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STUDYING THE MONOGENEAN *SILURODESCOIDES VISTULENSIS* IN THE FRESHWATER CAT FISHES IN MUZAFFARNAGAR, INDIA

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Abstract: Monogeneans are group of ectoparasite helminths which generally infect the skin, gills, and fins of fishes. In this study, during parasitological examination, the gill filaments of fresh water cat fishes *Pangasius pangasius* and *Mystus seenghala* revealed the presence of monogenean parasite *Silurodescoides vistulensis.* Out of 64 freshwater cat fishes, only 14 were found to harbor *Silurodescoides vistulensis* monogenean parasite and the result showed the rate of infection as 21.88% that cannot be ignored. The infection intensity found in the cat fishes during this study was total 196 helminths, which mean that approximately 10-15 parasites infested a single cat fish. A morphological redescription of this species' skeleton hard components is offered, as well as an updated assessment of the taxonomic position of the genus *Silurodescoides*.

Keywords: Monogenean, *Mystus seenghala, Pangasius pangasius,* Parasite, *Silurodescoides vistulensis.*

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INTRODUCTION

The omnivorous fish, *Pangasius pangasius*, consumes fish, molluscs, prawns, and algae during the dry season in addition to fruits and leaves during the flood season. It is predatory on snails and other mollusks but has great economic importance due to thick layer of fat in its flesh (Rahman, 2005). *Pangasius* is very tasty fish and is in high demand in Bangladesh (Nima *et al.*, 2018). *Mystus seenghala* (Sykes, 1839) possesses exceptionally long maxillary barbels and is a great source of protein. It is utilised both as a food fish and in laboratories. Two specimens of exotic aquarium fish *Puntius sutchii* (Tiger shark) and three specimens of teleost fish *Wallago attu* (family-Siluroidae), were found infected with rare monogenean *Silurodescoides vistulensis* (Bychowsky and Nagibina, 1957).

The flatworms are having dorsoventrally flattened body and belong to Phylum Platyhelminthes (Verma and Prakash, 2020). This phylum is retained as such both in five and six kingdom systems (Ashok, 2016) and is divided into three classes namely Turbellaria, Trematoda and Cestoda (Verma, 2017; Narayana *et al.*, 2021). Digenea and Monogenea are two groups of Trematoda. Lim (1996) and Lim *et al.* (2001) described six new host-specific species of monogeneans in *Pangasius* fish, all belonging to genera *Silurodescoides* (Gussev, 1976) and *Thaparocleidus* (Jain, 1952).

Akhmerov (1964) reported and described the genus *Silurodescoides* in detail from the gills of cat fish of family Pangasiidae (shark cat fish). Numerous scientists have identified several species of the genus

Silurodescoides from various teleost fish species under various names, including Jain (1952), Tripathi (1959), Akhmerov (1964), Kulkarni (1969), Gussev (1976), and Singh *et al.* (1992). Generally, all Ancyrocephalid monogeneans of the genus *Silurodescoides* are oviparous.

Simkova *et al.* (2013) explained the parasitic speciation of the genus *Thaparocleidus* monogenean that harmed the gills of *Pangasius* fish in Borneo and Sumatra. *Thaparocleidus* genus is closely related to the *Pangasius* diversification. According to Verma *et al.* (2016), this species is found only in freshwater fishes (Siluriforms) and seldom in other groups. Authors attempted to study the Monogenean *Silurodescoides vistulensis* in the freshwater Cat fishes in the region of Muzaffarnagar, India.

MATERIALS AND METHODS

A sum of 64 specimens of *Pangasius pangasius* and *Mystus seenghala* were examined from different water resources in Muzaffarnagar region of Uttar Pradesh (India). All fish were captured by means of netting and transported alive to the Zoology Department laboratory D.A.V College Muzaffarnagar, with proper handling.

For anesthesia, 'clove oil 'was used to immobilize the fishes and all fishes were examined externally and internally for parasites. Gills from both sides of the fishes were removed and each lamella was separated one by one, cutting them at their edges and examined, using low and high-power dissecting microscope and light microscope. Approximate intensity of infection of encountered parasites, recognition and site of attachment were recordedduring the study.

Mizelle's (1936 and 1938) freezing procedure was used to collect monogeneans. Live parasites were more visible due to their motions. The live worms were properly rinsed multiple times with cold distilled water under pressure to eliminate any mucus or debris that had adhered to the parasites. The worms were preserved in hot 4% neutral formaldehyde for 8-12 hours before being mounted in glycerine for further investigation.

Microphotographs of mounted parasites were acquired with the help of Motic DMB1-223ASC-B High Resolution digital compound microscope (Motic images plus 2.0) using W10x /18 oculars and 4x, 10x, 40x, and 100x objectives. The original photographs were cropped as was required.

RESULTS

Taxonomic status

Phylum: Platyhelminthes (Gegenbaur, 1859)

Class: Monogenea (Carus, 1863)

Order: Monopisthocotylea (Odhner, 1912)

Super: family: Dactylogyroidea (Yamaguti, 1963)

Family: Dactylogyridae (Bychowsky, 1933)

Sub-family: Ancyrocephalinae (Bychowsky, 1937)

Genus: *Silurodescoides* (Gussev, 1976)

Species: *vistulensis* (Siwak, 1932; Bychowsky and Nagibina, 1957)

Characteristics feature of Genus

The caeca was joined; posterior to the testis, and the body was elongated with four eye spots. The haptor was bilobed and clearly separated from the body. Dorsal anchors were where the patches were found. Dorsal anchors were bigger than ventral anchors. Both dorsal and ventral anchor roots were detected, varying in length. The dorsal bar was formed like a 'V'. Typically, the ventral bar had a 'V' shape or was split in half. There were hooks of various sizes and forms. The single, blind, sac-like structure was known as the seminal vesicle. There was a copulatory complex with an accessory piece and a coiled copulatory tube. The aperture of the vagina was sinistral. Body was lengthened having four eye spots.

Description (Plates 1-4):

Elongated body with blunt anterior and posterior ends, measuring 0.76 mm in length and 0.125 mm in maximum breadth at the gonad level, there were eight pairs of head organs in the blunt, triangular cephalic region. These head organs have thin ducts that emerge from their posterior extremity and extend posteriorly to join the cephalic glands on either side, posterior to the pharynx. There were two sets of eyespots. Because there were more melanistic granules in the posterior pair of eyespots than in the anterior, posterior pair were larger. (Plate 2 : Eye spots)

The oesophagus was small, measuring 0.008 mm in length, while the pharynx was spherical, measuring 0.025 x 0.027 mm in diameter (Plate 1, 4: Prohaptor area; Plate 2: Pharynx). The rear of the intestinal crura was confluent. The crura project backwards, forming a "V"-shaped termination at the place of confluence (Plates 1 and 2: W.M).

The male reproductive system consisted of testis, vas deferens, seminal vesicle, vasa efferentia, and cirrus. The testis was a solitary, elongated, fusiform,

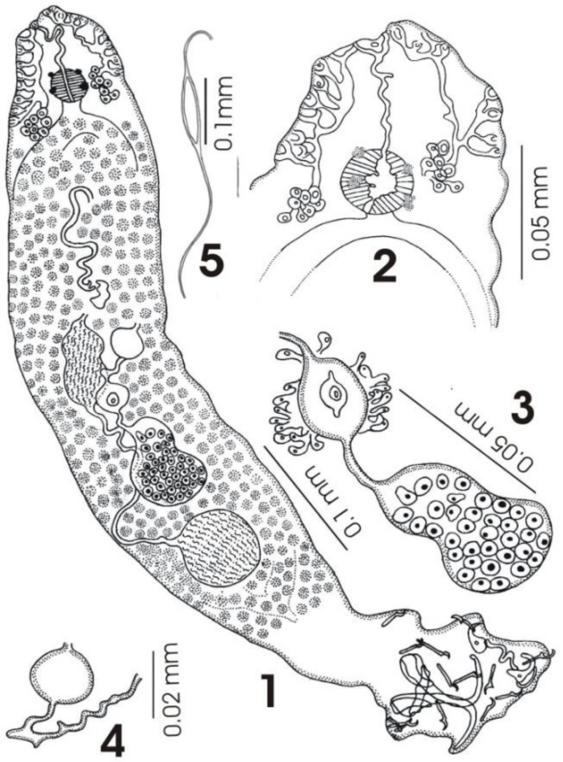

PLATE 1: *Silurodescoides vistulensis*
1. W.M. (400 X) 2. Prohaptor region (1000 X) 3. Ovary and Ootype (1000 X) 4. Seminal receptacle (1000 X) 5. Egg (400 X).

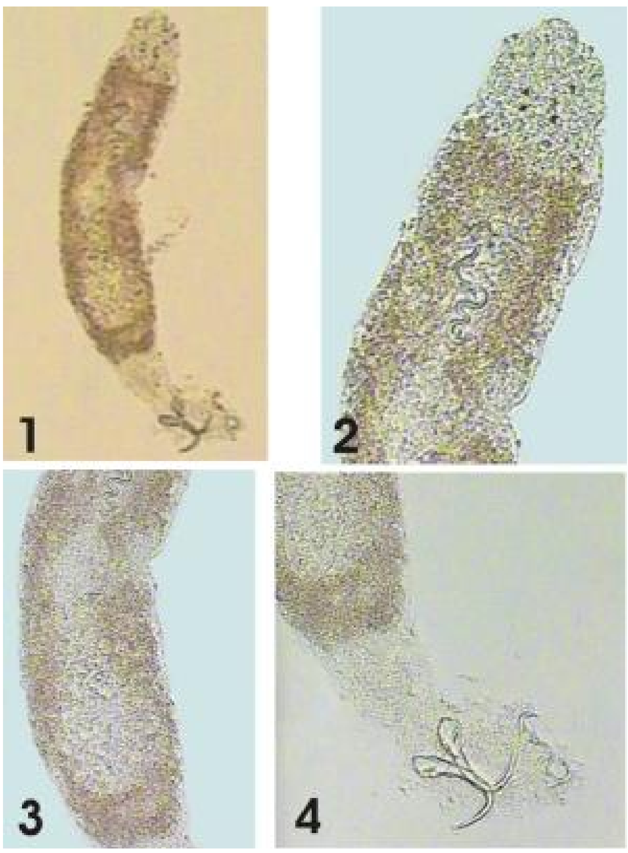

PLATE 2: Photographs of *Silurodescoides*
1. W.M. (100X) 2. Eye spots, Pharynx and Cirrus (400 X) 3. Ovary and testis (400 X) 4. Anchor region (400 X)

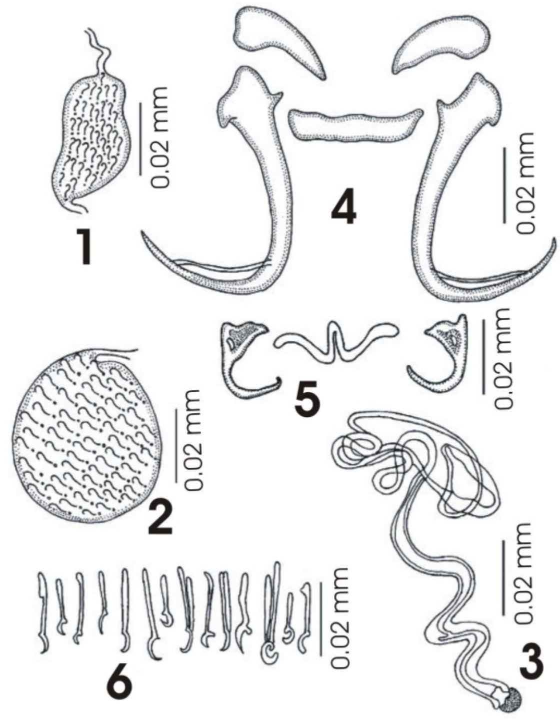

PLATE 3: *Silurodescoides vistulensis*
1. Seminal vesicle (1000 X) 2. Testis (1000 X) 3. Male copulatory complex (1000 X) 4. Dorsal anchor and Dorsal bar (1000 X) 5. Ventral anchor and Ventral bar (1000 X) 6. Hooks (1000 X)

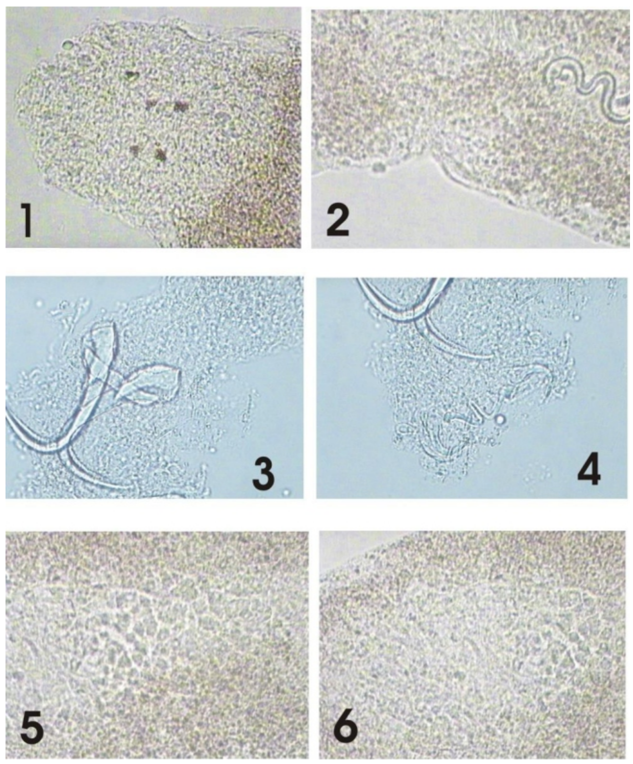

PLATE 4: Photographs of *Silurodescoides*
1. Prohaptorregion (1000 X) 2. Gonopore (1000 X) 3. Dorsal anchor and Dorsal bar (1000 X) 4. Ventral anchor and Ventral Bar (1000 X) 5. Ovary and ootype (1000 X) 6. Testis (1000 X)

intercaecal post-ovarian, post-equatorial, saccular structure measuring 0.05 mm length and 0.042 mm width (Plates 3, 4: Testis).

A tiny vasa deferens 0.21 mm long, emerges from the anterior edge of the testis. It moved forward and convoluted over the left intestine crura, then extended anteriorly and became extremely convoluted before dilating to form an elongated seminal vesicle in the pre-equatorial, inter-caecal area, immediately anterior to the ovary. The seminal vesicle measured 0.04 mm in length and 0.019 mm in median diameter (Plate 3). A long, thin, highly convoluted tube known as the vasa efferentia or ejaculatory duct emerges from the anterior edge of the seminal vesicle and opens at the base of the male copulatory complex. Its length (Plate 3: Male copulatory complex) was 0.015 mm. The 'hair-like' cirrus proper plus a little, semicircular, lobed accessory component forms the male copulatory complex. At 0.176 mm, the cirrus proper was a lengthy, double-walled, sclerotised tube. The distal portion of the cirrus was a 0.116 mm long, convoluted, single-walled, non-sclerotized tube. The proximal portion (base) of the cirrus had a diameter of 0.008 mm (Plate 2: Cirrus). The club-shaped, trilobed accessory component was situated close to the base of the cirrus. Its length and breadth were 0.007 mm and 0.005 mm, respectively.

The female reproductive system consists of ovary, oviduct, ootype complex and vaginal duct. Ovary was a pre-testicular, intercaecal, pre-testicular, elongated, and oval structure 0. 052 mm in length and 0.034 mm in width. The anterior portion of the testis overlaps the ovary (Plate 2: Ovary and testis). It opened into the ootype complex through a convoluted oviduct. The ootype complex is fusiform. It had a length of 0. 026 and a width of 0. 02 mm (Plate1, 4: Ovary and ootype).

The yolk sac on the anterolateral side of the ovary gives rise to a separate yolk duct. A highly coiled tube, 0.03 mm in diameter, leads to the blood vessels of the body. The seminal vesicle case is oval shaped and measures 0.0016 mm long and 0.0018 mm wide. A short, circular vaginal duct, 0.08 mm long, extends from the receptaculum seminis to the genital aperture (Plate 1: Seminal vesicles). The genital pore is funnel-shaped. It has two openings. The male genital pore opens above the vaginal opening (Figure 4: Genital pore).

The eggs are spindle-shaped, 0.35 mm long and 0.025 mm wide. The outer membrane of the egg extends into the polar filaments of the two narrow (anterior and posterior) ends. The posterior polar filaments are longer. The anterior and posterior polar filaments measure 0.091 mm and 0.17mm respectively (Plate 1: Egg).

Opisthaptor was globose and had a short peduncle that set it apart from the body proper. Opisthaptor had dimensions of 0.117 mm in width and 0.11 mm in length. The dorsal and ventral anchor pairs, a dorsal transverse bar, a ventral transverse bar, and seven pairs of marginal hooklets make up the haptor's armature (Plate 2: Anchor region). There were dorsal anchors of the 'Anchoratoid Wegeneri' type, which had a recurved point, an elongated inner root, and a nearly undetectable outer root. The cylindrical shaft was made even stronger by the sleeve sclerite. Its base was enlarged. There were tiny, inward-pointing conical patches (capitulum) at the base of the inner root of the dorsal anchors. The dorsal transverse bar is of the type 'Achoratoid Wegeneri'.

The dorsal transverse bar has projecting end. The ventral anchor is of the type “Wunderoid Nanus” with a short flexure and small forked root. A small oval space is present between the two bases for the attachment of the ventral transverse bar. Base of ventral anchor was swollen. Shaft was short, cylindrical, and supported by the sleeve sclerite. Ventral transverse bar was single piece, wide, “V” shaped bar with swollen outer ends (Plate 3,4: Ventral anchor and Ventral bar). Marginal hooklets were 'larval' type with flattened heel, sickle shaped hooklet and swollen base. The filament loop was attached at the distal part of sickle on ventral side (Plate 3: Hooks).

Details of measurements of haptoral armature (in millimeters) were as follows:

Dorsal anchors	
Total length	: 0.053-0.069
Dorso apical length	: 0.053-0.069
Ventro apical length	: 0.041-0.052
Length of the point	: 0.025-0.036
Length of capitulum	: 0.030-0.035
Dorsal transverse bar	
Length of the bar	: 0.032-0.039
Median width of the bar	: 0.006-0.013
Distal width of bar	: 0.029-0.009
Ventral anchors	
Total length	: 0.017-0.026
Dorso apical length	: 0.018-0.028
Ventro apical length	: 0.014-0.026
Length of point	: 0.068-0.009
Ventral transverse bar	
Length of I half	: 0.016- 0.025
Length of II half	: 0.017-0.023
Width at the ends	: 0.003-0.005
Median width of bar	: 0.005-0.009
Marginal hooklets	
Total length	: 0.014-0.028
Handle length	: 0.010-0.023
Hooklet length	: 0.003-0.008
Length of loop	: 0.009-0.018

Table 1: A comparative account of *Ancyrocephalus vistulensis* Siwak (1932); *Ancylodescoides vistulensis* Bychowsky and Nagibina (1957), *S. vistulensis* Rastogi *et al.* (2008) and present study.

Character	***Ancyrocephalus vistulensis* Siwak, 1932 (in mm)**	***Ancylodescoides vistulensis* Bychowsky and Nagibina, 1957 (in mm)**	***Silurodescoides vistulensis* Rastogi *et al.*, 2008 (in mm)**	***Silurodescoides vistulensis* present study (in mm)**
Host	*Silurusglanis*	*Silurusglanis*	*Wallago attu* and *Puntius sutchii*	*Mystus seenghala* and *Pangasius pangasius (upiensis)*
Total length Width Head organs	0.89 0.17 4 pairs	0.40 0.145 4 pairs	0.601 0.09 8 pairs	0.76 0.125 8 pairs
Eye spots	2 pairs	2 pairs	2 pairs	2 pairs
Cephalic glands	-	-	Present	Present
Pharynx	Oval	Almost spherical	Almost spherical	Almost spherical
Pharynx size	0.075 x 0.06	0.03 x 0.032	0.039	0.025x 0.027
Position and size of excretory pore	-	-	Extra-caecal, on either lateral side, at the level of receptaculum seminis; 0.003	Extra-caecal, on either lateral side, at the level of receptaculum seminis
Position, shape and size of testis	Post bifurcal, intercaecal, post-ovarian and post-equatorial; oval; 0.094 x 0.070	Post bifurcal, intercaecal, post-ovarian and post-equatorial; oval; 0.058 x 0.043	Post bifurcal, inter-caecal, post-ovarian and post-equatorial; fusiform; 0.089 x 0.0565	Post bifurcal, inter-caecal, post ovarian and post-equatorial; fusiform; 0.05 x 0.042
Course and length of vas deferens	Dextral; -	Sinistral; 0.11	Proximal dextral; distal sinistral; 0.357	Proximal dextral; distal sinistral; 0.21
Shape and size of seminal vesicle	Bean shaped; 0.08 x 0.03	Fusiform; 0.050 x 0.015	Fusiform; 0.109 x 0.0155	Fusiform; 0.04 x 0.019
Vasa efferential	0.13	0.015	0.239	0.015
Cirrus	Proximal part double walled and chitinoid; distal part single walled and non chitinoid	Proximal part double walled and chitinoid; distal part single walled and non chitinoid	Proximal part double walled and chitinoid; distal part single walled and non chitinoid	Proximal part double walled and chitinoid; distal part single walled and non chitinoid
Length of cirrus	0.62	0.88	0.355	0.176
Diameter of base	0.01	0.01	0.0065	0.008
Shape and size of accessory piece	-	-	Semicircular; 0.011	Semicircular; 0.007 x 0.005
Position, shape and size of ovary	Post bifurcal, intercaecal, equatorial and pre – testicular; pear shaped; 0.11 x 0.07	Post bifurcal, intercaecal, slightly pre-equatorial and pre – testicular; almost spherical; 0.040 x 0.037	Post bifurcal, inter-caecal, equatorial and pre – testicular; oval; 0.076 x 0.0415	Post bifurcal, inter-caecal, equatorial and pre – testicular; oval; 0.052 x 0.034
Oviduct	-	-	-	-
Shape and size of ootype complex	Spindle shaped; 0.09 x 0.02	Spindle shaped; 0.04 x 0.14	Fusiform; 0.030 x 0.025	Fusiform; 0.026 x 0.02
Vestibule	-	-	0.3195	-
Position and shape of vagina	-	Dextral, pre-equatorial Funnel shaped	Dextral, pre-equatorial Funnel shaped	Dextral, pre-equatorial Funnel shaped
Vaginal opening	-	0.018	0.016	-
Receptaculum seminis	Spindle shaped; 0.08 x 0.02	Oval; 0.025 x 0.02	Oval; 0.035 x 0.030	Oval; 0.016 x 0.018
Vaginal duct	-	0.124	0.152	0.08

Vitelline duct	-	-	0.051	-
Egg shape and size	Oval, unipolar polar filament short; 0.085 x 0.07	Fusiform, unipolar, polar filament long; 0.042 x 0.012	Fusiform, bipolar, posterior polar filament longer than anterior filament; 0.0945 x 0.031	Fusiform, bipolar, posterior polar filament longer than anterior filament; 0.35 x 0.025
Size of Polar filament	0.03	0.030	Anterior-0.10 Posterior-0.147	Anterior-0.091 Posterior-0.17
Haptor				
Haptor	Globose	Globose	Globose	Globose
Haptor size	0.16 x 0.11	0.078 x 0.089	0.0985 x 0.057	0.11 x 0.117
Dorsal anchor				
Total length	0.085	0.07	0.067	0.055
Dorso-apical length	0.085	0.07		0.055
Ventro-apical length	0.07	0.068	0.058	0.041
Length of shaft	0.07	0.06	0.048	0.04
Length of point	0.039	0.026	0.029	0.035
Length of patch	0.03	0.016	0.033	0.027
Proximal width of patch	0.009	0.005	0.009	0.004
Dorsal transverse bar				
Total length	0.039	0.025	0.035	0.038
Median Width of bar	0.009	0.006	0.009	0.008
Ventral anchor				
Total length	0.03	0.02	0.020	0.021
Dorso-apical length	0.03	0.02	0.022	0.023
Ventro-apical length	0.032	0.019	0.023	0.015
Length of shaft	0.029	0.013	0.011	0.012
Length of point	0.012	0.008	0.008	0.009
Ventral transverse bar				
Length of I half of bar	0.028	0.019	0.022	0.017
Length of II half of bar	0.030	0.019	0.020	0.018
Marginal hooklet				
Total length	-	-	0.016	0.028
Length of hooklet	-	-	0.011	0.023
Length of filament loop	-	-	0.0105	0.018

Copulation Biology

The male mating complex of *S. vistulensis* (Siwak, 1932 ; Bychowsky and Nagibina, 1957) is very long. The sclerotized and uncured tubes of the cirrus clouds are connected to each other like needle and thread.

The distal sclerotized part of the cirrus projects like a needle from the genital aperture and pulls the unsclerotized part in a needle like manner. The semicircular extension holds the base in place near the cirrus while the tip of the cirrus enters the genital aperture of its partner. The vasa tube opens at the base of the cirrus cloud.

DISCUSSION

Siwak (1932) described *Silurodescoides vistulenis* from the gills of Poland (European) cat fish as *Ancyrocephalus vistulensis*. In 1952, *Silurodescoides* was renamed as *Thaparocleidus*. Later, Bychowsky and Nagibina (1057) transferred it to the genus *Ancylodescoides*, keeping its status valid as species. Tripathi (1959) suggested another name for this genus, *Neomurraytrema*. Later, Akhmerov (1964) traced it to another species of *Parancylodiscoides*. Since some good studies of the changes in head structure, gonads, spermathecae, egg-like complex and egg structure are not available in previous records, a brief representation of the species is given as new material collected during the study. Kulkarni (1969) reported for the first time that a specimen of this genus came from the Indian subcontinent but he reported that as genus *Ancylodescoides* (Yamaguti, 1937). Gussev (1976) proposed a new combination and changed it from the genus *Ancylodescoides* (Yamaguti, 1937) to the genus *Silurodescoides; S. siluri,* a parasite of the European catfish (Zandt, 1924), was used as the type species. Authors agree with Gussev (1976), who considered *Ancylodescoides* (Yamaguti, 1937) together with *Silurodescoides*. Therefore, *A. vistulesis* (Siwak, 1932; Bychowsky and Nagibina, 1957) was transferred to the genus *Silurodescoides* to preserve the validity of this species.

Rastogi *et al.* (2008) described *Siluroscoides vistulensis* from the gills of *Wallago attu* in Meerut. The accompanying table (table 1) shows *Ancyrocephalus vistulensis* (Siwak, 1932), as described in this model. The difference between these models may be due to difference in development or may be due to the presence of parasites in ecological niches. A negative analysis of this structure was reported by Sivak (1932) and Bychowsky and Nagibina (1957). Sperms collected in the spermatheca and from there they are transported to the oval complex to fertilize the egg.

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