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New geographic distribution record of *Dactylogyrus labei* Musselius & Gusev (1976) (Platyhelminthes, Monogenea) of *Labeo rohita* (Teleostei: Cyprinidae) from Mizoram, northeast India

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Abstract
Dactylogyrus labei is a dactylogyrid monogenean parasite originally described by Musselius and Gusev (1976) from *Labeo rohita* (Hamilton, 1822) (Teleostei: Cyprinidae) in two alternative forms: a typical from Lucknow, north India and an atypical from Kalyani, east India. Fresh specimens of *D. labei* were collected from Mizoram in northeast India, and examined morphologically using high-resolution digital image processing and analysis. The recovered monogeneans most closely resembled the atypical form of *D. labei*, with only minor differences, indicating conspecificity. The atypical form of *D. labei* is distinguished from other species of the genus by the following combination of characters: the dorsal bar wing-shaped, with a fine membrane on the anterior margin and a fenestration in the middle; the ventral bar casing nail-shaped with two small antero-lateral processes (3-rayed); the male copulatory tube loosely S-shaped, slender, with an inflated initial part; the accessory piece proximally tubular, distally a complex of multi-layered sheath guiding the copulatory tube, and the vagina tubular, with one small loop and vaginal pore surrounded with a flap-like structure. This study expands the geographical distribution of *D. labei* while improving its morphological descriptions.

Keywords: *Dactylogyrus*, Chitinoid piece, Fish, Monogenean parasite, Morphology, Northeast India

INTRODUCTION

Accurate documentation of species distribution is critical for biodiversity assessments (Lenoir *et al*., 2020). In addition, it can help researchers studying the factors that influence the distribution of species, estimating changes in niches, quantifying the likelihood of disease outbreaks (Feng *et al*., 2019), prioritising biodiversity conservation (Thuiller *et al*., 2019), gaining insights into adaptation and dispersal processes, and serving as a reliable indicator of extinction risk (IUCN Standards and Petitions Subcommittee, 2019).

Labeo rohita (Hamilton, 1822) (Cyprinidae, Labeoninae), commonly known as the Indian major carp, is a key species in global aquaculture, accounting for more than 15% of total freshwater aquaculture production (FAO, 2009). In India alone, *L. rohita*, along with *Labeo catla* (Hamilton, 1822) (Cyprinidae, Labeoninae), and *Cirrhinus cirrhosus* (Bloch, 1795) (Cyprinidae, Labeoninae), account for over 75% of the total aquaculture production (FAO, 2003). As a result, it is widely consumed as an affordable, nutritious, and most delicious fish food available. However, like all other fishes, *L. rohita* is susceptible to various diseases, parasites and disorders (Froese and Pauly, 2024). To date, a total of nine species of monogenean parasites from five different genera have been identified from *L. rohita*, as shown in Table 1.

During an ongoing parasitological examination of freshwater fishes in a small hilly state of Mizoram, northeast India, specimens of a dactylogyrid monogenean parasite, namely *Dactylogyrus labei* Musselius and Gusev (1976) were collected from *L. rohita*. Using High-resolution digital micrographs, this study expands the

geographical distribution and improves morphological descriptions of *D. labei*.

MATERIALS AND METHODS

Study area and collection of host samples

In November–December 2023, ten moribund adult specimens of *L. rohita* were purchased from the commercial fish market in Aizawl, Mizoram, northeast India (23°43′38″N 92°43′04″). These samples were immediately fixed in lukewarm (60°C) 5% formalin. The identification and nomenclature of the fish followed Jayaram (1999).

Microscopy

The gills of each fish were removed within an hour of collection, opened in 0.9% saline and examined for the presence of monogenean parasites with fine needles under a binocular microscope (Leica EZ4HD) following standard procedures (Trivedi *et al*., 2022). The specimens collected were either cleared and mounted in glycerine jelly or dehydrated through a graded series of ethanol and stained with Gomori's trichrome before being mounted in DPX (Dibutyl phthalate Polystyrene Xylene). Photographs and measurements were taken with a Leica DM4B upright microscope equipped with phase-contrast optics, a DFC7000T digital camera, and LAS X image analysis software (Leica Microsystems Ltd., Germany). Measurements in micrometres were taken along straight lines between any two extreme points (except for the copulatory tube and vagina, which were measured over the curve) and have been presented in the text as mean followed by the range in parentheses. The enumeration and distribution of hooks followed Kulwiec (1927).

Ethics statement

In this study, freshly caught dead fish were used, thus no ethical declaration is required.

RESULTS AND DISCUSSION

Taxonomic account

Phylum Platyhelminthes Minot, 1876
Class Monogenea van Beneden, 1858
Order Dactylogyridea Bychowsky, 1937
Family Dactylogyridae Bychowsky, 1933
Genus *Dactylogyrus* Diesing, 1850
Dactylogyrus labei Musselius & Gusev (1976) (Fig. 1-2)
Type host: *Labeo gonius* (Hamilton 1822)
Type locality: Water-bodies, Lucknow

Previous record and locality: *Labeo calbasu* (Hamilton, 1822), Lucknow, Uttar Pradesh (Musselius & Gusev, 1976); *Labeo rohita* (Hamilton, 1822), Kalyani, West Bengal (Musselius & Gusev, 1976); *Catla catla* (Hamilton, 1822), Guwahati (Chiary *et al*., 2014)

Present record and locality: *Labeo rohita* (Hamilton, 1822), Bara Bazar Fish market, Aizawl, Mizoram (November 2023– December 2023)

Infection site: Gill lamellae
Infection parameters: Prevalence 40% (4/10); Mean Intensity 4.5 ± 1.5 (18/4)

Voucher specimens: Four specimens in the Helminthological Collection of Fish Parasitology Laboratory at the Department of Zoology, Lucknow, India

Brief redescription

Dorsal anchors 36 (32–42; n = 8) long, with elongated and stout inner root 17 (12–19; n = 8) long, moderately developed outer root 6 (4–8; n = 8) long, evenly curved, point 12 (11–15; n = 8) long, recurved. Dorsal bar 28 (24–30; n = 8) long, 6 (5–7; n = 8) wide, wing-shaped, with a fine membrane on the anterior portion and a fenestration in the middle. Ventral bar 33 (30–36; n = 8) long, casing nail-shaped with two small antero-lateral processes (3-rayed). Seven pairs of similar hooks, each

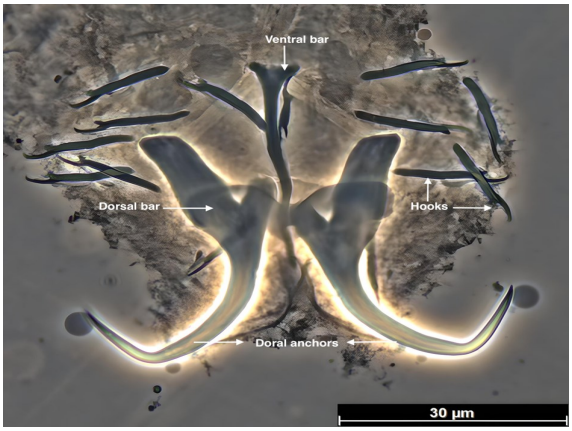

Fig. 1. *Phase contrast micrograph of haptoral armaments showing anchor-bar complex and hooks of atypical form of Dactylogyrus labei Musselius and Gusev, 1976 from Labeo rohita (Hamilton, 1822); Scale bar = 30µm*

Fig. 2. *Phase contrast micrograph of reproductive parts showing male copulatory organ, vagina and sclerotised plate of atypical form of Dactylogyrus labei Musselius and Gusev, 1976 from Labeo rohita (Hamilton, 1822); Scale bar = 20µm.*

with a shank of two subunits (proximal one dilated), erect thumb, and delicate point. Hook pair 1, 14 (11–55; n = 5) long; pair 2, 15 (12–17; n = 4) long; pairs 3, 14 (12–16; n = 4) long; pair 4, 15 (13–18; n = 3) long; pair 5, 14 (12–16; n = 3) long; pair 6, 13 (11–16; n = 5) long; pair 7, 14 (12–16; n = 3) long. Male copulatory organ comprised of a copulatory tube and a proximally articulating accessory piece. Copulatory tube 61 (57–67; n=8) long, loosely S-shaped, slender, with an inflated initial part. Accessory piece 53 (48–57; n=8) long, with a tubular proximal part that arises from the initial part of the copulatory tube and an expanded distal part that forms a complex of multi-layered irregular sheaths to help guide the copulatory tube; a heavily sclerotized piece present near the distal end of the male copulatory organ. Vagina 48 (44–53; n=8) long, tubular, with one small loop and vaginal pore surrounded with a flap-like structure.

Remarks

Dactylogyrus labei was first described by Musselius and Gusev (1976) from *L. rohita* collected from Lucknow, north India. These authors identified two alternative forms of *D*. *labei*: atypical and typical, as presented in Table 2. Thirty-eight years later, Chiary *et al*. (2014) recorded atypical form of *D*. *labei* from *Catla catla* (Hamilton, 1822) (now *Labeo catla*) collected from the River Brahmaputra in Guwahati, northeast India. Line drawings of Chiary *et al*. (2014) were highly diagrammatic and lacking in detail but confirmed the presence of atypical form of *D*. *labei*. Moreover, these authors sought to identify *D*. *labei* specimens molecularly by partially sequencing the 28S rRNA gene.

The monogeneans collected from Mizoram most closely resembled the atypical form of *D*. *labei*, with only minor morphological differences, supporting conspecificity (Table 3). The differences included the presence of the following additional characters in Mizoram specimens: (1) a fine membrane on the anterior face and a fenestration in the middle of dorsal bar, (2) two small but clear antero-lateral processes on the ventral bar, and (3) details of the accessory piece of male copulatory organ. The aforesaid differences must have been either intraspecific or overlooked by previous authors. Mizoram is a new geographic record for *D. labei* after Lucknow, Uttar Pradesh in north India and Kalyani, West Bengal in east India.

It is interesting to note that a structure similar to a large chitinoid piece located close to the male copulatory organ in the atypical form of *D. labei* has also been identified in other India *Dactylogyrus* spp., such as *D*. *barnae* Wangchu et al., 2017 and *D*. *anchoracanthoides* Khwaja et al., 2023, though the function of such structure remains unknown.

The sharp differences in the morphometrics between typical and atypical forms of *D. labei* (Table 2) warrant their status to be elevated to species rank. In fact, Musselius and Gusev (1976) themselves recommended that the atypical form of *D. labei* “needs checking up on additional material”. However, because modern taxonomy is largely based on integrative taxonomy, which combines morphology and DNA taxonomy, we will not propose raising these two forms at separate species levels in this communication. Nevertheless, in the future, it is planned to collect both typical and atypical forms of *D. labei* from Lucknow and Aizawl, respectively, and take a molecular approach to determine the relationship between the two forms, specifically whether they are closely related species or distinct isolates of the same species.

Monogeneans are widely regarded as harmful parasites, especially in farmed and ornamental fishes (Hoai, 2020; Ogawa, 2015), where transmission is facilitated and fish can get heavily infected. Because *L*. *rohita* is the most popular farmed fish species in the Indian subcontinent, knowledge of its monogenean parasite fauna and its potential threats to *L. rohita* is critical and can be used to develop appropriate contingency plans and management techniques. Further, the ability of *D. labei*

Table 1. List of monogenean parasite species recorded from *Labeo rohita* (Hamilton, 1822) [After contributions in Gusev (1976), Gibson *et al*. (1996), Pandey and Agarwal (2008), and WoRMS (2024)]

Parasite species	Locality	Reference
Dactylogyrus speciosus Gusev, 1976	Lucknow, north India	Gusev (1976)
Dactylogyrus scorpius Rahmouni, Řehulková, Pariselle, Rkhami and Šimková, 2017	Bhubaneswar, east India	Paul et al. (2021)
Dactylogyrus labei Musselius and Gusev (1976)	Lucknow, north India Kalyani, east India	Gusev (1976)
Dactylogyrus thapari (Agrawal, 1980) Gibson, Timofeeva and Gerasev, 1996	Lucknow, north India	Agrawal (1980)
Paradactylogyrus indicus Singh and Rastogi, 2000	Saharanpur, north India	Kumar and Singh (2004)
Gyrodactylus elegans indicus Tripathi, 1959	Bengal, east India	Tripathi (1959)
Gyrodactylus medius Kathariner, 1893	Hesarghatta, south India	Devaraj et al. (1977)
Paramazocraes gorakhanati Agrawal and Singh, 1985	Gorakhpur, north India	Agarwal and Singh (1985)
Mazocraes mamaevi Agrawal, 1988	Lucknow, north India	Agrawal (1988)

Table 2. Morphometric differences between typical and atypical forms of *Dactylogyrus labei* Musselius & Gusev, 1976

Body characters	Typical form (Musselius & Gusev 1976)	Atypical form (Present study)
Morphology		
Haptoral armament		
Dorsal bar	T-shaped	Wing-shaped
Ventral bar	5-rayed	3-rayed
Reproductive organs		
Male copulatory organ	A chitinoid piece absent	A chitinoid piece present
Vagina	End plate thin	End plate thick
Host	Labeo gonius and Labeo calbasu	Labeo rohita
Morphometrics		
Haptoral armament		
Dorsal anchor		
Inner length	30–35	36 (32–42)
Inner root	10–13	17 (12–19)
Dorsal bar		
Length	18–21	28 (24–30)
Width	3–4	6 (5–7)
Ventral bar		
Length	18–30	33 (30–36)
Reproductive organs		
Male copulatory organ	57-–61	61 (57–67)
Accessory piece	40–52	53 (48–57)
Vagina	33–45	48 (44–53)

Table 3. Comparative morphometric measurements (in µm) of atypical forms of *Dactylogyrus labei* Musselius & Gusev, 1976 from the present study and those presented by other authors (ranges, if available, with means inside the parenthesis)

Body characters	Measurements		
	Musselius & Gusev (1976)	Chiary *et al*. (2014)	Present study
Haptoral armaments			
Dorsal anchor			
Inner length	33–38	56	36 (32–42)
Inner root	10–13	14	17 (12–19)
Outer root	4–6	8	6 (4–8)
Point	13–14	13	12 (11–15)
Dorsal bar			
Length	22–24	24	28 (24–30)
Width	3–4	5	6 (5–7)
Ventral bar			
Length	26–28	26	33 (30–36)
Hooks			
Pair I	–	12	14 (11–15)
Pair II	–	12	15 (12–17)
Pair III	–	18	14 (12–16)
Pair IV	17	18	15 (13–18)
Pair V	–	18	14 (12–16)
Pair VI	12	15	13 (11–16)
Pair VII	–	12	14 (12–16)
Reproductive organs			
Male copulatory organ			
Copulatory tube	57– 61	75	61 (57–67)
Accessory piece	40–52	–	53 (48–57)
Female Organ			
Vagina	33–45	–	48 (44–53)

(Values indicated by – are not provided in the primary descriptions)

to infect up to four phylogenetically related cyprinid species from two genera (*Labeo* and *Catla*) suggests that it is a generalist parasite, which is often thought to be more dangerous to host populations than their specialist counterparts due to their high abundance and the ability to infect more than two related host species.

Following the description of *Dactylogyrus kolodynensis* from *Osteobrama cotio* (Hamilton, 1822) (Cypriniformes, Cyprinidae) (Trivedi *et al*., 2022), the present communication is only the second record of monogenean parasites from Mizoram, a region known for its high biodiversity (ENVIS Centre: Mizoram, 2016). This demonstrates the existing knowledge gap in the field of fish parasitology in Mizoram, highlighting the need for more intensive parasitological studies to map the diversity of fish parasites, especially monogeneans, common to the region.

Conclusion

An atypical form of *D. labei* is redescribed and validated using high-resolution digital image processing and analysis of fresh material collected from Mizoram in northeast India. This study expands the geographical distribution range of *D. labei* to Mizoram, improving its morphological characterisation. Both of these advancements are critical for accurate assessments of parasite biodiversity. A molecular approach is required to determine whether the atypical and typical forms of *D. labei* are closely related species or distinct isolates of the same species.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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