

Research Article

***Dogielius kaelensis* n. sp. (Monogenea, Dactylogyridae), a gill parasite of *Garra annandalei* Hora, 1921 (Cyprinidae, Labeoninae) in Arunachal Pradesh, India**

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Abstract

Parasite biodiversity of fish in Arunachal Pradesh of northeast India is still unexplored. The present study describes here a new species of *Dogielius* (Monogenea: Dactylogyridae) from the gill filaments of *Garra annandalei* (Cyprinidae), collected from the River Kael, Arunachal Pradesh. *Dogielius kaelensis* n. sp. is distinguished from its congeners by two key features: (i) a robust ventral bar with a medial part twisted forward, and (ii) an accessory piece with a ring to help guide the copulatory tube. Since the discovery of *Dogielius gyropetalum* Lang, 1981, this is only the second time a member of the *Dogielius* genus has been observed parasitizing a *Garra* species. This highlights the unexplored diversity of fish parasites in Arunachal Pradesh.

Keywords: Arunachal Pradesh, *Dogielius kaelensis* n. sp., *Garra annandalei*, Monogenea

INTRODUCTION

The species of genus *Garra* (Hamilton, 1822) are from bottom-dwelling cyprinid fishes found widely distributed from Borneo to West Africa through Southern China, South and Southeast Asia, the Middle East, the Arabian Peninsula, and East Africa (Sun *et al.*, 2018; Roni *et al.*, 2019). *Garra annandalei* Hora, 1921 (Cyprinidae, Labeoninae), commonly known as 'Annandale garra', is a benthopelagic species that mainly occurs in mountain streams of India, Eastern Nepal, Bangladesh, and also Bhutan (Froese and Pauly, 2022). In India, the species is currently restricted to the northern part of Bengal, Bihar, Assam, west coast of India (Bhakta *et al.*, 2022), and Arunachal Pradesh (Darshan *et al.*, 2019).

Dogielius Bychowsky, 1936 (Monogenea, Dactylogyridae), with 40 species, is found only in Africa, China (including the Amur region of Russia); Indian subcontinent; and Eurasia (Timofeeva *et al.*, 1997; WoRMS, 2022). Four *Dogielius* species have been described in the Indian subcontinent, all of them from In-

dia: *D. catlaius* (Jain, 1961) Gusev, 1974, *D. gusevi* Singh and Jain, 1988, *D. indicus* Agrawal and Singh, 1984, and *D. lucknowensis* Agrawal and Sharma, 1988, (Pandey and Agarwal, 2008). Representatives of an undescribed species of *Dogielius* were collected on the gills of *G. annandalei* during a parasitological study of monogeneans of freshwater fishes in Arunachal Pradesh, which is described and illustrated in this paper.

MATERIALS AND METHODS

Fish sampling

Throughout January 2022, specimens of *G. annandalei* were collected from the River Kael, Yachuli in Arunachal Pradesh, India (29°30' N; 97°30' E), using the stone piling method and gillnetting. They were identified using keys provided by Talwar and Jhingran (1991). Their gills were removed and observed under the stereomicroscope for the presence of monogeneans. Experiments were conducted in accordance with institutional guidelines for animal care.

Parasite sampling

Dogielius specimens were detached from the gills using fine dissection needles. Five specimens were stained with acetic carmine, dehydrated in a graded ethanol series (70%, 90% and 100%), cleared in xylene, and mounted on glass slides in DPX (Dibutylphthalate Polystyrene Xylene). To study the haptor and reproductive hard parts, three specimens were directly mounted in Hoyer's medium. The mounted specimens were examined, and measured using a light microscope equipped with phase-contrast optics (Leica DM4B, Leica Microsystems) and image analysis software (LAS X; Leica Microsystems Ltd.). Measurements (in micrometres) are indicated in the text as the mean followed by the ranges and the number of samples in parentheses. Illustrations were drawn with the help of the drawing tube attached to Olympus BX51 microscope (Olympus Corporation, Japan), and then recreated using Photoshop CS6.0 (Adobe, USA). Numbering and distribution of hooks followed Kulwiec (1927).

RESULTS AND DISCUSSION

Class Monogenea Bychowsky, 1937
 Order Dactylogyridea Bychowsky, 1937
 Family Dactylogyridae Bychowsky, 1933
 Genus *Dogielius* Bychowsky, 1936
Dogielius kaelensis n. sp. (Figs. 1)
 Type host: *Garra annandalei* Hora, 1921
 Type locality: River Kael, Yachuli, Arunachal Pradesh, India (29°30' N; 97°30' E)
 Prevalence: 8 of 8 hosts infected (100%) with a total of 25 worms.
 Type material: Holotype (AT/DK2022/01) and four paratypes (AT/DK2022/02-5) in the helminthological collection of the Laboratory of Parasitology, Department of Zoology, University of Lucknow, India.

Etymology: The specific name is derived from the name of the river where the species was found from.

Description

Body length 120 (100–150; n=7) long; greatest width 75 (60–90; n=7) usually near midlength. Cephalic region broad and well developed; head organs 4 pairs; cephalic glands indistinct. Two pairs of eye spots. Pharynx prominent, muscular, spherical 39 (34–40; n=7) in diameter.

Testis not observed; vas deferens ascends from dorsal region to the ventral side of body; seminal vesicle a dilation of vas deferens. Two oval-shaped prostatic reservoirs opening at the base of copulatory tube. Copulatory tube 26 (25–26; n=7) long, nearly straight with swollen base; accessory piece 35 (35–37; n=7) long, proximal part articulates with the base of copulatory tube, middle region ringed structured through which passes the copulatory tube. Ovary with many ova oviduct and ootype not observed. Vagina flower-shaped, sclerotised, sinistral 16 (16–18; n=7) in diameter; vaginal tube not visible. Vitelline follicles dense, extend throughout trunk except in regions occupied by reproductive organs. Egg not observed.

Haptor 19 (16–26; n=7) long and 60 (60–70; n=7) wide. Single pair of anchors (ventral): 40 (40–42; n=7) long, outer root 40 (40–42; n=7) long, inner root 30 (30–32; n=7) long, with a deep cleft, point bent at the end. One bar (ventral): 43 (39–43; n=7) long, robust with medial part twisted forward, ends bilobed. Hooks seven pairs, similar in size 19 (19–20) long, with shank comprising two subunits, rounded thumb.

Remarks

The following morphological features of monogeneans observed on the gills of *G. annandalei* were used to classify them as *Dogielius*: ventral anchors with straight points oriented towards each other, just one connective

Table 1. Comparative measurements (in µm) of sclerotised parts of haptor and reproductive organs of *Dogielius* spp.

Character	Measurements	
	<i>Dogielius kaelensis</i> n. sp. (Present study)	<i>Dogielius cattaius</i> (Jain, 1961) Gusev, 1976
Haptoral parts		
Ventral anchor	40-42	42-46
Ventral bar	39-43	55-66
Hooks	19-20	16-21
Reproductive organs		
Male copulatory organ		
Copulatory tube	25-26	22-28
Accessory piece	35-37	16
Vagina	16-18	–

(– showing that these measurement values were not provided by the respective author).

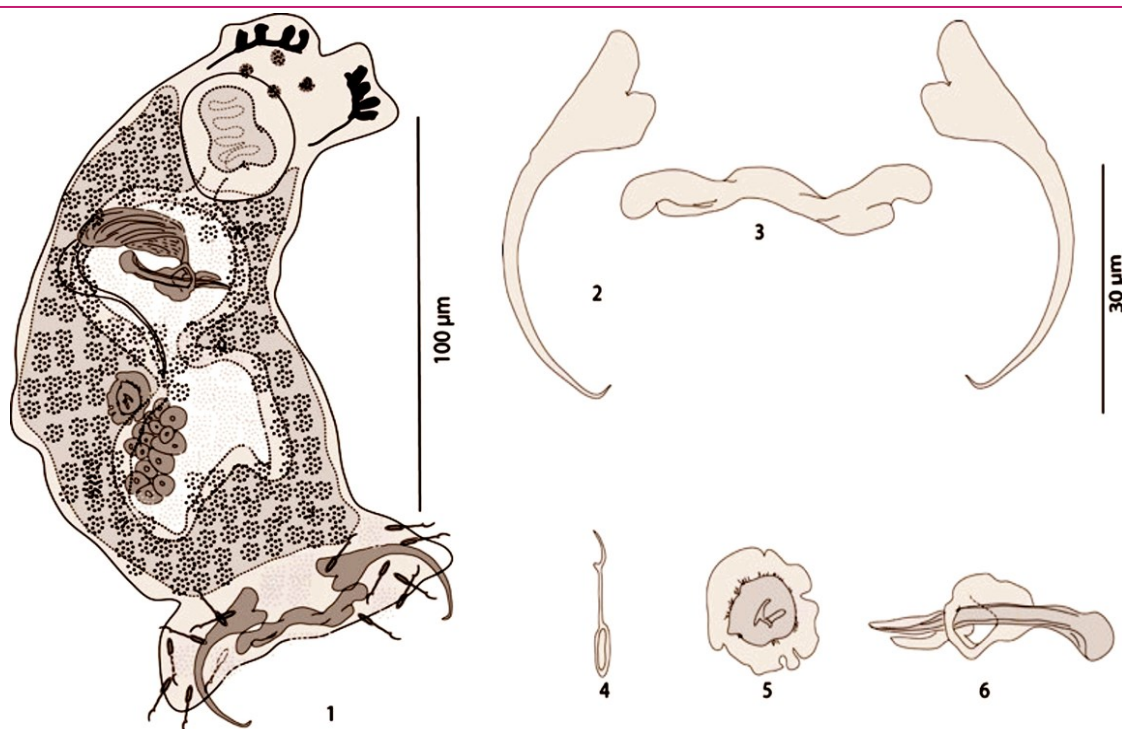


Fig. 1. Line drawings of whole mount and hard parts of haptor and reproductive organs of *Dogielius kaelensis* n. sp. from *Garra annandalei* Hora, 1921. 1. Whole mount (dorsal view). 2. Ventral anchor. 3. Ventral bar. 4. Hook. 5. Vagina. 6. Male copulatory organ. Scale bar = 100 µm for 1 and 30 µm for 2-6.

bar (ventral), and caecum confluent. *Dogielius kaelensis* n. sp. resembles *D. catalius* (Jain, 1961) Gusev, 1976 and *D. grandijugus* Guegan, Lambert & Euzet, 1989 in the overall morphology of haptor parts. The new species, however, differs from *D. catalius* in the details of copulatory complex. In *D. catalius*, the copulatory tube is curved (nearly straight in *D. kaelensis* n. sp.) and accessory piece has three process at its end (absent in *D. kaelensis* n. sp.). At the same time, the accessory piece of *D. kaelensis* n. sp. has a ring through which passes the copulatory tube (absent in *D. catalius*). The new species also differs from *D. grandijugus* in having a smaller ventral bar (39-43 µm in *D. kaelensis* n. sp. and 80-100 µm in *D. grandijugus*). Moreover, the end dilations of the dorsal bar are smooth in *D. kaelensis* n. sp. while they are rough in *D. grandijugus*. The comparison of morphometrics of *D. kaelensis* n. sp. and *D. catalius* from India is presented in Table 1. This is the second report of a monogenean parasite from the *Garra* sp. after *D. gyropetalum* Lang, 1981, and bring the total number of nominal *Dogielius* species known from India to five.

Arunachal Pradesh, the extreme northeast part of India, is a part of Himalayan biodiversity hotspot. The state is home to 259 confirmed fish species, accounting for roughly 27% of all Indian freshwater fishes (Gurumayum et al., 2016). If we take into account a conservative estimate of one *Dogielius* species from one *Garra* species and the fact that there are approxi-

mately 21 *Garra* species in Arunachal Pradesh (Gurumayum et al., 2016), the possible number of *Dogielius* species on these hosts could reach at least 21. This means that the current number of *Dogielius* species (five spp., including the one described in this work) parasitising Indian fishes is just 23% of the actual number, and new species descriptions from this area are highly anticipated. Although the pathogenic implications of *D. kaelensis* n. sp. are currently unknown, the discovery underscores the unexplored diversity of fish parasites in Arunachal Pradesh.

Conclusion

Dogielius kaelensis, a new monogenean species, is described and illustrated from the gill filaments of *G. annandalei* (Cyprinidae), collected from the River Kael, Arunachal Pradesh. A robust ventral bar with a medial part twisted forward, as well as an accessory piece with a ring to help guide the copulatory tube, distinguishes the new species from its congeners. This is only the second species of the genus *Dogielius* that has been found parasitizing a *Garra* species.

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Conflict of interest

The authors declare that they have no conflict of interest.

Ethical statement

Experiments were conducted in accordance with institutional guidelines for animal care.

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