A REVIEW OF THE GENUS *PARAMONOSTOMUM*, LÜHE; WITH DESCRIPTIONS OF TWO NEW SPECIES AND REMARKS ON THE GENERA OF THE SUB-FAMILY NOTOCOTYLINAE.

By Makund Behari Lal, M.Sc.
(From the Department of Zoology, Lucknow University.)

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Although good deal of work has been done on the trematode parasites of birds, there is, as will appear from the following pages and papers to be published subsequently, a certain amount of confusion in the morphology and nomenclature of the trematodes of this group of Vertebrates. I, therefore, undertook at the suggestion of Dr. G. S. Thapar, the study of some forms that were available from birds at and about Lucknow.

In my communications on the genus *Notocotylus*, I have laid emphasis on the importance of the position of genital pore in the generic diagnosis and as a result, the genus *Notocotylus* has been revised, with the consequent creation of two new genera—*Hindia* and *Naviformia*. The present communication reveals further the importance of this character in the diagnosis of genera in the sub-family Notocotylinæ and lends support to the view already expressed. Thus, while two new species of the genus *Paramonostomum* are being described, advantage is taken to review the hitherto known species of the genus *Paramonostomum* on the basis of this character. It is hoped that this may remove the existing confusion with regard to the forms described under the sub-family Notocotylinæ.

I may here express my indebtedness to Dr. G. S. Thapar for his guidance and valuable suggestions during the course of this work.

Genus *Paramonostomum*.

The genus *Paramonostomum* was erected by Lühe (1909) to include *Monostomum alveatum* (Mehlis) Creplin and is characterised mainly by the complete absence of the ventral glands that are present in other members of the sub-family Notocotylinæ. Barker (1916) questioned the validity of this genus created on the absence of the ventral glands, but it is strange to find that he accepts the genus *Catatropis* based mainly on the non-protrusibility of these glands. There appears to me a greater reason to accept a genus

formed on the absence of an organ than to accept one founded on its non-protrusibility. I, therefore, agree with Harrah and other workers in recognizing the genus *Paramonostomum* as valid. The following two new species are described under this genus :—

Paramonostomum querquedulum n.sp.

This trematode was obtained from the intestinal cæca of the Garganey, *Querquedula circia*. It measures 3·398 mm. in length and has a maximum width of 1·11 mm. in the middle region of the body behind the cirrus sac.

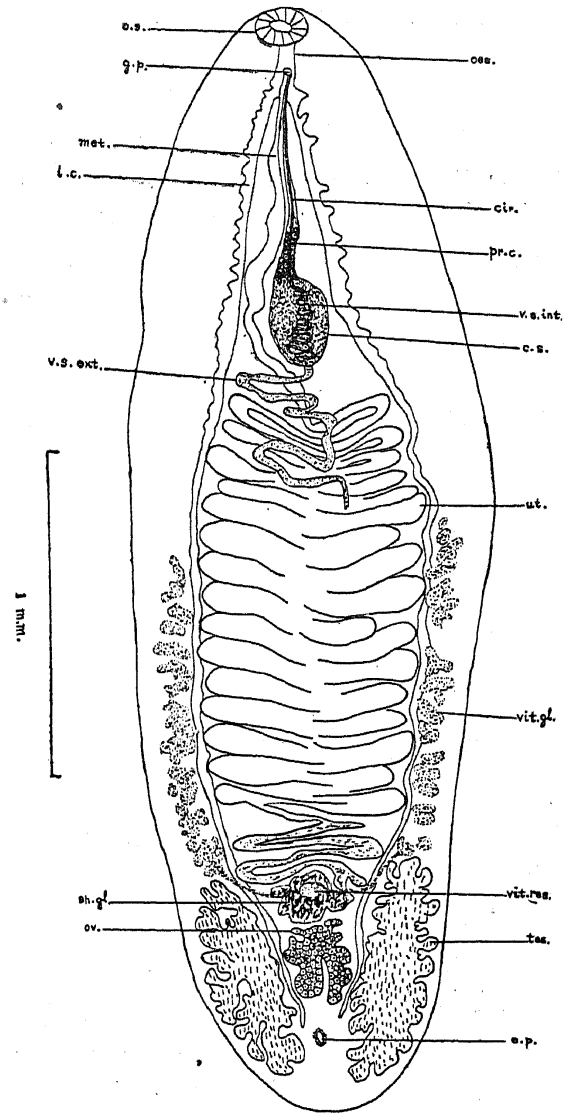

FIG. 1. *Paramonostomum querquedulum*, n.sp., showing the disposition of the internal organs.

The oral sucker is sub-ventral and measures ·17 mm. by ·12 mm. and is followed by an elongated œsophagus, ·165 mm. long. At its posterior end the œsophagus divides into two intestinal cæca which run upto the posterior end of the body. The intestinal cæca at their proximal end show slight irregular projections along their external border.

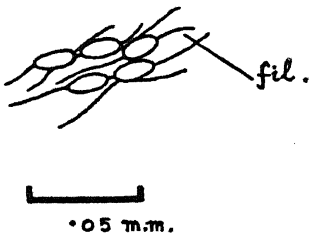

FIG. 2. *Paramonostomum querquedulum*, n. sp., eggs with filaments.

The excretory system is as usual, with an excretory pore at the posterior end of the body behind the ovary.

The testes are two in number, and extracæcal in position. Their outer margin is deeply lobed. The left testis is slightly larger than the right and measures ·74 mm. by ·235 mm. The right testis measures ·66 mm. by ·24 mm. The two vasa deferentia meet in the middle to form the vesicula seminalis consisting of a proximal portion (vesicula seminalis externa) and a distal portion enclosed within the cirrus sac (vesicula seminalis

interna). The cirrus sac is pear-shaped with long neck and measures ·93 mm. in length. It contains a long but feeble cirrus and a few prostatic gland-cells near the base of its neck.

The ovary which is more or less bifid posteriorly measures ·265 mm. by ·22 mm. The öotype is situated in front of the ovary and receives ducts from the vitelline glands. The shell-gland cells are present and surround the öotype and the vitelline reservoir. The vitelline glands consist of separate follicles mostly extracæcal, and occupy about the middle region of the animal. The two horizontal vitelline ducts of the two sides unite in the region of the öotype to give rise to the vitelline reservoir. The uterus arises from the left side of the öotype and runs forward forming transverse loops ending in the metraterm at its distal end. The metraterm runs parallel to the cirrus sac and opens with it at the genital pore which is situated midway between the oral sucker and the intestinal bifurcation. The uterus is full of thin-shelled eggs that are provided with a filament at their either end. They measure ·02 mm. by ·009 mm. without filaments.

This species is characterised thus :—

1. Monostomes without ventral glands.
2. Genital pore situated midway between the oral sucker and the intestinal fork.
3. The ovary bifid posteriorly and the uterus with transverse loops in the intercæcal region.
4. Vitellaria extend slightly beyond the middle of the body from the posterior end.
5. The intestinal cæca show slight lateral projections on their outer margin.

This species differs from the type species *Paramonostomum alveatum* and from the species *Paramonostomum pseudalveatum* in the proportion of length and breadth of the body, in the general topography of the organs, and specially in the deeply-lobed condition of the testes, the extent of vitellaria, and greater number of uterine loops. Hence it is designated as a new species.

Paramonostomum casarcum n.sp.

This trematode was obtained from the intestinal cæca of the Brahminy duck, *Casarca rutila* and appeared pink in fresh condition. It measures 3·8 mm. by ·95 mm. The body is quite flat with the anterior end narrower than the posterior.

The oral sucker, situated ventrally at the anterior end, measures ·14 mm. by ·1 mm. and is followed by œsophagus ·14 mm. long. The œsophagus divides into two intestinal cæca which run to the posterior end of the body.

The excretory pore lies midway between the ovary and the posterior end. It is a small slit-like aperture in the middle in between the last lobe of the testes.

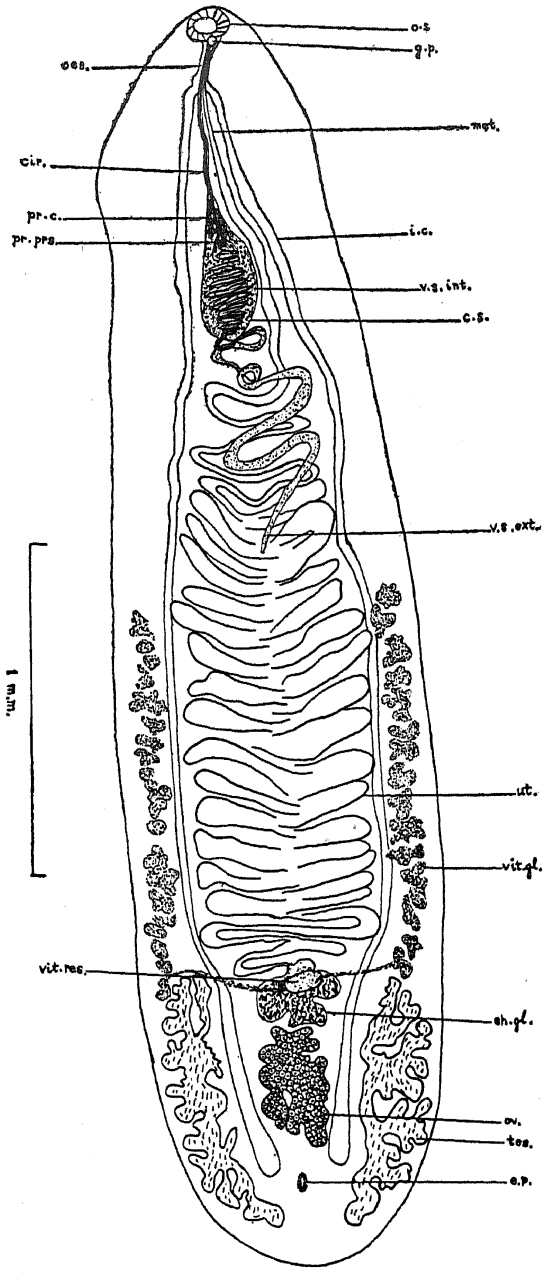

FIG. 3. *Paramonostomum casarcum*, n.sp., showing the disposition of the internal organs.

The testes are deeply lobed on their external margins. They are of different sizes—the right testis, measuring ·8 mm. by ·15 mm., is slightly longer than the left which measures ·76 mm. by ·175 mm. The vasa deferentia arising from the testes join together anteriorly to form the vesicula seminalis. The vesicula seminalis interna occupies the base of the cirrus sac which is tubular, wide at the base, and measures ·91 mm. in length. The genital aperture opens at the posterior border of the oral sucker. The cirrus is long and muscular. The pars prostatica and the prostatic cells are present.

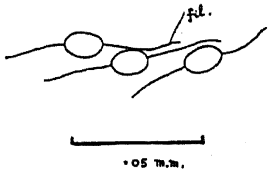

FIG. 4. *Paramonostomum casarcum*, n.sp., eggs with filaments.

The ovary is deeply lobed and measures ·38 mm. by ·22 mm. The ötotype is situated in front of it. The shell-glands consist of small gland-cells and occupy a large area in the region of the ötotype. The vitellaria are in the form of separate follicles placed in the usual position and extend from the anterior tip of the testes forward beyond the middle of the body. Their horizontal ducts meet in the region of the ötotype to form a vitelline reservoir, that opens into the ötotype. The uterus seems to arise from the right side of the anterior boundary of the ötotype. It runs forward forming loops and finally forms the metraterm which runs parallel to the cirrus sac and opens

along with the latter at the genital aperture. The eggs measure ·015 mm. by ·01 mm. without filament. Each egg is thin-shelled and provided with a filament at each pole.

To sum up, the characters of the species are :

1. Monostomes without ventral glands
2. Genital pore at the posterior border of the oral sucker.
3. Uterus with transverse loops in the intercæcal region in front of the öotype.
4. Vitelline glands extend beyond the middle of the body from the posterior end.

This species differs from *Paramonostomum alveatum* and *Paramonostomum pseudalveatum* in the deeply lobed condition of the testes, the extent of the vitellaria, and the greater number of the uterine loops ; from the allied species *Paramonostomum querquedulum* it differs in the forward position of the genital pore, in the proportionate width of the animal, and the size of the eggs. It is, therefore, described as a new species.

Discussion.

Besides the two new species of the genus *Paramonostomum* described above, eight other species have so far been described under this genus. They are :—

Paramonostomum alveatum (type species).
Paramonostomum pseudalveatum.
Paramonostomum ionorne.
Paramonostomum echinum.
Paramonostomum elongatum.
Paramonostomum parvum.
Paramonostomum microstomum.
Paramonostomum bucephale.

They can be arranged into two distinct groups as regards the position of their genital pore :

1. Genital pore in front of the intestinal fork.
   - *Paramonostomum alveatum.*
   - *Paramonostomum pseudalveatum.*

   (To this list are being added two new species described above, *viz.*, *Paramonostomum querquedulum* and *Paramonostomum casarcum.*)

2. Genital pore behind the intestinal fork.
   - *Paramonostomum ionorne.*
   - *Paramonostomum echinum.*
   - *Paramonostomum elongatum.*
   - *Paramonostomum parvum.*
   - *Paramonostomum microstomum.*
   - *Paramonostomum bucephale.*

The type species of the genus, *Paramonostomum alveatum*, has its genital pore in front of the intestinal fork. Evidently, therefore, only those species of the genus should be included under it that agree with the type species in general characters including the position of the genital pore. Other species have, evidently, been misplaced and their authors appear to have taken a great latitude in including them under this genus. The writer, therefore, suggests to split the genus *Paramonostomum* in the same way as he has done in *Notocotylus*. The so-called genus *Paramonostomum* is divided into two genera as follows :—

Genus *Paramonostomum* Sens. Str.

Type species—*Paramonostomum alveatum.*

Characters of the Genus.—Monostomes *without ventral glands* and a pharynx; intestinal cæca run almost upto the posterior end of the animal ; testes may or may not be lobed, extra-cæcal in the posterior part of the body ; part of the vesicula seminalis enclosed within the cirrus sac ; ovary in between the testes ; shell-glands pre-ovarial ; uterine loops mostly confined to the intercæcal region behind the cirrus sac ; receptaculum seminis absent ; *genital pore always opens in front of the intestinal fork and behind the oral sucker ; vitelline glands never end behind the midbody from the posterior end ;* eggs with filaments at either end.

Other species :—

Paramonostomum pseudalveatum.
Paramonostomum querquedulum.
Paramonostomum casarcum.

Key for the Identification of the Species of the Genus, Paramonostomum *Sens. Str.*

1. Uterine loops few, about 6-8 2
   Uterine loops always more than 15 .. 3
2. Vitellaria upto equator of body .. .. *P. alveatum.*
   Vitellaria upto $\frac{2}{3}$ of the body .. .. *P. pseudalveatum.*
3. Genital pore at the base of oral sucker, intestinal cæca show slight projections at their anterior end .. .. *P. querquedulum.*
   Genital pore much behind oral sucker, intestinal cæca show no such projections .. .. *P. casarcum.*

Genus *Neoparamonostomum* is created for those forms which have the genital pore behind the intestinal fork.

Type species—*Neoparamonostomum ionorne*
(Syn. *Paramonostomum ionorne* Travassos).

Characters of the Genus.—Monostomes *without ventral glands* and pharynx; intestinal cæca run almost upto the posterior end of the animal; testes extra-cæcal and posterior and generally lobed; part of the vesicula seminalis enclosed within the cirrus sac; ovary in between the testes; shell-glands pre-ovarial; uterine loops mostly confined behind the cirrus sac; receptaculum seminis absent; *receptaculum seminis uterinum may be present*; *genital pore always opens behind intestinal fork*; *vitelline glands end behind midbody from the posterior end*; eggs with filaments at either end.

Other species:—

Neoparamonostomum echinum (Syn. *Paramonostomum echinum*).
Neoparamonostomum parvum (Syn. *Paramonostomum parvum*).
Neoparamonostomum elongatum (Syn. *Paramonostomum elongatum*).
Neoparamonostomum microstomum (Syn. *Paramonostomum microstomum*).
Neoparamonostomum bucephale (Syn. *Paramonostomum bucephale*).

Key for the Identification of the Species of the Genus Neoparamonostomum.

1.	Length and breadth almost equal, size conspicuously small, about ½ mm. ..	*N. parvum.*
	Length several times the breadth	2
2.	Intestinal cæca present short internal and external diverticula	*N. echinum.*
	No such diverticula present	3
3.	Vitellaria upto level of base of cirrus sac ..	*N. ionorne.*
	Vitellaria never reach level of base of cirrus sac	4
4.	Vagina as long as cirrus sac	*N. microstomum.*
	Vagina shorter than cirrus sac	5
5.	Cirrus covered with tubercles	*N. bucephale.*
	Cirrus smooth, not covered with tubercles ..	*N. elongatum.*

Characters of other genera of the sub-family Notocotylinæ.

Genus *Notocotylus* Sens. Str.*—*Monostomes with two to five rows of protrusible ventral glands*; pharynx absent; testes extra-cæcal and posterior; ovary in between testes; shell-glands pre-ovarial; uterine loops confined to the inter-cæcal region behind the cirrus sac; receptaculum seminis absent; part of the vesicula seminalis enclosed within the cirrus sac; *cirrus sac never extending beyond half of body length; vagina about ⅓ to as long as cirrus sac; genital pore situated behind the intestinal bifurcation*; *vitelline glands extend upto the middle of the body*; eggs ·018–·022 mm. long with filaments at either end. Type species—*Notocotylus attenuatus.*

* For the identification keys of this genus, refer to Lal, M. B., *Proc. Ind. Acad. Sci.*, 1935, Vol. 2, No. 5.

Genus *Hindia*.*—Monostomes *with three rows of protrusible ventral glands;* pharynx absent ; testes extra-cæcal and posterior ; ovary in between testes ; shell-glands pre-ovarial ; uterine loops lie in the inter-cæcal region behind the cirrus sac ; receptaculum seminis absent ; part of the vesicula seminalis enclosed within the cirrus sac ; *cirrus sac extending about* $\frac{1}{4}$ *to* $\frac{1}{2}$ *body length ; vagina never more than* $\frac{3}{4}$ *of the cirrus sac ; genital pore at the intestinal fork ; vitelline glands extend* $\frac{1}{3}$ *to* $\frac{1}{2}$ *of the body length from the posterior end ;* eggs ·014–·0209 mm. long, with filaments at either end.

Type species—*Hindia gibbus.*

Genus *Naviformia.*—Monostomes *with three rows of protrusible ventral glands ;* pharynx absent ; testes extra-cæcal and posterior ; ovary in between the testes ; shell-glands pre-ovarial ; uterine coils lie in the inter-cæcal region behind the cirrus sac ; receptaculum seminis absent ; part of the vesicula seminalis is enclosed within the cirrus sac ; *cirrus sac extending about* $\frac{1}{3}$ *of the body length ; vagina* $\frac{4}{5}$ *of the cirrus sac ; genital pore in front of the intestinal fork ; vitelline glands behind midbody ;* eggs ·0178–·0208 mm. long, with filaments at either end.

Type species—*Naviformia naviformes.*

Only one species described under this genus.

Genus *Catatropis.—Monostomes with three rows of weakly developed non-protrusible ventral glands ; the middle row of ventral glands may be placed on a median keel or a ridge ;* pharynx absent ; testes extra-cæcal and posterior ; ovary inter-testicular ; shell-glands pre-ovarial ; vesicula seminalis is divisible into an external and an internal portion ; receptaculum seminis absent ; *vagina is very much developed, about as long as cirrus sac ; genital pore situated behind the intestinal fork ;* eggs with filaments at either pole.

Type species—*Catatropis verrucosa.*

Key for the Identification of the Genera of the Sub-Family Notocotylinæ :

1.	Ventral glands present	.. ..	2
	Ventral glands absent	.. ..	3
2.	Ventral glands protrusible	.. ..	4
	Ventral glands non-protrusible	.. ..	*Catatropis.*
3.	Genital pore between oral sucker and intestinal fork	.. ..	*Paramonostomum.*
	Genital pore behind intestinal fork	..	*Neoparamonostomum* n.g.

* For the identification keys of this genus, refer to Lal, M. B., *Proc. Ind. Acad. Sci.*, 1935, Vol. 2, No. 5.

4. Genital pore behind intestinal fork .. *Notocotylus.*
Genital pore at the intestinal fork .. *Hindia.*
Genital pore in front of intestinal fork .. *Naviformia.*

LIST OF ABBREVIATIONS USED IN THE FIGURES.

cir.	.. Cirrus.	*pr.c.*	.. Prostatic cells.
c.s.	.. Cirrus sac.	*pr. prs.*	.. Pars prostatica.
e.p.	.. Excretory pore.	*sh. gl.*	.. Shell-glands.
fil.	.. Filament of egg.	*tes.*	.. Testis.
g.p.	.. Genital pore.	*ut.*	.. Uterus.
i.c.	.. Intestinal cæca.	*v.s. ext.*	.. Vesicula seminalis externa.
met.	.. Metraterm.	*v.s. int.*	.. Vesicula seminalis interna.
o.s.	.. Oral sucker.	*vit. gl.*	.. Vitelline glands.
oes.	.. Oesophagus.	*vit. res.*	.. Vitelline reservoir.
ov.	.. Ovary.		

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