian types produced by most representatives of Opisthorchioidea. The rescue of this discussion and the reestablishment of the use of these terms as originally coined is a recognition of pioneering works that have leveraged our knowledge on morphology and biology of larval trematodes.

References

[1] M. Lühe, I. Parasitische Plattwürmer, Trematodes, in: A. Bauer (Ed.), *Die Süsswasserfauna Deutschlands*, Gustav Fischer, Jena, 1909, pp. 1–217.
[2] W.W. Cort, Larval trematodes from north American fresh-water snails, J. Parasitol. 1 (1914) 65–84.
[3] R.B.S. Sewell Cercariae indicae, Indian J. Med. Res. 10 (1922) 1–370.
[4] H.M. Miller, Comparative studies on furcocercous cercariae, Illinois Biol. Monogr. 10 (1926) 1–112.
[5] G. Dubois, Les cercaires de la région de Neuchâtel, Bull. Soc. Neuchatel. Sci. Nat. 53 (1929) 1–177.
[6] B. Dawes, The Trematoda with Special Reference to British and Other European Forms, Cambridge University Press, Cambridge, 1946.
[7] S.C. Schell, How to Know the Trematode, Brown Company Publishers, Iowa, 1970.
[8] K.V. Galaktionov, A.A. Dobrovolskij, The Biology and Evolution of Trematodes. An Essay on the Biology, Morphology, Life Cycles, and Evolution of Digenetic Trematodes, Kluwer Academic Publisher, Dordrecht, 2003.
[9] R.A. Bray, Superfamily Opisthorchioidea Looss, 1899, in: R.A. Bray, D.I. Gibson, A. Jones (Eds.), Keys to the Trematoda, Vol. 3 CAB International and Natural History Museum, UK, 2008, pp. 7–8.
[10] J.Y. Chai, K. Darwin Murrell, A.J. Lymbery, Fish-borne parasitic zoonoses: status and issues, Int. J. Parasitol. 35 (2005) 1233–1254.
[11] T.N. Petney, R.H. Andrews, W. Saijuntha, A. Wenz-Mücke, P. Sithithaworn, The zoonotic, fish-borne liver flukes *Clonorchis sinensis*, *Opisthorchis felineus* and *Opisthorchis viverrini*, Int. J. Parasitol. 43 (2013) 1031–1046.
[12] N.M. Hung, H. Madsen, B. Fried, Global status of fish-borne zoonotic trematodiasis in humans, Acta Parasitol. 58 (2013) 231–258.
[13] M. Langeron, Recherches sur les cercaires des piscines de Gafsa et enquête sur la Bilharziose tunisienne, Arch. Inst. Pasteur de Tunis 13 (1924) 19–67.
[14] H. Vogel, Der Der Entwicklungszyklus von Opisthorchis felineus (Riv.) nebst Bemerkungen über die Systematik und Epidemiologie, Zoologica 33 (1934) 1–103.
[15] M. Rothschild, The excretory system of *Cercaria coronanda* n. sp. together with notes on its life-history and the classification of cercariae of the superfamily Opisthorchioidea Vogel 1934 (Trematoda), Novit. Zool. 41 (1938) 148–163.
[16] H. Vercammen, Grandjean Les trematodes du lac Kivu Sud (Vermes), Ann. Mus. Roy. Afr. Centr. Scien. Zool. 5 (1960) 1–171.
[17] A. Ramachandrula, S.M. Agarwal, Two new species of pleurolophocercous (parapleurolophocercous) cercariae from snails at Raipur, Indian J. Helminthol 42 (1990) 164–170.
[18] F. Frandsen, N.O. Christensen, An introductory guide to the identification of cercariae from African freshwater snails with special reference to cercariae of trematode species of medical and veterinary importance, Acta Trop. 41 (1984) 181–202.
[19] H.A. Pinto, A.L. Melo, Larvas de trematódeos em moluscos no Brasil: panorama e perspectivas após um século de estudos, Rev. Patol. Trop. 42 (2013) 369–386.
[20] J. Waikagul, U. Thaenkham, Approaches to Research on the Systematic of Fish-Borne Trematodes, Academic Press, Amsterdam, 2014.
[21] E.W. Price, A review of the trematode superfamily Opisthorchioidea, Proc. Helminthol. Soc. Wash. 7 (1940) 1–13.
[22] R.P. Mukherjee, The Fauna of India and Adjacent Countries, *Larval Trematodes of India, Part II Parapleurolophocercariae and Echinostome Cercariae*, Zool. Surv., India. Calcutta, 1992.
[23] E.C. Faust, Larval Flukes associated with the cercariae of *Clonorchis sinensis* in bithynoid snails in China and adjacent territory, Parasitology 22 (1930) 145–155.
[24] A. Porter, The larval Trematoda found in certain South African Mollusca with special reference to schistosomiasis (Bilharziasis), 8 Publications of the South African Institute of Medical Research, 1938, pp. 1–492.
[25] K. Okabe, On the first intermediate host of Hasegawa's metacercaria A, Annot. Zool. Japon. 18 (1939) 188–193.
[26] A. Fain, Contribution à l'étude des formes larvaires des trematodes au Congo belge et spécialment de la larvae de *Schistosoma mansoni*, *Mém. Inst. Royal Col. Belge Sec. Sci. Nat. et Méd.* 22 (1953) 1–312.
[27] A. Mohandas, Studies on the freshwater cercariae of Kerala V. Paramphistomatoid

and opisthorchioid cercariae, Vest. Cs. Spol. Zool. 40 (1976) 196–205.
[28] S. Yamaguti, A Synoptical Review of Life Histories of Digenetic Trematodes of Vertebrates with Special Reference to the Morphology of their Larval Forms, Keigaku Publishing Co, Tokyo, 1975.
[29] V.V. Besprozvannykh, D.M. Atopkin, A.V. Ermolenko, A.V. Kharitonova, A.Y. Khamatova, Life-cycle and genetic characterization of *Astiotrema odhneri* Bhalerao, 1936 sensu Cho & Seo 1977 from the Primorsky Region (Russian Far East), Parasitol. Int. 64 (2015) 533–539.

H.A. Pinto
Laboratório de Biologia de Trematoda, Department of Parasitology, Instituto de Ciências Biológicas, Universidade Federal de Minas Gerais, Belo Horizonte, Minas Gerais, Brazil
E-mail address: hudsonalves13@icb.ufmg.br