

# ***Dactylogyrus anchoracanthoides* (Platyhelminthes: Monogenea), a new species previously confused with *D. anchoracanthus* Kulkarni, 1970 in North India**

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**Abstract.** *Dactylogyrus anchoracanthoides* n. sp. is described and illustrated from the gills of large razor-belly minnow *Salmostoma bacaila* collected from the Gomti River at Lucknow, North India. The new species can be distinguished from *D. anchoracanthus* and other related species by having the following unique combination of characters: an accessory piece consisting of three overlapping sheaths with two distinct growth patterns, and two opposing claw-like terminal extensions, falcatoid dorsal anchors, almost identical length of anchors and hooks (with the exception of pair 6), and a sclerotized plate between the male copulatory organ and the vagina. *Dactylogyrus anchoracanthus* is considered as *species inquirenda* until it is redescribed based on fresh specimens from the type host and locality. The description of this new species brings the total number of species of *Dactylogyrus* known from India to 58 species. A detailed study combining microscopy and PCR assays is needed to determine the true species composition of monogenean parasites of *S. bacaila*.

**Keywords:** Monogenea; *Dactylogyrus anchoracanthoides* n. sp.; *Salmostoma bacaila*; India.

***Dactylogyrus anchoracanthoides* (Platyhelminthes: Monogenea), o specie nouă confundată anterior cu *D. anchoracanthus* Kulkarni, 1970 în India de Nord**

**Rezumat.** *Dactylogyrus anchoracanthoides* n. sp. este descrisă și ilustrată din branhiile unui piscicol cu burtă mare *Salmostoma bacaila* colectate din râul Gomti la Lucknow, India de Nord.

Noua specie poate fi distinsă de *D. anchoracanthus* și alte specii înrudite având următoarea combinație unică de caractere: o piesă accesorie constând din trei învelișuri suprapuse cu două modele de creștere distincte și două prelungiri terminale opuse în formă de gheare, ancore dorsale falcatoide, lungime aproape identică a ancorelor și cârligelor (cu excepția perechii 6) și o placă sclerotizată între organul copulator masculin și vagin. *Dactylogyrus anchoracanthus* este considerată specie de investigat, până când este redescrișă pe baza

exemplarelor proaspete din gazda tip și localitate. Descrierea acestei noi specii aduce numărul total de specii de *Dactylogyrus* cunoscute din India la 58. Este necesar un studiu detaliat care să combine microscopia și testele PCR pentru a determina compoziția adevărată a speciilor parazitare monogene la *S.bacaila*.

**Cuvinte cheie.** Monogenea; *Dactylogyrus anchoracanthoides* n. sp.; *Salmostoma bacaila*; India.

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## Introduction

*Dactylogyrus* Diesing, 1850 is the most diverse genus within the Monogenea, having more than 1000 nominal species worldwide (WoRMS, 2022), including 57 species from India (Trivedi *et al.*, 2022). *Dactylogyrus anchoracanthus* was first described by Kulkarni (1970) from the gill lamellae of *Cirrhina reba* (Hamilton 1822) [now *Cirrhinus reba* (Hamilton, 1822)] in Hussain Sagar Lake, Hyderabad, South India. Gusev (1976) redescribed this species from *Chela bacaila* [now *Salmostoma bacaila* (Hamilton, 1822)] in Lucknow, North India. There has been no further record of the species since.

*Salmostoma bacaila*, commonly known as large razor-belly minnow, is a potamodromous fresh/brackish water fish found in slow-moving streams throughout the Indian sub-continent (Froese and Pauly, 2021). It is an important food item because of its high levels of micro and macro minerals, vitamins and proteins (Mohanty *et al.*, 2013). It is also useful as a larvivorous and bait fish (BdFish, 2010). During a parasitological examination of *S. bacaila* from the River Gomti in Lucknow, North India, some monogenean specimens were found that matched the morphometric description of Gusev (1976), but not those of Kulkarni (1970) (figures 1, 2, Table 1).

To clear up this taxonomic confusion, we started searching for the type-material or any other original material collected by Kulkarni (1970) and Gusev (1976), in different museums and collections, including Zoological Institute in St. Petersburg in Russia and Osmania University in Hyderabad, India. Our efforts were, however, unsuccessful and we were forced to conclude that type material of *D. anchoracanthus* no

longer exists. Kulkarni's (1970) identification of *D. anchoracanthus* is problematic because it is based solely on a relatively brief description and highly diagrammatic illustrations of the reproductive and haptor hard parts, with no verifiable type specimens. Unfortunately, Gusev (1976), in redescribing *D. anchoracanthus* from *S. bacaila* in Lucknow, followed the identification of Kulkarni (1970), despite the fact that host and geographic locations of his worms differed from that of Kulkarni (1970). Thus, the purpose of this paper was to describe the specimens from *S. bacaila* in Lucknow as new species previously confused with *D. anchoracanthus*.

## Materials and methods

### Host sampling

Seven moribund individuals of *S. bacaila* (total weight: 3-7 gm, length: 6-10 cm) were obtained from professional fishermen operating in the River Gomti, Lucknow, North India between July and September 2021. Their gills were removed and examined under a stereomicroscope (Leica EZ4, Leica Microsystems, Germany) for the presence of monogenean parasites. The scientific name, including taxonomic authority and date, of host fish followed FishBase (Froese and Pauly, 2021).

### Parasite sampling

Twelve monogeneans were collected and processed in the manner described by Gusev (1976). The worms were examined, photographed and measured (in micrometres) using a light microscope (Leica DM4B) equipped with phase-contrast and differential interference contrast (DIC) optics, a digital

camera (Leica DFC7000 T) and image analysis software (LAS X; Leica Microsystems Ltd.). A drawing tube attached to the light microscope (Olympus BX51) was used to prepare an illustration plate. Prevalence and mean intensity of infection were calculated according to Bush *et al.* (1997).

## Results

### Taxonomic summary (Figures 1, 2)

Monogenea (Van Beneden, 1858) Bychowsky, 1937

Dactylogyridea Bychowsky, 1937

Dactylogyridae Bychowsky, 1933

*Dactylogyryus* Diesing, 1850

*Dactylogyryus anchoracanthoides* n. sp.

Syn. *Dactylogyryus anchoracanthus* as redescribed by Gusev (1976)

Type host: *Salmostoma bacaila* (Hamilton, 1822) (Cypriniformes: Danionidae)

Type locality: River Gomti, Lucknow, India (26°52'12" N; 80°55'20" E)

Infection site: Gill lamellae

Infection parameters: 42.85 % (3 out of 7 fishes) were infected with intensity of 3–6 (mean = 4) parasites/infected host

Date of sampling: July 2021 to September 2021

Deposition of specimens: Holotype (ZSI/W10934/1) and four paratypes (ZSI/W10935–38) in Zoological Survey of India, Kolkata, India.

ZooBank registration: The Life Science Identifier (LSID) for *Dactylogyryus anchoracanthoides* n. sp. is urn:lsid:zoobank.org:pub:DFD8A6A0-27C4-48E3-B7C0-48F4ACBD7301

*Etymology*: The epithet is from the species *anchoracanthus* with the Greek suffix -oides (resembling), referring to the similar appearance of two species.

### Description (Figures 1-2)

[Based on 10 adult specimens; metrical data in Table 1]

**Table 1.** Comparative measurements (presented in micrometres as the mean with the range in parentheses) of haptor armaments and reproductive organs of *Dactylogyryus anchoracanthoides* n. sp. (present study) with *Dactylogyryus anchoracanthus* Kulkarni (1970) and Gusev (1976) (previous studies).

Characters	Measurements		
	Kulkarni (1970)	Gusev (1976)	Present study (n=10)
Haptor parts			
Dorsal anchor			
Total length	36-45	31-36	32 (30-36)
Inner root length	<b>6</b>	10-12	10 (9-12)
Outer root length	<b>4</b>	5-6	6 (5-7)
Angle between roots	<b>90°</b>	<b>110°</b>	112°
Dorsal bar length	22-28	22-35	26 (22-33)
Hook	26-28	16-30	15-30
Reproductive organs			
Copulatory tube	-	80-95	84 (82-93)
Accessory piece	-	29-40	33 (31-39)
lower sheath	-	-	33 (31-39)
middle sheath	-	-	23 (21-26)
upper sheath	-	-	16 (14-18)
Vagina	-	45-50	39 (38-44)

(Values in bold were calculated by us using the scale bar provided by the authors; those indicated by - were not provided in the primary descriptions and could not be calculated because the numerical on scale bars was unreadable)

### Male Reproductive Organ

The male copulatory organ consists of a copulatory tube and a basally articulated accessory piece. Copulatory tube a loose coil of less than one clockwise ring following a comma-shaped path with swollen proximal base and delicate distal termination. Accessory piece complex, with three overlapping sheaths forms a wide plate to encase the distal end of the copulatory tube. The lower sheath has two distinct growth patterns in the middle region and ends with a downward-pointing claw and a lightly sclerotized, plate-like extension below; the middle sheath overlaps with lower sheath to form a funnel-shaped bubble (through which the copulatory tube passes) and terminates in an upward-pointing claw; the upper sheath is a rod-like structure that rests on the sclerotized extension of lower sheath.

### Female Reproductive Organ

Vagina sclerotized, dextral, tubular with slightly expanded distal half and two reduced lateral expansions at its proximal end. A heavily sclerotized plate near the distal end of the vagina. Eggs not observed.

### Haptor

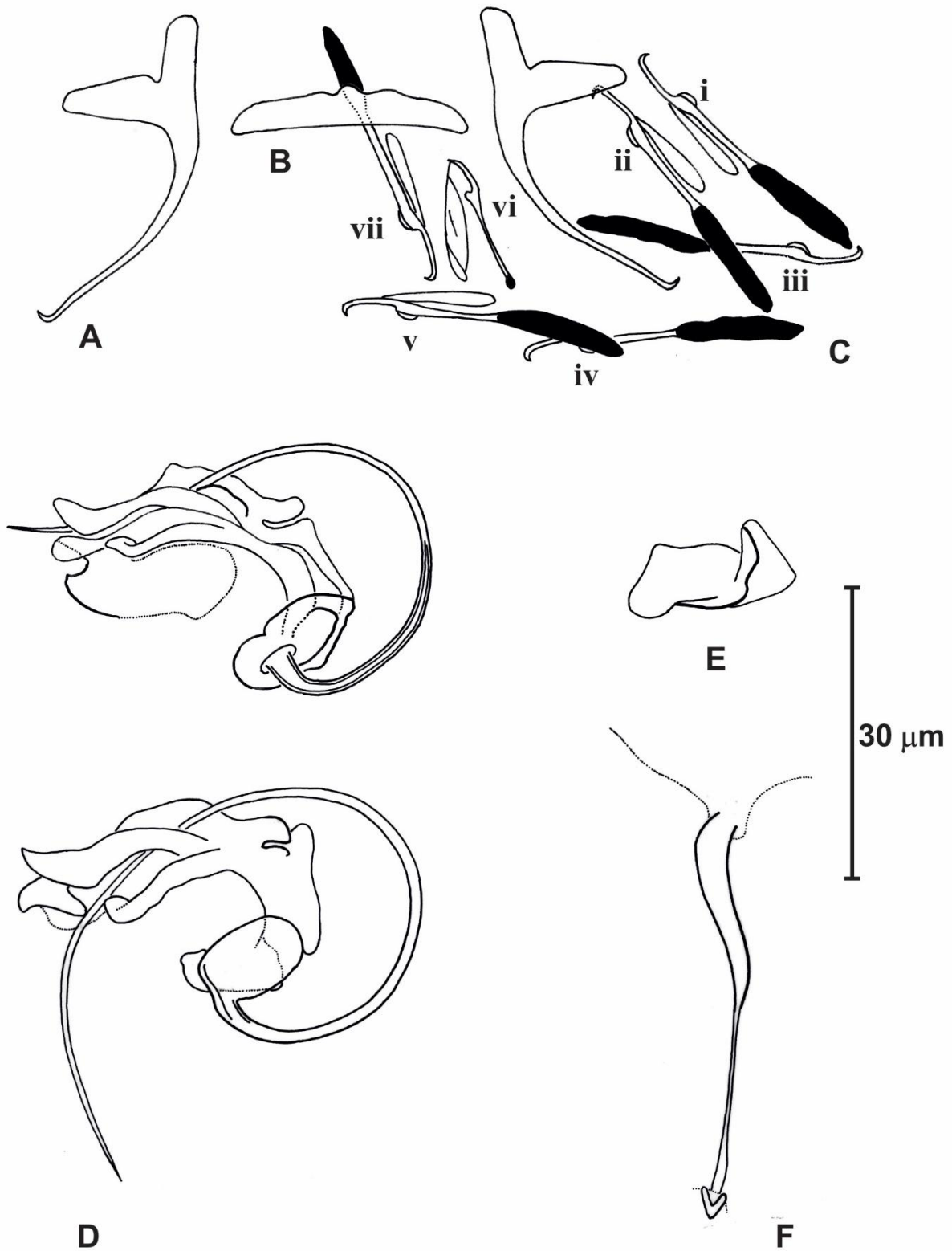
A single pair of falcatoïd-type dorsal anchors (where shaft-to-point border is indistinguishable), a straight point bending subterminally, an elongated inner root and shorter outer root uniting at an angle of 112°. A single straight dorsal bar with tapered ends and slight medial dilation on the anterior margin. Hooks seven pairs, similar in shape, each with a long and delicate point, rounded thumb, and a robust shank consisting of inflated proximal and slender distal parts; with the exception of pair six, hooks relatively large, almost equal to the

length of anchors; hook pair seven at level of dorsal bar, remaining pairs marginal.

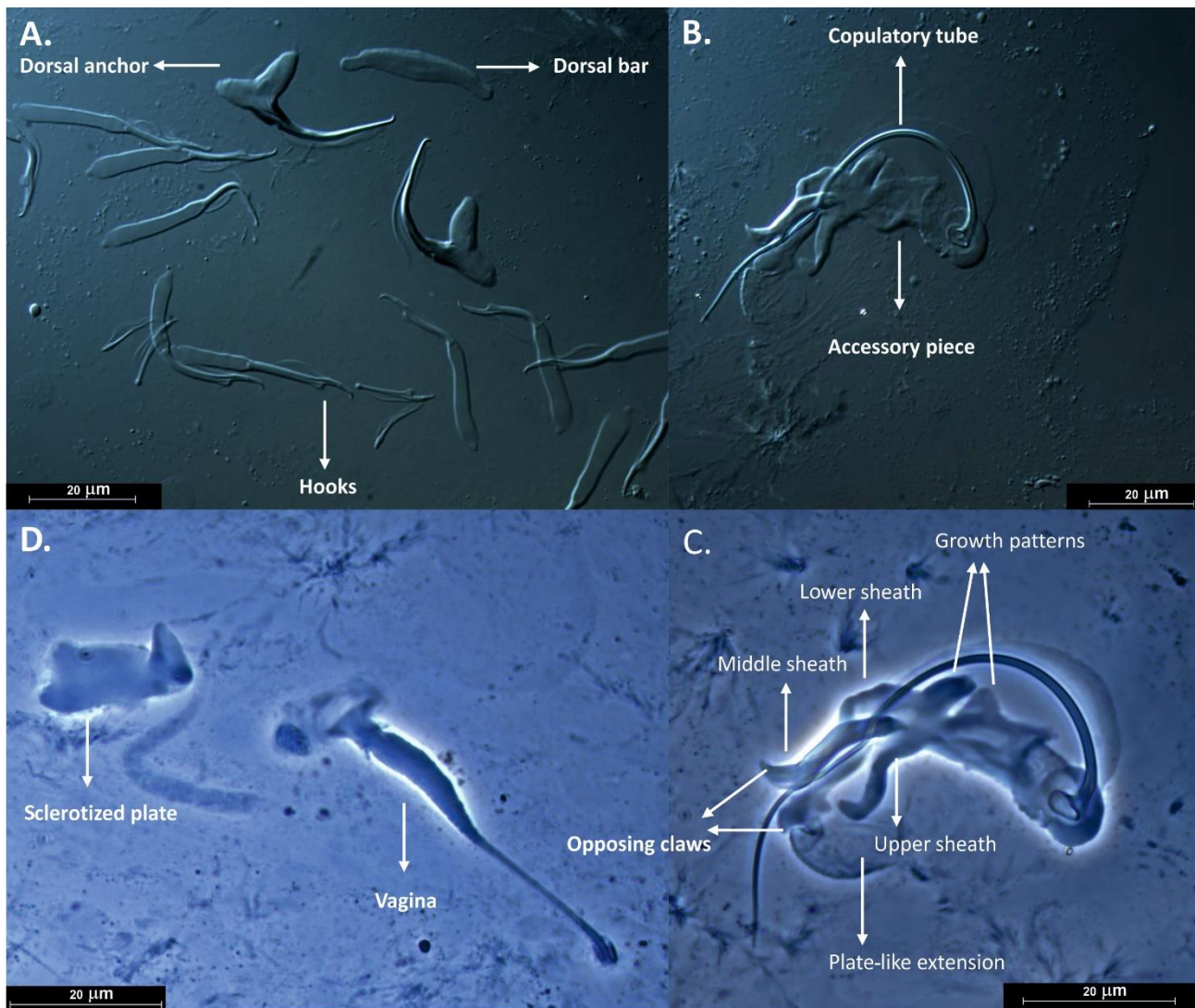
### Differential diagnosis

Taxonomically, *D. anchoracanthoides* n. sp. is closely related to *D. anchoracanthus*, from which it can be reliably distinguished by the comparative morphometry of male copulatory organ and dorsal anchors. Accessory piece of male copulatory organ of *D. anchoracanthoides* n. sp. has three overlapping sheaths with two distinct growth patterns in the middle, and two opposing claw-like terminal extensions (absent in *D. anchoracanthus*). Dorsal anchor of *D. anchoracanthoides* n. sp. has a shorter length (30-36 vs 36-45 µm in *D. anchoracanthus*), a longer inner root (9-12 vs 6 µm in *D. anchoracanthus*), a larger obtuse angle between the inner and outer roots (112° vs 90° of right angle in *D. anchoracanthus*) and subterminal bend in its point (absent in *D. anchoracanthus*). Additionally, the hooks of the new species are smaller (16-30 vs 26 to 28 µm in *D. anchoracanthus*). The new species further differs from *D. anchoracanthus* in the length ratio of the anchors to the hooks, which is about equal in *D. anchoracanthoides* but about half in *D. anchoracanthus*.

The new species can be distinguished from other related species of *Dactylogyrus* [(most notably, *D. chauhani* Gusev & Musselius, 1975 from *Cirrhinus mrigala* (Hamilton, 1822) and *D. barnae* Wangchu *et al.* 2017 from *Barilius barna* (Hamilton, 1822)] by having the following unique combination of characters: an accessory piece consisting of three overlapping sheaths with two distinct growth patterns, and two opposing claw-like terminal extensions, falcatoïd dorsal anchors, almost identical length of anchors and hooks (with the exception of pair 6), and an unusual sclerotized plate between the male copulatory organ and the vagina.



**Figure 1.** Line drawings of haptor and reproductive hard parts of *Dactylogyrus anchoracanthoides* n. sp. from *Salmostoma bacaila* (Hamilton, 1822). A. Dorsal anchor. B. Dorsal bar. C. Hook (pairs I–VII). D. Different configurations of male copulatory organ (dorsal view). E. Sclerotized plate. F. Vagina. Scale bar = 30 μm



**Figure 2.** Differential Interference Contrast (DIC) and phase contrast images of haptoral and reproductive hard parts of *Dactylogyrus anchoracanthoides* n. sp. from *Salmostoma bacaila* (Hamilton, 1822). A. haptoral hard parts (anchor-bar complex and hooks). B. male copulatory organ (dorsal view). C. details of accessory piece. D. vagina and a sclerotized plate. Scale bar = 20 µm

## Discussions

The morphometric data for studied specimens here were compared to and determined to be consistent with those reported by Gusev (1976) (Table 1). In other words, monogeneans from *S. bacaila* in Lucknow (both Gusev, 1976 and this study) are conspecific, whereas those from *Cirrhinus reba* in Hyderabad (Kulkarni, 1970) represents a closely related, but nevertheless distinct species. Apparently, Gusev (1976) misidentified and mistakenly designated his specimens as *D. anchoracanthus*. We, in the interest of stabilizing the nomenclature, herein consider our specimens as new species with

verifiable type specimens and designate the specimens of *D. anchoracanthus* as redescribed by Gusev (1976) its junior synonym. Since *D. anchoracanthus* cannot be positively identified due to its poor description, diagrammatic figures, lost type-material, and lack of other records, we consider it a *species inquirenda* (a species with doubtful identity that requires further investigation) until it can be redescribed from the type host and type locality.

*Dactylogyrus anchoracanthoides* n. sp. is distinguished by three characteristics. The first is an accessory piece with three overlapping complex sheaths, one of which has two distinct

growth patterns in the middle, and two opposing claw-like terminal extensions. Second, a sclerotized plate is placed between the male copulatory organ and the vagina. Gusev (1976) drew this plate but didn't comment on it, implying that even he was not sure what it was for. In our high-resolution imaging, this sclerotized plate is consistently seen at the distal end of the vaginal pore, indicating that it is likely involved in reproduction. Interestingly, Wangchu *et al.* (2017) described a very similar structure in *D. barnae* which they described from the gills of *Barilius barna* (Hamilton, 1822) [now *Opsarius barna* (Hamilton, 1822)] in Arunachal Pradesh, but did not assign a function to it. Third, with the exception of pair 6, the hook length is nearly identical to the dorsal anchor length, which is atypical in monogeneans and likely reflects the highly efficient attachment and stability of *D. anchoracanthoides* n. sp. on its host. The description of *Dactylogyrus*

*anchoracanthoides* n. sp. brings the total number of Indian *Dactylogyrus* species to 58. *Salmostoma bacaila* hosts up to 11 monogenean species concurrently (Table 2). This multiple parasite infection may be explained by the fact that parasite densities are normally low, in the natural environment and potential niches on the gills are always available (see Simkova *et al.*, 2006). Because many monogenean parasites are potentially pathogenic, especially to cultured fish (Thoney and Hargis, 1991; Cable *et al.*, 2000; Busch *et al.*, 2003; Whittington, 2005), additional taxonomic studies are required for precise taxonomic validation of multiple monogenean species of *S. bacaila*. Since PCR-based technique alone may not work in simultaneous parasite infections, a combination of microscopy and PCR assays is recommended. The resulting data would serve as a foundation for creating management measures to combat gill parasite infections in aquaculture.

**Table 2.** A list of hitherto known records of monogenean parasites from *Salmostoma bacaila* (Hamilton, 1822)

Monogenean parasite		Locality	References
Genus	Species		
<i>Ancyrocephalus</i>	<i>A. ghoshi</i>	Lucknow, Uttar Pradesh	Gusev (1976)
	<i>A. baughi</i>	Lucknow, Uttar Pradesh	Gusev (1976)
	<i>A. spiculus</i>	Lucknow, Uttar Pradesh	Gusev (1976)
<i>Dactylogyrus</i>	<i>D. anchoracanthus</i>	Hyderabad, Andhra Pradesh	Kulkarni (1970)
	<i>D. circumphallus</i>	Hyderabad, Andhra Pradesh	Venkatanarsaiah (1981)
	<i>D. bacailai</i>	Lucknow, Uttar Pradesh	Agrawal and Singh (1982); Gibson, Timofeeva and Gerasev (1996)
	<i>D. parvionchoris</i>	Lucknow, Uttar Pradesh	Gusev (1976)
	<i>D. anchoracanthoides</i> n. sp.	Lucknow, Uttar Pradesh	This report
<i>Dogielius</i>	<i>D. indicus</i>	Gorakhpur, Uttar Pradesh	Agrawal and Singh (1984)
	<i>D. lucknowensis</i>	Lucknow, Uttar Pradesh	Agrawal and Sharma (1988)
<i>Diplozoon</i>	<i>D. indicum</i>	Rohtas, Bihar	Tripathi (1959); Pandey and Agarwal (2008)

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