ON STRIGEIDA (TREMATODA) FROM INDIA[1].

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A fairly large number of " Holostomes " have been recorded from this country, mainly as a result of the researches of Verma (1936) and Vidyarthi (1937-38). Unfortunately in a large majority of cases the descriptions given are far from satisfactory and the taxonomic positions of the parasites concerned erroneously determined. This is probably due to the difficult nature of the group and to the fact that the relevant literature is scattered and is inaccessible to the average Indian worker. Recently (1938), however, Dubois has brought out a very comprehensive monograph on this group of parasites. In the present monograph it is intended to offer criticism in regard to the shortcomings of the descriptions and the wrong interpretations of structure. Wherever possible an attempt has been made to assign the proper systematic position to the species which, in the opinion of the writer or other workers, were wrongly classified. Some time ago the writer endeavoured to obtain specimens from other workers but met with little success. The object of the present communication is to stimulate workers in this country to re-examine their old specimens with a view to providing the missing links in their description and to interpreting correctly the different structures. This will facilitate the work of the taxonomist and will, it is hoped, largely remove the existing confusion in this complicated group of parasites. It may be remarked here that *Cleistogamia holothuriana* Faust, 1924 has been shown to be a Rhadocoele Turbellarian of the family Umagillidae by Baer (1938).

1. *Apharyngostrigea egretii.*—Verma (1936*a*) gave a very brief account of this parasite from the intestine of a Cattle Egret shot near Patna. No figure is given.

2. *A. ardeolina.*—Vidyarthi (1937 *d*) described this species from the intestine of the Eastern Grey Heron shot near Pholpore, Allahabad.

3. A. *indiana.*—Vidyarthi (1937 *d*) described this species from the intestine of *Egretta alba* at Allahabad. The measurements of the eggs appear to have been ten times exaggerated.

4. *A. simplex.*—This has been recorded from the intestine of a Night Heron shot at Allahabad. It was originally described as *Holostomum simplex* by S. J. Johnston (1904) from a heron in Australia and was later assigned to the genus *Strigea* by Mathias (1925). Szidat placed it under *Apharyngostrigea* in 1929. Only a very meagre account of this parasite is available. In the original description, the pharynx is stated to be much smaller than the suckers but there is no indication of this organ in the figures. It is noteworthy that the genus is characterised by the absence of a pharynx.

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5. *Ophiosoma macrocephalum.*—Verma (1936 *a*) obtained this species from the intestine of a Hawk Cuckoo in Allahabad and gave a very brief description.

6. *O. microcephalum.*—This species was originally described by Szidat (1928) from the intestine of *Buteo magnirostris* and *Circus cyaneus* in Brazil. Verma (1936 *a*) claims to have obtained this species from the intestine of herons in Allahabad. He has published neither a description nor a figure of the parasite.

7. *Ridgeworthia rami.*—This species, assigned to a new genus and obtained from the intestine of a Night Heron in Allahabad, was described by Verma (1936 *a*). The genus like *Pulvinifer* Yamaguti possesses mascular patches at the lateral corners of the fore-body. The hold-fast organ is a peculiar muscular ridge bent upon itself.

8. *Strigea annandalei.*—Faust (1927) described this metacercarial from encysted in the subcutaneous tissue and muscles of the small loach, *Nemachilus rupicola*, obtained in the hill streams in Kashmir. He assigned this form to the genus *Strigea* though its position in this genus would appear to be improbable on account of the presence of a long neck region; moreover the hold-fast organ is stated to be absent in the metacercaria. Presumably the structure is labelled in figure 7 pl. XVIII as the hold-fast organ in error. In his description of the parasite, he refers to a canal which he designates " cirrus sac " In reality this tubular portion of the male genital duct should be called ductus ejaculatorius, since the whole of the superfamily Strigeides is characterised by the absence of a cirrus sac. Faust remarks: " This latter organ (Vesicula seminalis) opens into a canal (the cirrus sac), which empties along with the uterus into the genital atrium " This statement gives the impression that the ductus ejaculatorius (cirrus sac of Faust) and the uterus open into the genital atrium separately. As a matter of fact, the ductus ejaculatorius unites with the terminal portion of the uterus to form an hermaphroditic duct which opens into the genital atrium. This is evidenced in Faust's figure but his description is incorrect.

9. *S. elongata* var. *indica.*—This variety was obtained by Verma (1936 *a*) from the intestine of the Black-headed Oriole in Calcutta. The variety differs from the species *Strigea elongata* Yamaguti, 1935 in that the host is different, as are also the dimensions of the body, while the anterior testis is larger. It would appear that the incorrect dimensions of the eggs are the fault of the printer.

10. *S. falconis* Szidat, 1928.—Gogate (1940*b*) gave a very meagre description of the parasite. He does not make any mention of the adhesive gland and the details of the genitalia are insufficient.

11. *S. falconis* var. *eaglesa.*—Verma (1936 *a*) has recorded this variety from the intestine of the Indian Fishing Eagle in Bihar. The variety is stated to differ from the species *Strigea falconis* Szidat, 1928, in the dimensions of the body and of the internal organs.

12. *S. globocephala.*—Verma (1936 *a*) described this species from the intestine of the Crested Serpent Eagle in Bihar. The species is stated to have a close affinity with *S. elongata* and *S. falconis* but to differ from both of them in the more forward position of the ovary and testes.

13. *S. orientalis.*—Vidyarthi (1937 *d*) described this species from the small intestine of a King Vulture shot in the suburbs of Allahabad.

14. *S. nephronis.*—Vidyarthi (1937 *d*) described this species from the intestine of the Scavenger Vulture.

15. *S. streptocorpus.*—Verma (1936 *a*) described this species from the intestine of the Fishing Eagle in Bengal. The species was originally assigned to the genus *Cotylurus* but, as the vitellaria extend into the fore-body, Dubois (1938) transferred it to *Strigea.* The writer is in entire agreement with this. Verma gives a very brief account of this parasite.

16. *Apatemon sarcogyponis.*—Vidyarthi (1937 *b*) described this species from the intestine of *Sarcogyps calvus* in Allahabad and assigned it to the genus *Pseudostrigea* Yamaguti, 1933. In order to accommodate his species in the genus, he modified the definition of the genus *Pseudostrigea.* Dubois (1938, p. 491) remarks that the emended diagnosis of *Pseudostrigea* does not differ in any way from that of *Apatemon* Szidat, 1928. The degree of development in the musculture of the bursa copulatrix is not considered by him to be a character of generic importance. Vidyarthi describes the presence of " two prominent suctorial pockets, one on each side of the oral sucker " Yamaguti (1933), in describing the genotype, remarks ; " At the anterior end of the body there is a prominent sucker and a broad notch on either side of it. Immediately behind these notches there are conspicuous lateral depressions similar in structure as in all the members of the subfamily Strigeini " It would appear from the above remarks that Dubois is definitely in favour of assigning this species to *Apatemon* and the writer is in complete agreement with this view.

17 *A. casarcus.*—Vidyarthi (1937 *b*) described this species from the intestine of *Casarca ferrunginea* in Allahabad.

18. *A. indicus.*—Vidyarthi (1937 *b*) described this species from the intestine of *Casarca ferrunginea* in Allahabad.

19. *A. pandubi.*—Recently Pande (1939) described this species from the intestine of the Indian Darter or Snake-bird from Allahabad.

20. *Cotylurus orientalis.*—Vidyarthi (1937 *b*) described this species from the intestine of the common Teal in Allahabad. He claims to have seen a receptaculum seminis in this species, although the whole of Strigeida is characterised by its absence. He also describes a genital cone. The genus *Cotylurus* does not possess this structure. It would, therefore, appear that Vidyarthi failed to interpret correctly the various parts of the genitalia of this parasite. In this genus the protrusion of the genital pore is caused by the protraction of the anterior and dorsal wall of the bursa. This was probably mistaken by Vidyarthi for the genital cone. In regard to the receptaculum seminis, this structure does not exist at all.

21. *Diplostomum ketupanensis.*—Vidyarthi (1937 *c*) described this species from the intestine of the Northern Brown Fishing Owl in Lucknow. He mentions a small genital cone but presumably this is a mistake ; as the genus is characterised by the absence of this structure.

22. *D. buteii.*—Vidyarthi (1937 *c*) described this species from the intestine of *Buteo rufinus rufinus* in Lucknow.

23. *D. thaparia.*—Lal (1939) described this species from the intestine of a King Vulture in Lucknow and assigned it to his new genus *Neolaria.* He tried to separate this genus from *Alaria* and *Pralaria* thus indicating that it belongs to Alariinae. The location of the vitellaria, however, is against this decision. The fact that in this species the vitellaria are present in both segments of the body and are well distributed, places it in the subfamily Diplostomini. In this group it approaches most nearly to the genus *Diplostomum.* Amongst other peculiarities of the species, Lal emphasises the instinct division of the fore- and the hind-body, the trough-shaped hold-fast organ and the peculiarly dumbbell-shaped tests. In many species of *Diplostomum* the body is somewhat indistinctly divided into two regions. In many the tests are bi-lobed. The hold-fast organ in some species has a tendency to recurve anteriorly or posteriorly. Probably this recurving was much pronounced in Lal's species. The bursa is simple in all the members of the genus *Diplostomum.* From all these considerations, it must unmistakably belong to the genus *Diplostomum.*

24-27.—Verma (1936 *a*) mentions four forms obtained respectively from a Duck and a Sea Eagle in Calcutta and an Osprey and a Vulture in Allahabad. All these, according to Verma, are referable to *Diplostomum* (syn. *Proalaria*). He gives no description of these parasites and withholds his final decision about them.

28. "*Proalaria alcedensis*".—This parasite has been recorded by Patwardhan (1935) from the intestine of the King Fisher in Nagpur and by Verma (1936 *a*) from the intestine of the Pied King Fisher in Allahabad. In the first instance it should be noted that *Proalaria* is a synonym of *Diplostomum.* This species cannot, however, be included in this genus since the vitelline follicles are confined to the posterior segment of the body. Dubois (1938) doubts the presence of pseudo-suckers in the species. In the figure they are not represented as definite organs and it is possible that their supposed presence may have been more apparent than real. The terminal parts of the genital ducts are not described.

29. *Neodiplostomum kashmirianum.*—Faust (1927) described an encysted form from the skin nodules of *Schizothorax curvifrons, S. niger* and *Crossochilus latea* in Kashmir. As in the previous case, namely, that of *Strigea annandalei,* the bursa copulatrix is mistaken for the "cirrus-pouch".

30. *N. cochleare* var. *calaophilum* Dubois, 1938.—Originally Verma (1936 *a*) described briefly specimens from the Horn-bill in Calcutta as the species *N. cochleare* but Dubois (1938) created a new variety for it as it appears in a different host and as the eggs are much larger.

31. *N cuckooai.*—Verma (1936 *a*) originally described this species from a cuckoo in Allahabad and assigned it to his newly created genus *Procrassiphiala* but as the host is of a different order (not Charadrii) and as the posterior portion of the body is smaller than the anterior Dubois (1938) places it in the genus *Neodiplostomum.* He considers that the species approaches *N. ellipticum* (Brandes, 1888) and this would appear to be very probable. Verma gives an extremely brief account of this parasite.

32. *N. dilacaecum.*—Lal (1939) describes this species from the intestine of *Athene brama* in Lucknow. Unfortunately he does not describe the bursa copulatrix.

33. "*N. gavialis*".—Narain (1930) originally described this species from the intestine of *Gavialis gangeticus* in Allahabad. Vidyarthi (1937 *a*) assigned it to the genus *Crocodilicola*. Dubois (1938), however, does not agree with Vidyarthi, as in this species the genital system, with the various genital ducts, is not described in sufficient detail to make it possible to assign it to any genus of Strigeida. He, therefore, prefers to retain the original nomenclature placed in inverted commas.

34. *N. globiferum.*—Verma (1936 *a*) described this species from the intestine of a cuckoo in Allahabad. The terminal portions of the genital ducts and the bursa copulatrix are not properly described.

35. *N. gumbudia.*—Gogate (1940 *b*) described very briefly an immature specimen of this species from the intestine of a common Kite in Pilibhit.

36. *N. laruei.*—Vidyarthi (1938 *a*) described this species from the intestine of *Sarcogyps calvus* in Allahabad. In this species, also, the bursa copulatrix and the genital ducts are inadequately described.

37 *N mehranium.*—Vidyarthi (1938 *a*) described this species from the intestine of *Haliaetus leucoryphus* in Allahabad. The bursa copulatrix and the terminal portions of the genital ducts are not described.

38. *N mehrii.*—This species was originally described as *Neodiplostomides mehrii* by Vidyarthi (1938 *a*) from the intestine of a Bonell's Eagle in Allahabad. Dubois (1938) remarks that the genus *Neodiplostomoides* differs from *Neodiplostomum* by the (?) presence of a genital bulb and the form of the testes. He doubts whether a genital bulb really did exist in the specimen described by Vidyarthi : the posterior extremity of the body was very much deformed and, moreover, the form of the testes is considered by him to be of secondary importance. The species is, therefore, here assigned to the well-established genus *Neodiplostomum.*

39. *N orientalis.*—Vidyarthi (1938 *b*) originally described this species from the intestine of *Buteo rufinus rufinus* in Allahabad and assigned it to the genus *Bolbophorus.* Vidyarthi describes the presence of pseodosuckers in this species but the correctness of this is very much open to question. Dubois (1938) remarks that, taking into account the host, the pointed cephalic extremity and the structure of the bursa copulatrix it is doubtful whether this species can really be assigned to the genus *Bolbophorus.* It appears to be a member of the genus *Neodiplostomum.*

40. *Neodiplostomum* sp.—This form, insufficiently described, was reported by Lal (1939) from the intestine of the Blue Jay in Lucknow.

41. *N. tytense.*—This form was originally described by Patwardhan (1935) from the intestine of *Tyto alba stertens* in Nagpur. Verma (1936 *a*) recorded it from the Osprey and the common vulture in Allahabad. The bursa copulatrix and the terminal portions of the genital ducts are not described by Patwardhan. Verma obtained from a kestrel in Allahabad somewhat similar forms which were shorter than *N. tytense.* The forms from the kestrel were 1·85-2·05 mm. long and in them the fore- and the hind-body were in the proportion of 1 : 1·1, and the vitellaria

extended more anteriorly than in *N. tytense.* Verma reserves his final opinion on these, remarking that they may be a different species.

42. *N. bagulum.*—Lal (1939) described this species from the intestine of the Eastern Grey Heron in Lucknow. He assigned this species to the genus *Pharyngostomum* of the subfamily Alariinae. The members of this subfamily are parasites of mammals and very rarely of birds; moreover, in this subfamily the vitelline follicles are confined to the anterior segment of the body. This species, having an avian host and the vitelline follicles distributed in both segments of the body, can be assigned to the subfamily Diplostominae and the subfamily Diplostomini Dubois, 1931. In this subfamily it can easily be assigned to the genus *Neodiplostomum* on account of the absence of pseudo-suckers, the body being distinctly bisegmented, the bursa copulatrix being very small and non-evaginate, the oral sucker being elliptical and the anterior segment of the body being longer than the posterior. The only thing puzzling about this parasite is that the anterior testis is larger than the posterior and the former is bilobed while the latter is more or less pear-shaped. This is rather an exceptional feature, the reverse being the rule amongst this group of parasites. As a matter of fact, no known member of *Neodiplostomum* possesses the testicular character described by Lal. It is, therefore, probable that Lal has incorrectly interpreted the testicular structures. The two obliquely situated large lobes appear to be parts of the posterior testis and the asymmetrical smaller lobe on the left side appears to be the anterior testis. With this rectification in the interpretation of the testicular structures, the species described by Lal can be assigned to the genus *Neodiplostomum.*

43. *Allodiplostomum hindustani.*—Verma (1936 *a*) described this species from the intestines of the Indian Red-wattled Lapwing in Allahabad. He has given a short description and the measurements of the pharynx, the anterior testis and the ovary appear to be erroneous.

44. *Procrassiphiala triticum.*—Verma (1936 *a*) described this species from the intestine of the Red-wattled Lapwing in Allahabad and assigned it to his newly created genus *Procrassiphila.* He defined this genus very briefly and, as remarked by Dubois (1938), there do not exist outstanding anatomical differences between this genus and *Neodiplostomum* Railliet, 1919. Dubois has, however, accepted this genus on the grounds that the fore-body is broader than the hind-body and that the latter is much longer than the former.

45. *P. halcyonae.*—Gogate (1940 *a*) described this species from the intestine of *Halcyon smyrnensis* in Rangoon.

46. *Glossodiplostomoides* gen. nov.—Vidyarthi (1938 *b*) described *Glossodiplostomum hieraetii* and *G. buteoides* from the intestine of *Hieraetus fasciatus* and *Buteo rufinus* respectively in Allahabad. Dubois (1938) considers that the latter species is a synonym of the former and he appears justified in holding this opinion. Except for minor differences both species seem to be identical. The question now arises whether Vidyarthi is justified in assigning these species to *Glossodiplostomum* as Dubois suspects. This genus is up to the present moment represented by the single species *G. glossoides* (Dubois, 1928) Dubois, 1932. A comparison of this species with *G. hieraetii* (syn. *G. buteoides*) indicates that the latter

species differs from the former in many important respects, *viz.*, (1) a marked difference between the fore- and the hind-body, the hind-body being at least twice as long as the fore-body, (2) a larger hold-fast organ and (3) the occupation of more body space by the genital organs. These points of difference being very significant, it is proposed to create a new genus for its reception for which the name *Glossodiplostomoides* is suggested. The new genus is defined as follows :—

Diplostomini : Body somewhat indistinctly bisegmented : constriction being absent. Fore- and hind-body distinct. Anterior end bearing oral sucker conical. Maximum breadth in the region of the hold-fast organ. Cuticle smooth. Fore-body spoon-shaped. Hind-body cylindrical, more than twice the length of fore-body. Pseudo-suckers present. Hold-fast organ spherical, one-eighth to one-fourth of the total body length. Genital pore subterminal. Genital organs occupying half the total length of the body. Testes transversely oval, tandem or slightly oblique. Ovary anterior to testes. Vitellaria arranged in two lateral bands. Eggs few, operculate.

Type species.—G. heiraetii (Vidyarthi, 1938) Bhalerao, 1942.

47. *Posthodiplostomum botauri.*—Vidyarthi (1938 *a*) described this species from the intestine of *Botauras stellaris* in Allahabad. He does not make any mention of the hermaphroditic duct. It is not stated whether the bursa copulatrix is eversible, this being one of the important generic characters.

48. *P. grayii.*—Verma (1936*a*) described this species from the intestine of the Pond Heron assigning it to the genus *Proalaria*, which is a synonym of *Diplostomum*. Dubois (1938), however, assigns it to *Posthodiplostomum*, mainly on account of the eversible nature of the bursa, the terminal genital pore, the limited anterior and posterior extent of the vitelline follicles, the presence of the acetabulum in the posterior half of the fore-body, the form and situation of the genital glands and the adaptation to Ardeidae. He doubts the presence of an accessary pit, with hair-like cilia projecting outwards, on margin of fore-body a short distance behind oral sucker " This is evidently a pseudo-sucker but the genus *Posthodiplostomum* is devoid of this structure. Should this prove to be correct, the forms described by Verma will have to be placed in a new genus.

49. *Uvulifer ceryliformis.*—Vidyarthi (1938 *a*) described this species from the intestine of *Ceryle radis leucomalanara* in Allahabad and assigned it to the genus *Crassiphiala*. It does not, however, fit exactly into this genus since its hold-fast organ is much smaller and does not extend anteriorly as far as the pharynx. It has closer affinity with the genus *Uvulifer* Yamaguti, 1934 from which it differs only in the absence of the ventral sucker. In this respect it agrees with *Crassiphiala*, but the nature of the hold-fast organ has more taxonomic importance than the absence or presence of the acetabulum. For this reason it is assigned to the genus *Uvulifer*.

50. *U. stunkardi.*—Pande (1938) described this species from the intestine of *Halcyon smyrensis fusca* in Allahabad and assigned it to the genus *Crassiphiala*. This species does not satisfy all the requirements

of the genus *Crassiphiala* : the acetabulum being much smaller than normal. It, however, agrees in all respects with the genus *Uvulifer*.

51. *Pseudodiplostomum cochlearis*.—Verma (1936 *a*) gave a brief account of this species from the intestine of the King Fisher in Allahabad. As remarked by Dubois (1938), this species having a smaller ventral sucker has affinity with the genus *Uvulifer*. As against this it is supposed to have no genital bulb. This character precludes one from assigning it to *Uvulifer*. This structure being more important than the comparative sizes of the two suckers, the writer agrees with Dubois in keeping it tentatively in the genus *Pseudodiplostomum*.

52. *P. fraterni*.—Verma (1936 *a*) described very briefly this species from the intestine of *Ceryle radis* in Allahabad.

53. *Alaria robusta*.—Verma (1936 *a*) described this species from the intestine of the King Vulture in Allahabad. This is the only species of the genus recorded from a bird. The infection is very probably accidential. Normally *Alaria* is found in Mammalian hosts.

54. *A. alata*.—Maplestone and Bhaduri (1940) recorded this species from a dog in Calcutta. The joint authors do not mention the organ of infection but it has been known to occur in the stomach, duodenum, small and large intestines, rectum and hepatic canals of the host.

55. *Travassosstomum tropidonotis*.—This species, obtained from the intestine of *Natrix piscator*, was described by Vidyarthi (1937 *a*) under the name *Proalarioides tropidonotis*. Simultaneously with this a paper by the present writer giving an account of the same parasite was in the press at Rio de Janeiro in connection with the Jubilee Volume published in 1938 in honour of Prof. Travassos. Since the paper of Vidyarthi appeared some months before the publication of the Jubilee Volume, the specific name proposed by Vidyarthi has priority. Vidyarthi, being unable to interpret correctly many anatomical features of the parasite, assigned the species to the genus *Proalarioides* Yamaguti, but the correctness of this was very much doubted by Dubois (1938). The writer (Bhalerao, 1938) assigned it to the new genus *Travassosstomum* which differs in many respect from *Proalarioides*. The writer has, moreover, given a fuller account of this parasite and suggested the inclusion of the genera *Travassosstomum* and *Proalarioides* in the new subfamily Travassosstominae. He has also pointed out the impropriety of including *Prolarioides* in Ophiodiplostominae as was proposed by Dubois (1936). The writer's material was obtained in Nagpur while that of Vidyarthi was collected at Allahabad.

56. Verma (1936 *b*) records his having obtained some specimens from the Black-necked Stork resembling the species *Holostomum serpens* which is a synonym of *Nematostrigea serpens* (Nitzsch, 1819) Sandground, 1934. The author has not studied these specimens fully and for this reason it is not possible to state whether the specimens belong to one of the already known species or to a new one, and the decision must wait further study.

57 *Cyathocotyle calvusi*.—This species obtained from the intestine of the king vulture (*Sarcogyps calvus*) in Allahabad was briefly described by Verma (1936 *b*). He does not make any mention of the ventral sucker nor does he show it in the figure. This structure is therefore

presumably absent in this species. As remarked by Dubois (1938), the elongated nature of the testes appears to have been the effect of the similar disposition of the parasite.

58. *Gogatea serpentium.*—Gogate (1932) described this species from the intestine of *Natrix piscator* in Rangoon and assigned it incorrectly to the genus *Prohemistomum.* Lutz (1935) created the new genus *Gogatea* for its reception. Dubois (1938), who examined two specimens of this species, remarks that he has not seen the median cleft of the holdfast organ described by Gogate as a " narrow central depression."

59. *Mesostephanus burmanicus.*—Chatterji (1940) described this species from the intestine of *Enhydris enhydris*, a snake in Burma. The previous members of this genus have been recorded either from mammals or birds. The discovery of a species of this genus in a reptilian host disproves the rigid views of host specificity held by Dubois. The dimensions of the caudal appendage and ventral sucker published by Chatterji appear to be wrong in some respects. Although the author has separated this species from *M. appendiculatoides* (Price, 1934) there do not seem to be clear-cut differences between the two species. Examination of some more material might prove that the two species are identical.

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