

## HISTORICAL SURVEY OF MONOSTOMES WITH DESCRIPTION OF *PARAMONOSTOMUM NARABALI* SP.NOV. (DIGENEA: NOTOCOTYLIDAE LUHE, 1909) FROM *FULICA ATRA*

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**ABSTRACT:** The group of monostomes is very well known because it has been widely studied notwithstanding availability of relatively incomplete works of these flukes. Though the earliest account of monostomes was recorded by Zeder (1800) but earlier to that there are several scattered contributions by Goeze(1782) and Schrank(1788). Monostomes attracted the attention of several helminthologists beginning with the early nineteenth century and thereafter several workers have contributed their lot to this group. Notable amongst the older authors are Zeder, Rudolphi, Von Siebold and others who have contributed materially to our knowledge of monostomes. *Paramonostomum narabali* sp.nov. is also described from *Fulica atra* which is the first detailed report of the species of the family from Srinagar, Kashmir, India. A comparative table depicting dimensions recorded by some authors of certain species along with the new species is also enclosed.

**Key words:** Trematode, Monostome, *Paramonostomum*, Notocotylidae, *Fulica atra*, India.

### INTRODUCTION

**Monostomes: A Historical Data:** While going through the available literature and contributions made from time to time by several researchers, I am convinced that a more exhaustive and up-to-date study of this group for additional information regarding history of monostomes is desirable, which could be of immense help to future helminthologists. Whereas three comparative studies have already been made during the first quarter of 20<sup>th</sup> century initiated by Stossich(1902) based on European materials; the second by Kossack(1911) on the same material and a comprehensive and outstanding contribution by Harrah in 1922 through his thesis submitted to the university of Illinois.

The first of the monostomes were described in the early nineteenth century and thereafter there have been significant contributions to the study of this group by subsequent workers. Notable contributions in the early stages have been made by Zeder, Rudolphi, Von Siebold, Van Beneden and Diesing followed by remarkable contributions by Brandes, Stossich, Looss, Luhe, Monticelli, Kossack, Odhner and Harrah, though the later helminthologists restricted their studies to European forms only. This group has not attracted too much attention from India, but whatever little contribution available is due to

the efforts of Moghe, Bhalerao, Khan, Srivastav, Lal, Fotedar and Kaw and Kharoo.

The earliest record of monostomes available is that of Goeze (1782) who described two species in Klasse II of his family (genus) Planaria which he believed to have only one sucker. However (Harrah, 1922) while contradicting the existence of mouth opined that “from the description of figures this appears to be the crown of spines which Goeze mistook for a mouth”. This was followed by the publication of catalogue of species by Schrank(1788) where he proposed the name *Festucaria* for the two species *F.anatis* and *F.strigis*. Gmelin(1790) renamed the former as *Fasciola anatis* and Zeder (1800) changed the nomenclature of the genus *Festucaria* to *Monostoma* which was accepted subsequently by other helminthologists. Zeder(1800,1803) was the first who gave an earliest account of monostomes and established this group. He created the genus *Monostoma* based on five species; *M.ocreatum*, *M.bombyna*, *M.verrucosum*, *M.prismaticum* and *M.mutabile*. Whereas the first two have since been removed to distomes, the third one has been identified (synonymised) as a Notocotylid and the last two transferred to the genus *Cyclocoelium*. The publication of *Synopsis Entozoorum* by Rudolphi was a significant contribution towards early organization of this

**Table 1 : Comparative measurements of certain species of *Paramonostomum* recorded by different authors.**

	<i>P.alveatum</i>	<i>P.brantae</i>	<i>P.iorne</i>	<i>P.parvum</i>	<i>P.fulicai</i>	<i>P.microstomum</i>	<i>P.narabali</i>
Body	0.50-0.85 x 0.40-0.53	0.5-0.9 x 0.3-0.5	3.2 x 1.5	0.25-0.5 x 0.2-0.35	2.4 x 1.16	1.52-1.58 x 0.43-0.51	1.44-1.96 x 0.57-0.91
Oral sucker	0.059-0.115	0.036-0.056 (dia.)	0.21(dia.)	0.035-0.046 (dia.)	0.215 (dia.)	0.096-0.128 x 0.112-0.144	0.112-0.128 x 0.112-0.160
Oesophagus	As short as oral sucker length	0.04-0.05 long	Very small	Small	0.078 long	0.048 x 0.096	0.064 long
Cirrus pouch	0.16-0.24 x 0.10-0.13	0.12-0.25 long	0.61 long	—	0.564 long	0.43-0.49 x 0.06-0.08	0.35-0.4 x 0.06-0.096
Testes	0.12-0.18 x 0.10- 0.14	0.1-0.16 x 0.06-0.12	0.5-0.52 x 0.21	—	0.33 x 0.19	0.16-0.2 x 0.08-0.09	0.16-0.288 x 0.08-0.176
Ovary	0.08-0.15 (dia.)	0.06-0.1 (dia.)	0.33-0.35 long	—	0.182 x 0.149	0.08-0.112 x 0.096-0.128	0.08-0.144 x 0.096-0.16
Vitellaria	.extend from testes to level of cirrus sac	extend beyond middle of body	extend up to cirrus sac	extend up to middle of cirrus sac	extend up to middle of body	Terminate far behind middle of body length	Extend up to middle or slightly behind
Eggs	0.019-0.021 x 0.011-0.012	0.015-0.019 x 0.009-0.012	0.019 x 0.012	0.021-0.024 x 0.011-0.013	0.018-0.020 x 0.010-0.013	0.012-0.015 x 0.006-0.009	0.015 x 0.006-0.009
Host	Anas sp.	<i>Branta canadensis</i>	<i>Ionornis martinica</i>	Unidentifie duck	<i>Fulica atra</i>	<i>Philomachus pugnax</i>	<i>Fulica atra</i>
Location	Caeca	Caeca	Intestine	Intestine	Caeca	Caeca	caeca
References	(Mehlis in Creplin,1846) Stunkard, 1967*	Bullock, 1952	Travassos, 1921	Stunkard et Dunihue, 1931.	Baugh, 1958	Moghe, 1932	Author's collection

\*“the previous accounts include the inadequate redescriptions of the original specimens by Monticelli(1892), brief statement by Luhe(1909) and the account by Cossack(1911)” (Stunkard,1967).

group, though, the classification of a large number of species was imperfectly known. It was not until the work of Von Siebold (1835) who published the anatomy of these parasites which was clearly understood. In his publication the author gave a detailed description of *Monostoma mutabile* Zeder along with the early stages of life history through development of the egg before being discharged from the uterus. Further, while reorganizing the genus, Diesing (1850) included all the species hitherto described. Van Beneden (1861) reviewed the anatomy of *Monostomum mutabile* and also described the anatomy of *M. verrucosum* Frolich besides presenting description of a cercaria which he thought to be the larval form of this species. While contributing to the knowledge of this group, Monticelli (1892) described the genus *Notocotyle* Diesing in detail and in the same year he published an account of *Monostomum cymbium* Diesing. During the same year Brandes (1892), while revising the genus, proposed a new form *Cyclocoelium* to include *M. mutabile*, *M. flavum*, *M. arcuatum*, *M. tringae* and *M. ellipticum*.

This group was also represented in the eastern

region previously by *Cyclocoelium nigropunctatum* (Von Linstow, 1883) in Turkestan and *C. tringae* Brandes, 1892) from *Tringa variabilis* on the Sinai Peninsula. Skrjabin (1913) described *Cyclocoelium orientale* from *Totanus glareolus* and *Tracheophilus sisowi* from *Anas hoschas* from Turkestan and *Octatropus charadii* from *Helodromus ochropus* along Ural Mountains. Nicoll (1914) and Johnston (1916) reported a number of species from birds in Australia.

In the beginning of twentieth century, the works of Stossich (1902), Odhner (1905, 1907) and Kossack (1911) stand out as important contributions to the knowledge of this group, though the studies carried out by Looss(1899) and Luhe(1900) in the organization of this group as a unit cannot be overlooked. The only report of monostomes in the beginning of twentieth century was by Stossich (1902) as *Haematotrephus phaneropsolus* from *Totanus* sps. in Japan. He also made an attempt at the comparative study of this group which was followed by Kossack (1911) too.

Though the earliest record of monostomes from North America is that of Joseph Leidy (1856-1895) but

with inadequate descriptions which were considered as *species inquirende*. However, Pratt (1902) gave a systematic arrangement of this group from the same region and Ward (1918) published a descriptive key, though, with isolated description of the species. Harrah (1921) published his work on Asian monostomes and described a new species *Cyclocoelium elongatum* from a Magpie from China. Harrah (1922) submitted a thesis to the University of Illinois having worked in detail on monostomes and described a number of species under the genus *Cyclocoelium*. While studying the genus *Cyclocoelium*, Ward (1918) and Harrah (1921, 1922) described the oral sucker as either weak or vestigial but Morishita (1923), apart from describing an oral sucker also recorded the presence of small but distinct acetabulum in Japanese species of the genus. Stunkard (1929) thereafter concluded that “these observations confirm the contentions of Odhner, Stunkard, Harrah and other helminthologists that monostomes have descended from various distome groups”. The work on monostomes was later on carried out by a number of workers, prominent among whom are Yamaguti, Ku, Harwood, Dollfus, Witenberg and others. Although the work on monostomes in India is not very extensive yet whatever little accomplishment, is due to Moghe (1932), Bhalerao (1935), Srivastava (1935), Khan (1935), Lal 1935 and Kharoo (1974).

**Families:** Harrah (1922) while discussing the status of the families recognized only four families within Monostomata as:

Cyclocoelidae Kossack, 1911; Notocotylidae Luhe, 1909; Collyriclidae Ward, 1917 and Heronimidae Ward, 1917.

Out of the four *Monostoma* families, Notocotylidae has attracted maximum attention and studied thoroughly. The earliest record of monostomes within this family is that of *Catatropis verrucosa* (Frolich, 1789) Odhner, 1905 which were described as *Fasciola* by Frolich and Gmelin. However, Zeder (1800) classified them within the genus *Monostoma* and thereafter placed in a new genus *Notocotylus* by Diesing (1839) as a genotype of the family but Odhner (1905) removed it to a new genus *Catatropis* as a type species. The family is also represented in the early part of twentieth century by *Notocotylus quinqueserialis* (Barker et Laughlin, 1911), *Notocotylus urbanensis* (Cort, 1914), *Catatropis filamentis* (Barker, 1915, 1916), *Paramonostomum echinum* (Harrah, 1922), etc.

**Origin of Monostomes:** Though some

helminthologists consider trematodes of polyphyletic origin but Faust (1918) opined that these observations are the result of “lack of study and consequent inability to recognize the fundamental resemblance of the genital, excretory and nervous systems”. Harrah, 1922 while working upon the origin of monostomes commented that “this group of parasites has served for a dumping ground for inaccurately studied species in which the acetabulum has been wrongly interpreted or overlooked entirely. Many species have since been studied more carefully and consequently have been transferred to other genera. Out of this has arisen the problem of the origin of Monostomata. Accumulative evidence has led to the belief that these forms are directly related to various other groups”.

Whereas Monticelli (1893) discussed relationship between Monostomata and Distomata by describing the similarities between *Kollikeria* and *Didymozoon*, Ariola (1906) grouped the two genera *Monostoma fillicole* Rud. and *Distoma okeni* Kollicker together on the basis of their anatomical similarity. MacCallum and MacCallum (1916) while presenting their views grouped together *Kollikeria* and *Nematobothrium* on the basis of similar anatomical features despite the fact that the former has a well developed acetabulum (Harrah, 1922). Further studies carried out on the origin of monostomes by Cohn (1904), Fuhrman (1904), Odhner (1907) and Harrah (1922) substantiates the view that monostomes have descended from various distome groups. Harrah (1922), while discussing the inter-relationships of the monostome families as a unit or natural group of trematodes reiterated that “Since the great diversity of structure in this group seems to indicate that the monostomes have arisen from different sources, there remains to be considered in conjunction with this fact the close affinity of certain of the families to widely separated groups”. The author supports the views expressed by Harrah (1922) that both external and internal factors could be responsible for modifications and these changes may occur gradually through mutations where no trace of the ancestry can be traced down. The author is of the opinion that because of the difficulty in assigning an exact chronology to the sources, it is impossible to be precise as to when particular changes took place. Though the evidence about the origin of monostomes is sharply divided and descriptions in many instances are inadequate, indefinite or confused, there is sufficient reason to believe that they have arisen from divergent groups and that the final decision must be left to the further studies on anatomy and life history by future helminthologists.

The aim of the present paper is to investigate the

history and origin of Monostomes apart from describing a new monostome parasitizing the Common Coot in India.

## MATERIALS AND METHODS

*Fulica atra* is a member of the Rallidae family called Eurasian Coot in England and Common Coot in India. It is a blackish grey bird, the size of a hen, often seen swimming about on open water or across waterside grasslands. It is an omnivore bird feeding upon a variety of small live prey including algae, vegetation and fruits. Found in Europe, North Africa and Central Asia to Japan, their population swells in India during winters after migration from Central and West Asia. During the course of survey of endohelminth parasites of the migratory birds in Kashmir, India, eight mature and four immature specimens referable to a new species of *Paramonostomum* Luhe, 1909 were collected from the rectal caecae of two *Fulica atra* Linn. obtained from Narabal, Srinagar. The parasite being cosmopolitan in nature has also been reported from Anseriformes, Charadriiformes, Ciconiiformes, Galliformes, Gruiformes and mammals (Barton et Blair, 2005). The birds were necropsied in accordance with the ethical procedures and dissected organs kept in petri dishes with 0.85 NaCl solution and examined under high power microscope. The worms as far as possible were examined in living conditions to study movements and changes in shape and position of various organs. The excretory and details of reproductive systems were particularly studied. The monostomes were mounted in toto, compressed-fixed in Bouin's fluid, stained in Ehrlich's haematoxylin, dehydrated in graded series of alcohol, cleared in xylol and kept as whole mounts in Canada balsom. Drawings were made with the help of camera lucida. Identification of the parasites was done at Zoology department, University of Allahabad. Holotype and paratypes were deposited in the helminthological collection of the said department.

## OBSERVATIONS AND DISCUSSION

Family: Notocotyliidae Luhe, 1909

Sub-family: Notocotylineae Kossack, 1911

Genus: *Paramonostomum* Luhe, 1909

Species: *Paramonostomum narabali* sp.nov.

(Fig.1-2; Table-1)

**Description:** Based on holotype and five paratypes in toto; measurements are in mm.; mean followed by range appear within brackets.

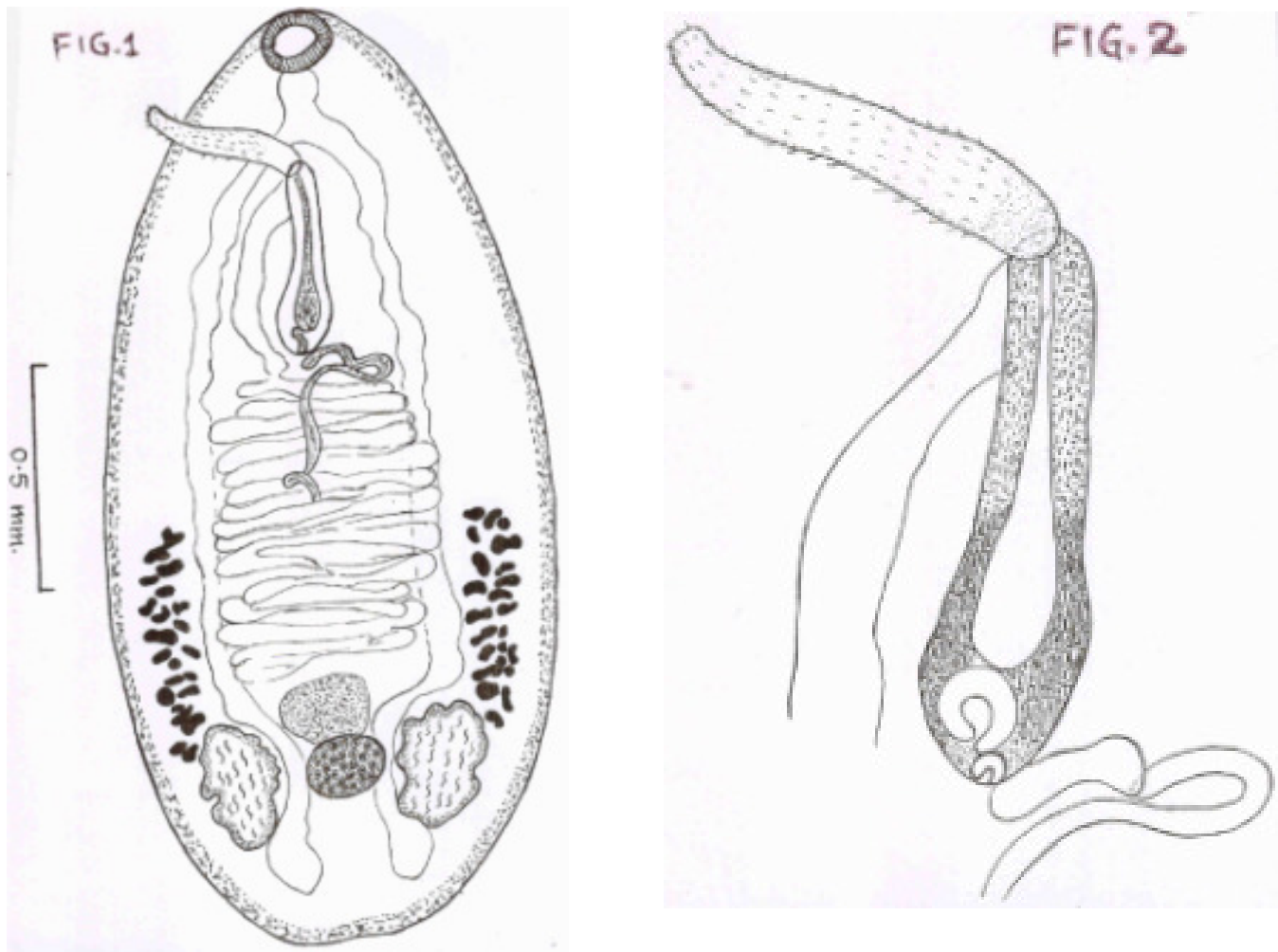
Sexually mature specimens of the worms are oval in shape, tapering more towards the blunt anterior end than at the posterior which is invariably rounded. The length of the body varies between (1.704) 1.44-1.968 and

the maximum breadth (0.744) 0.576-0.912 is mostly in the region of vitellaria. Cuticle appears to be aspinose, because no spines were seen. Oral sucker more or less rounded, almost terminal, (0.120) 0.112-0.128 x (0.136) 0.112-0.16 in size. Oesophagus 0.064 long; pharynx absent. Intestinal caeca almost of equal length, extending nearly upto hinder body end, forming a curve or a loop between ovary and testes, partly overlapped by testes prior to their blind endings.

Testes symmetrically opposite to each other on either side of ovary outside caeca at the posterior end of body; deeply lobed on the inner margin than the outer, measuring (0.224) 0.16-0.288 in length and (0.128) 0.08-0.176 in breadth. The two vasa efferentia after emerging from the testes unite to form a long vas deferens which runs forward and enlarges to form a convoluted vesicula seminalis at the anterior level of vitellaria, part of which is also enclosed within the cirrus sac as vesicula seminalis interna, whereas major portion lies outside in parenchyma as vesicula seminalis externa. Cirrus sac median, more or less flask shaped extending just behind the level of intestinal bifurcation within the anterior two fifth of body length, measuring (0.376) 0.352-0.4 in length and (0.080) 0.064-0.096 in breadth across the bulb. The bulb contains in its basal part the vesicula seminalis interna; oval pars prostatica surrounded by dense prostate gland cells continues into a long tubular ductus ejaculatorius. Cirrus (0.232) 0.144 - 0.32 long, everted and armed with spines. Genital opening is slightly behind intestinal bifurcation.

Ovary more or less rounded with an entire margin, situated mesially in the intercaecal space immediately behind Mehli's gland between testes, (0.112) 0.08-0.144 x (0.128) 0.096-0.16 in size. Mehli's gland well developed, (0.104) 0.08-0.128 x (0.16) 0.144-0.176 in size. Vitellarium composed of two lateral groups of 20-24 irregular follicles, 0.016-0.096 x 0.016-0.08 in size, extracaecal; commence from the anterior margin of testes upto almost middle of body length but fail to reach equator. The length of vitelline gland is 0.368-0.528. Uterus extending anteriorly from ovary in 12-16 major transverse coils in a characteristic manner is confined to the space between ovary and basal end of cirrus sac, intercaecal but some uterine coils slightly exceed caeca. Distally, uterus terminates into a muscular metraterm more or less of the same length as that of cirrus sac and opens externally through the common genital pore. Eggs oval, 0.015 x 0.006-0.009 in size. Excretory opening median and dorsal situated a little ahead of posterior body extremity.

**Discussion:** The genus *Paramonostomum* was created by Luhe (1909) with *Monostomum alveatum*



Figs. 1-2 : *Paramonostomum narabali* sp.nov. 1. Holotype, entire worm, ventral view. 2. Magnified view of cirrus pouch.

(Mehlis) Creplin, 1846 as type species. The species was earlier included by Monticelli (1892) in the genus *Notocotylus* (Diesing, 1839) but Luhe (1909) said that it is not congeneric with *Notocotylus*. Luhe characterized the genus as: Body compressed, egg shaped, greatest breadth a little caudad from middle of body, posterior end broad, anterior tapering and pointed; anterior half of ventral surface thickly set with short spines; ventral glands absent; cirrus pouch weakly muscular; vagina usually one half of cirrus pouch (Harrah, 1922). Though Barker (1916) criticized the erection of a new genus on the basis of the absence of ventral glands but Harrah (1922) accepted its validity. Lal (1936) subdivided the genus into two genera, *Paramonostomum* and *Neoparamonostomum*, but Harwood (1939) and subsequent authors did not accept the validity of Lal's genus. Yamaguti (1971) recognized two subgenera, *Paramonostomum* and *paramonostomoides* but Gtoschaft and Tenora (1981) did not accept these as valid which was also supported by Barton and Blair, 2005.

Yamaguti (1958) recognized twelve species of the genus *Paramonostomum* described worldwide though Stunkard (1967) accepted the validity of twenty species but was very critical of raising new species without sufficient grounds especially when the distinctions between them are tenuous. He did not commend the creation of a new species from a single specimen and opined that "final determination of specific identity in the genus *Paramonostomum* may depend on discovery of life cycles and the description of larval stages". While commenting upon the Indian species *P. microstomum* (Moghe, 1932), he says that "the description is incomplete, uterus is represented in diagrammatic manner and locations of ovary and Mehlis's gland are reversed". The present species is characterized from all the known species in many respects. From India the so far known and accepted species are: *P. querquedulae* Lal, 1936 in *Querquedula circica*; *P. microstomum* Moghe, 1932 (syn. *Neoparamonostomum m. (M.)* Lal, 1936 in *Philomachus pugnax* (Yamaguti, 1958); *P. casarcam* Lal, 1936 in

*Casarca rutila* and *P.fulicai* Baugh, 1958 in *Fulica atra*. In its relationship it stands nearest to *P.fulicai* and *P.microstomum*. Whereas with the former the new species resembles in body shape, small oesophagus, extent of vitellaria and position of genital pore behind caecal bifurcation. But it can be sharply differentiated from the same in the shape of ovary (lobed in older species), size of eggs (considerably smaller in new species) besides fairly large size of cirrus pouch and testes in the older species. From *P.microstomum* the new species is distinguishable in shape of gonads (testes are deeply multilobed and ovary is partially lobed in the former) and extent of vitellaria which are confined to posterior third of body length in the former species. Though *P.narabali* sp.nov.also resembles several other species in many morphological and anatomical characters but it can be separated from them thus: from *P.brantae* Bullock, 1952 in the shape of gonads, smaller size of cirrus sac, distribution of vitellaria and size of eggs; from *P.iorne* Travassos, 1921 in dimensions of body and cirrus pouch, shape of ovary and extent of vitellaria. The new species can be distinguished from the type species *P.alveatum* (Mehlis in Creplin, 1846) Stunkard, 1967 by size of body, cirrus pouch and eggs (fairly large in the latter), position of genital pore besides a prominent oesophagus in the new species. There is also a marked difference in shape and size of body, size of oral sucker and disposition of vitellaria between the new species and *P.parvum* Stunkard et Dunihue, 1931 besides distinctly large ova in the latter. The most striking difference between the present form and the so far known species is the shape of ovary which is more or less rounded with smooth margin in the new species under discussion. After studying carefully in detail the differences in morphological and anatomical features, it can be concluded that the new form does not resemble any species described in the genus so far. It is therefore proposed to accommodate it as a new species *Paramonostomum narabali*.

The present work is part of an unpublished doctoral dissertation submitted and approved by the University of Allahabad in 1974 for the award of D.Phil. degree. The same has been reviewed, emended and updated by incorporating the contributions of subsequent workers through their published records and original data on the Group/family/genus wherever necessary as on date. Certain details concerning bird nomenclature, habit/habitat is also added to the previous description.

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