Two new species of furcocercous cercariae from freshwater gastropods of Western Ghats

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Abstract Two new furcocercous cercariae, *Cercaria* sp. I Western Ghats n. sp. and *Cercaria* sp. II Western Ghats n. sp. were found infecting the freshwater snails *Indoplanorbis exustus* and *Thiara tuberculata* respectively of the Wayanad region of the Western Ghats. *Cercaria* sp. I Western Ghats n. sp., a distome, apharyngeate, non-ocellate and spinose cercaria having three pairs of penetration glands, kidney-shaped small caeca and 20 pairs of flame cells including a pair in the furcae was recovered from *I. exustus* and *Cercaria* sp. II Western Ghats n. sp., a non-ocellate, pharyngeate, longifurcate furcocercous cercaria with two pairs of irregularly bordered penetration glands, septate caeca and 21 pairs of flame cells including three pairs in the furcae, from *T. tuberculata*. Sporocysts of *Cercaria* sp. I Western Ghats n. sp. were sausage-shaped while that of *Cercaria* sp. II Western Ghats n. sp. were thread-like and both of them developed in the hepatopancreas of their hosts. This paper describes the two new cercariae with their intramolluscan stages and compares them with related species to establish their systematic positions.

Keywords Furcocercous · *Cercaria* · Western Ghats · Wayanad · *Indoplanorbis exustus* · *Thiara tuberculata* · Freshwater snail

Introduction

The Western Ghats, one of the global biodiversity hotspots, is located along the west coast of India from the river Tapti in the north to the southern tip of India. Wayanad district is surrounded by the mountains of the Western Ghats and shares borders with Tamil Nadu and Karnataka States. Wayanad has ideal ecological conditions for rich vertebrate and invertebrate fauna. Hardly any studies were conducted in this region to identify and understand the biology and ecology of molluscs (Subba Rao 1989), the only first intermediate host of trematodes. Likewise, the information on trematode parasites this region is also meagre. The intensive effort taken by Sewell (1922) was the pioneer work to understand the cercariae of this region. Three distome, furcocercous cercariae were reported by Sewell (1922) from the Wayanad region of the Western Ghats, followed by many works on trematodes. Even though freshwater gastropods, *Indoplanorbis exustus* and *Thiara tuberculata* are prevalent in the study area, reports on their cercarial fauna in Wayanad region are meagre. During the present study, one furcocercous cercaria each infecting *I. exustus* and *T. tuberculata* was encountered. Detailed studies revealed that the present cercariae are different from the previously described forms in their morphology and morphometry and hence reported here as new. The cercariae are designated by Roman numerals, followed by 'Western Ghats' indicating the area of collection.

Materials and methods

The study area for the present investigation was the Wayanad region of the Western Ghats. *I. exustus* and *T. tuberculata* were collected from rivers, streams, ponds and

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other water bodies in different localities of Wayanad. Collected snails were brought to laboratory, placed in glass beakers containing freshwater and were exposed to sunlight for cercarial emergence. By regular check the infected snails were identified and isolated. Emerged cercariae were studied alive, with or without staining, under a Nikon Ni-U phase contrast research microscope. Intramolluscan stages were studied after dissecting the infected snails and observing them under a binocular stereozoom microscope, Luxeo 4Z. Digestive gland and other tissues were examined for the presence of sporocysts/rediae. Photomicrographs were taken with a Nikon Y-TV55 camera attached to the Nikon ECLIPSE Ni-U research microscope with the aid of Nikon NIS Elements Imaging software. Sketches were drawn using Nikon Y-IDT drawing tube and details from live observations were added free hand. Measurements, in μm , of 20 specimens were taken.

Results and discussion

Cercaria sp. I Western Ghats n. sp

Host *Indoplanorbis exustus* (Deshayes 1834)

Site of infection Digestive gland

Type locality Sulthan Bathery in Wayanad district, Kerala

Holotype Deposited in the Helminth parasite collections, Ecological Parasitology and Tropical Biodiversity Laboratory, Department of Zoology, Kannur University, Mananthavady Campus, Wayanad-670645, Kerala, India (Accession number: C.F.I.1)

Etymology Area from where the species was first recorded

Period of collection September, 2017 to March, 2018

Prevalence Four out of one hundred and twenty five snails (0.032%) screened were infected

Cercarial behaviour Cercarial emergence starts in the morning hours. Swim actively and rest spreading the furcae parallel to water surface and then move down towards the substratum. Cercariae settle down after active swimming.

Description (Fig. 1a, b)

Distome, apharyngeate, non-ocellate. Elongate body measured 117.61–241.97 (183.48) in length and 43.78–76.52 (55.95) in width. Surface of the body covered with small, uniformly arranged, backwardly directed spines. Tail terminal; spinose; longer than body 211.47–308.48 (248.67)

Fig. 1 *Cercaria* sp. I Western Ghats n. sp. **a** Cercaria **b** Sporocyst

long and 24.09–46.58 (33.47) wide. Furca small constricted from tail stem, with uniformly arranged spines, measuring 89.18–134.34 (110.48) $\times$ 9.38–28.7 (16.29). Anterior organ terminal; armed with 20 rows of spines, slightly larger than body spines, in the anterior region of anterior organ; measured 35.22–85.11 (57.87) $\times$ 22.83–47.40 (32.35). Ventral sucker post-equatorial, globular, measured 11.14–28.78 (19.39) long and 8.80–25.11 (18.37) wide, provided with single row of spines. Two pairs of lateral muscle bands attached to body wall on either side and a single longitudinal muscle band below, attached to posterior body wall support the ventral sucker. Mouth terminal, followed by long, narrow oesophagus, measured 23.92–99.09 (43.64) $\times$ 1.39–4.31 (2.54). Caeca small, kidney-shaped, with a deeply stained area inside the caeca, measured 9.85–18.69 (13.69) $\times$ 6.42–11.63 (9.06). Three

Table 1 Comparison of characters and measurements of *Cercaria* sp. I Western Ghats n. sp. with four related cercariae

Cercariae	<i>Cercariae Indicae</i> XXX (Sewell 1922)	<i>Cercariae Indicae</i> XV (Sewell 1922)	<i>Cercaria</i> sp. XIX Malabar, (Sanil and Janardanan 2018)	<i>Cercaria bilharziellae polonicae</i> Kow (Szidat 1926); (Iles 1959)	<i>Cercaria dubaensis</i> (Jansen van Rensburg et al. 2016)	<i>Cercaria</i> sp. I Western Ghats n. sp.
Body	Spinose, ocellate, 172 × 46	Aspinose, 316–368 × 72– 158	Spinose, ocellate, 155.1–191.4 (176.6) × 59.4–79.2(68.6)	Spinose, Ocellate, 270–360 (310) × 90–120 (105)	Elongate, spinose, sensory cilia present, 110–180 (141) × 35–80 (53)	Spinose, 117.61–241.97 (183.48) × 43.78–76.52 (55.95)
Tail	Spinose, 211 × 28	Aspinose, 210–368 × 53–70	Spinose, longer than body, 181.5–283.8 (251.0) × 39.6–52.8 (45.8)	Spinose, wider at base with proximal cup-shaped depression, 225–315 (280) × 53–70 (62)	Spinose, longer than body, presence of sensory cilia, 150–300 (235) × 10–50 (25)	Spinose, longer than body, 211.47–308.48 (248.67) × 24.09–46.58 (33.47)
Furcae	Spinose, short, 85	Aspinose, finfold present, 263–316	Spinose, longer than tail stem, 243.3–277.2 (252.6) × 29.7–36.3 (32.6)	Spinose, fin folds along entire length, 105–135 (123) × 10	Spinose, short, presence of sensory cilia, 50–150 (78) × 5–20 (10)	Spinose, 89.18–134.34 (110.48) × 9.38– 28.7–28.7 (16.29)
Anterior organ	43 × 32	58–46	29.7–36.3(32.8) × 29.7– 36.3(31.2)	25–30 rows of spines, 75–90 (80) × 60–75 (61)	Pear-shaped, longer than wide, 20–80 (35) × 15–42 (28)	35.22–85.11 (57.87) × 22.83–47.40 (32.35)
Ventral sucker	14 in diameter	Rudimentary	26.4–29.7 (27.7) × 26.4– 29.7 (29.0)	30 × 30	Spherical, 15–25 (18) × 15–25 (18), covered with long sharp spines	11.14–28.78 (19.39) × 8.80–25.11 (18.37)
Distance between anterior organ- ventral sucker	–	–	–	–	–	58.42–121.14 (86.38)
Pre-pharynx	Absent	Short	Short	Absent	Absent	Absent
Pharynx	Absent	Well developed, 22	Pear shaped, 16.5– 23.1(17.2) × 16.5– 19.8(17.4)	Absent	Absent	Absent
Oesophagus	Long, narrow	Long	Long, narrow	Short	Long	Long, 23.92–99.09 (43.64) × 1.39–4.31 (2.54)
Caeca	Small sac-like	Wide, reach till excretory bladder	Up to the posterior quarter	Very short, wide caeca	Small, end above penetration glands	Short, kidney-shaped 9.85–18.69 (13.69) × 6.42–11.63 (9.06)
Excretory bladder	Small, at extreme posterior end of the body	Trifoliate	Triangular	Small	Small, oval, situated at posterior end of body	Oval, 5.86–18.22 (11.57) × 4.65–21.95 (12.36)

Table 1 continued

Cercariae	<i>Cercariae Indicae</i> XXX (Sewell 1922)	<i>Cercariae Indicae</i> XV (Sewell 1922)	<i>Cercaria</i> sp. XIX Malabar, (Sanil and Janardanan 2018)	<i>Cercaria bilharziellae polonicae</i> Kow (Szidat 1926); (Iles 1959)	<i>Cercaria dubaensis</i> (Jansen van Rensburg et al. 2016)	<i>Cercaria</i> sp. I Western Ghats n. sp.
Caudal excretory canal	Till tip of furca	Till tip of furca	Opens out one-third from the furcal base	Till tip of furca	Till end of furca on inside	Till tip of furca
Flame cell formula	$2[(2 + 2+2) + (1)] = 14$	$2[(12) + (3)] = 30$	$2[(2 + 3) + (2 + 1+(2))] = 20$	$2[(3 + 3) + (1)] = 14$	$2[(1 + 1) + (1 + 1) + (1)] = 10$	$2[(2 + 2+2 + 2+2) + (2 + 2+1) + [(1 + 1+1 + 1) + (1)] = 40$
Caudal flame cell formula	1 Pair	3 Pairs	2 Pairs	1 Pair	1 Pair	$2[(1 + 1+1 + 1) + (1)] = 10$
Flame cell on furcae	Absent	Absent	Absent	Absent	Absent	1 Pair
Penetration gland	5 Pairs	4 Distinct sets	2 Pairs	5 Pairs	5 Pairs	3 Pairs
Genital Primordia	Mass of small round cells behind ventral sucker, series of 5–6 larger cells along the posterior and lateral margin	Oval mass of small round cells between the two intestinal caeca & extending forwards from the excretory vesicle to the ventral sucker	Irregular mass of cells behind ventral sucker	Round mass of nuclei anterior to excretory bladder & between most posterior pair of penetration glands	Not mentioned	Small round mass of cells between ventral sucker and excretory bladder
Intra molluscan stage	Oval to sausage shaped sporocyst	Sausage-shaped sporocyst	Filamentous Sporocyst	Long, filiform sporocyst, breadth 40–90	Not mentioned	Sausage-shaped sporocyst
Host	<i>Indoplanorbis exustus</i> , <i>Limnaea acuminata</i>	<i>Melanoides tuberculata</i> (Muller) <i>M. lineatus</i> (Grey)	<i>Gyraulus convexusculus</i> (Hutton)	<i>Planorbis cornes</i>	<i>Biomphalaria pfeifferi</i>	<i>Indoplanorbis exustus</i>

Fig. 2 *Cercaria* sp. II Western Ghats n. sp. **a** *Cercaria*
b Sporocyst

pairs of penetration glands arranged as pre-acetabular, acetabular and post-acetabular, containing fine granular contents. Gland ducts run forward up to the anterior organ and separately open out lateral to mouth. Prominent, small, triangular spines present near the opening of penetration gland. Genital primordia represented by a mass of cells between ventral sucker and excretory bladder. Excretory

bladder at the posterior end of body, oval, thin-walled, $5.86\text{--}18.22$ (11.57) $\times$ $4.65\text{--}21.95$ (12.36) in size. Each primary collecting duct arises at the antero-lateral margin of excretory bladder, ascends lateral to ventral sucker and branches into anterior and posterior collecting vessels. Posteriorly, bladder continues as caudal excretory canal, bifurcates near the furcal origin and passes to the end of

Table 2 Comparison table of characters and measurements of *Cercaria* sp. II Western Ghats n. sp. with related cercariae

Cercariae	<i>Cercariae of Cotylurus brevis</i> , Dubois et Rausch 1950 (by Faltynkova et al. 2007)	<i>Cercaria spinulosa</i> , Ginetsinskaya 1959 (by Faltynkova et al. 2007)	<i>Cercariae Indicae XXII</i> Sewell 1922	<i>Cercaria</i> sp. II Western Ghats n. sp
Body (LXB)	Spinose, 4 pairs of sensory cilia, small colourless eye-spots equatorial, 195–235 (218) × 50–63 (55)	Spinose, 5 pairs of sensory cilia, small eye spot, 153–168 (161) × 50–60 (57)	Aspinose, 161 × 23	Spinose, 5 pairs of sensory hairs 169.20–315.52 (259.24) × 62.64–104.86 (89.09)
Tail	Spinose, 7 pairs of sensory cilia, 212–227 (221) × 35–45 (37)	Spinose, a group of cilia in the first and last third of tail and approximately one pair in its mid-length, 165–175 (170) × 38–40 (36)	Aspinose 143 × 23	Aspinose, 2 pairs of sensory hairs at the base of the tail & 5 tuft of sensory hairs with two hairs in each tuft at the furcal bifurcation, 134.22–207.69 (185.29) × 5.57–65.68 (47.635)
Furcae	Spinose, 202–227 (220) × 15–25 (18)	Spinose, 128–160 (144) × 15–18 (17)	Aspinose, long, lancet shaped, 143	Aspinose, longer than tail stem, 169.58–256.92 (213.87) × 16.93–3.56 (25.26)
Anterior organ	40–48 (44) × 28–35(30)	Terminal, 2 rows of 12–19 pre-oral spines; post-oral spines arranged in 11–12 rows, 45–50 (47) × 25–33 (28)	Oval, 40 × 22	Pear-shaped, 51.16–77.15 (64.98) × 20–34.35 (27.52)
Ventral sucker	Post-equatorial, 33–35(35) × 30–35(32), with 134–137 large spines arranged in 3 rows	Post-equatorial, 3–4 rows of 150 spines, 30–35 (32) × 25–33 (30)	Large, well developed, single row of spines diameter of 22	Circular, 19.50–33.41(28.02) × 21.65–31.96 (27.40)
Distance between anterior organ- ventral sucker	–	–	–	36.81–293.53 (98.87)
Pre-pharynx	Present	Distinct	Absent	Narrow, long
Pharynx	Oval, 13–20 (15) × 10–15 (13)	Spherical, 13–18 (15) × 10–15 (13)	Absent	5.31–16.67 (11.39) × 5.40–14.16 (9.88)
Oesophagus	Long as pharynx, bifurcates at two-thirds of forebody	Short, as long as pharynx	Narrow	Narrow, long, 10.74–45.43 (26.11) × 2.40–4.57 (3.43)
Caeca	Caeca with six septa, reach close to reproductive primordia	7–8 Septa, reaching close to genital primordia	Extended below the ventral sucker with pair of rounded globular masses	Extend near posterior end of body, caecum with 3 septae, 102.86–185.86 (148.55) × 13.90–29.07 (21.95)
Excretory bladder	Trilobed	Trilobed	Bicornuate	Bicornuate, 8.67–23.6(14.08) × 7.91–19.62(14.18)
Caudal excretory canal	Not mentioned	Anterior third of tail stem	Branch opening halfway down furcae	Till tip of furca

Table 2 continued

Cercariae	Cercariae of <i>Cotylurus brevis</i> , Dubois et Rausch 1950 (by Faltynkova et al. 2007)	<i>Cercaria spinulosa</i> , Ginetsinskaya 1959 (by Faltynkova et al. 2007)	<i>Cercariae Indicae</i> XXII Sewell 1922	<i>Cercaria</i> sp. II Western Ghats n. sp
Flame cell formula	$2[(2 + 2) + (2 + 2 + [2])] = 20$	$2[(2 + 2) + (2 + 2 + [2])] = 20$	$2[(3 + 2) + (2 + 2 + [2])] = 20$	$2[(2 + 2 + 2) + (2 + 2 + 2) + [(2 + 2 + 2) + (1 + 1 + 1)]] = 42$
Caudal flame cell formula	2	2	2	$2[(2 + 2 + 2) + (1 + 1 + 1)] = 18$
Flame cells of furcae	Absent	Absent	Absent	3 Pairs
Penetration gland	2 Pairs, anterior to ventral sucker, between caeca; can be temporarily para-acetabular	2 Pairs, posterior to ventral sucker	2 Pairs, lying on either side of the middle line in front of ventral sucker	2 Pairs
Genital Primordia	Anterior to excretory bladder	Between penetration gland-cells and excretory bladder	Compact mass of small round cells between ventral sucker & excretory bladder, A small mass of cells in front of ventral sucker, between posterior salivary cells	Conical mass of cells anterior to excretory bladder
Intra molluscan stage	—	—	Sausage-shaped sporocyst	Long, thread-like
Host	<i>Lymnaea stagnalis</i>	<i>Lymnaea stagnalis</i>	<i>Lymnaea ovalis</i>	<i>Thiara tuberculata</i>

furcae, forms a small dilation and opens out. Two pairs of cilia below ventral sucker. Four pairs of flame cells on the tail stem and a single pair in the furca arise from the caudal excretory canal. Flame cell formula $2[(2 + 2 + 2 + 2 + 2) + (2 + 2 + 1) + [(1 + 1 + 1 + 1) + (1)]] = 40$.

Sporocyst (Fig. 1b)

Cercariae develop in sporocyst in the digestive gland of *I. exustus*. Sporocyst sausage-shaped, measured 246.38–727.05 (488.09) in length. Each cercaria develops in a small pouch inside the sporocyst. On an average, each sporocyst contains two cercariae and three germ balls.

Remarks

The distome, furcocercous cercariae is comparable to *Cercariae Indicae* XXX Sewell 1922, *Cercariae Indicae* XV Sewell 1922, *Cercaria* sp. XIX Malabar, Sanil and Janardanan 2018, *Cercaria bilharziellae polonicae* Kow (Szidat 1926), Iles (1959) and *Cercaria dubaensis* Jansen van Rensburg et al. 2016. A comparison of the morphology and morphometry of present cercaria with that of the related ones is given in the Table 1.

Difference in size, absence of eye spots and presence of a single mass of genital primordia distinguish the present cercaria from *Cercariae Indicae* XXX. Spinose body and tail, prominent ventral sucker, absence of pharynx and short, kidney-shaped caeca make it different from *Cercariae Indicae* XV. Smaller furca, shorter than tail stem, absence of pharynx and eye spots, shorter caeca, that too in the pre-equatorial region, caudal excretory canal that runs up to the end of furca and the difference in host distinguish it from *Cercaria* sp. XIX Malabar.

When compared to *Cercaria bilharziellae polonicae*, the present cercaria is non-ocellate, without fin fold, having long oesophagus followed by small, wide intestinal caeca and four pairs of flame cells in tail stem. *Cercaria dubaensis* infecting *Biomphalaria pfeifferi* differs from the present cercaria as it is nocturnal and having sensory cilia on body, tail and furca. Besides, difference in the number of penetration glands, flame cell formula and presence of flame cells in the furcae further discriminate the present cercaria from the other ones. Considering the above factors, the present cercaria is treated as new to science and is reported as *Cercaria* sp. I Western Ghats n. sp.

Cercaria sp. II Western Ghats n. sp

Host *Thiara tuberculata* (Mueller 1774)

Site of infection Digestive gland

Type locality Sulthan Bathery in Wayanad district, Kerala

Holotype Deposited in the Helminth parasite collections, Ecological Parasitology and Tropical Biodiversity Laboratory, Department of Zoology, Kannur University, Mananthavady Campus, Wayanad-670645, Kerala, India (Accession Number: C.F.T.1)

Etymology Refers to area from where the species was first recorded

Period of collection September, 2017 to March, 2018

Prevalence Seven of sixty-four snails (10.94%) screened were infected

Cercarial behaviour Cercariae emerge throughout the day with higher intensity during morning hours; positively phototactic; actively swim by the lashing movement of the tail; during rest furcal rami will be spread out and tail stem hanging down in the water column; after active swimming cercariae settle down and show creeping movements with the help of ventral sucker; revert to active swimming if disturbed.

Description (Fig. 2a, b)

Non-ocellate, distome, pharyngeate, longifurcate furcocercous cercariae with elongate body measuring 169.20–315.52 (259.24) $\times$ 62.64–104.86 (89.09). Body covered with small backwardly directed spines and five pairs of sensory cilia. Tail terminal, aspinose having two pairs of sensory hairs at the base of the tail and five sets of paired sensory hairs on either side of furcal bifurcation on the tail stem, measuring 134.22–207.69 (185.29) $\times$ 35.57–65.68 (47.63). Aspinose furca longer than the tail stem, not constricted off from the tail stem and measured 169.58–256.92 (213.87) $\times$ 16.93–33.56 (25.26). Anterior organ pear-shaped, 51.16–77.15 (64.98) $\times$ 20.00–34.35 (27.52) in size. Ventral sucker post-equatorial, circular, measuring 19.50–33.41(28.02) $\times$ 21.65–31.96 (27.40), armed with single row of inwardly directed spines. Mouth sub-terminal surrounded by 20 spines followed by a narrow pre-pharynx; pharynx globular, measuring 5.31–16.67 (11.39) $\times$ 5.40–14.16 (9.88). Oesophagus long, narrow, 10.74–45.43 (26.11) $\times$ 2.40–4.57 (3.43) in size. Caecae tri-septate, below the level of ventral sucker; turn inward lateral to the ventral sucker and run posterior with increase in size, measured 102.86–185.86(148.55) in length and 13.90–29.07 (21.95) width. Two pairs of penetration glands with irregular margin positioned below pharynx; contain pigmented granular substances and prominent nuclei. Ducts of glands run forward, enter the anterior organ and

open out independently lateral to mouth. Genital primordium represented by conical mass of cells anterior to excretory vesicle. Excretory bladder bicornuate; primary collecting ducts originate at the antero-lateral margin of excretory bladder with bulging at its base, run forward to the side of ventral sucker, splits into anterior and posterior collecting vessels. Anterior collecting vessel provided with cilia in its tip. The excretory bladder continues as caudal excretory canal that runs up to the tip of the furcae. Caudal excretory canal provided with two cilia, one at the middle of the tail stem and other just above the furcal bifurcation. Flame cell formula: $2[(2 + 2+2) + (2 + 2+2) + [(2 + 2+2) + (1 + 1+1)]] = 42$. Three pairs of flame cells arise from caudal excretory canal present in the furcae.

Sporocyst (Fig. 2b)

Sporocysts were found developing in the digestive gland of *T. tuberculata*. Body elongate, thread like, darkly pigmented; measured 2914.26–9765.85 (6190.56) $\times$ 163.03–341.64 (229.43). An average of six developed cercariae and 43 germ balls were observed within the sporocysts.

Remarks

The present longifurcate, pharyngeate, non-ocellate cercaria with two pairs of penetration glands resembles Cercariae of *Cotylurus brevis*, Dubois *et* Rausch 1950 (Faltynkova *et al.* 2007), *Cercaria spinulosa*, Ginetsinskaya 1959 (Faltynkova *et al.* 2007) and *Cercariae indicae* XXII, Sewell 1922. Comparison and measurements of the present cercaria with that of the other three furcocercous cercariae is given in the Table 2.

Smaller size, absence of eye spots, nature of spination, distribution of sensory hairs on body, tail and furcae and position of the penetration glands distinguish the present cercaria from cercaria of *Cotylurus brevis*. Unlike *Cercaria spinulosa*, the present cercaria is non-ocellate, larger with aspinose tail stem and furca, differs in the arrangement of sensory hairs on the body and tail, nature of caudal excretory canal and presence of two pairs of penetration glands antero-lateral to ventral sucker. It differs from *Cercariae indicae* XXII in having larger body size, spines on body, pear-shaped anterior organ, distinct pharynx, caudal excretory canal, single mass of genital primordium, long thread-like sporocyst and in the position of the penetration glands. Moreover, it differs from all the compared cercariae in the flame cell formula, presence of flame cells on the furcal ramus and tri-septate caeca. In view of the above differences the present cercaria is regarded as a new species and the name *Cercaria* sp. II Western Ghats n. sp. is proposed.

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Author's contribution Dr P. K. Prasad designed and guided the study. Mrs. K. Arusha carried out the survey, collected and studied the cercariae in detail. The manuscript was written by both the authors.

Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest between them.

Ethical approval All applicable international, national, and/or institutional guidelines for the care and use of animals were followed. All procedures performed in the study involving animals were in accordance with the ethical standards of the institution or practice at which the study was conducted.

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