TREMATODE PARASITES OF PIGS IN BENGAL.

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Contents.

Through the courtesy of Dr. P. A. Maplestone the opportunity was afforded to me to examine the material dealt with in this paper. The material was collected from the same forty-nine pigs the nematodes from which have already been described by Maplestone (1930). The intensity of infection by the different flukes is indicated in Table I.

Table I.

Trematode.	Intensity of infection.
Paryphostomum surfrartyfex	33 per cent.
Opisthorchis noverca lobata	5 „ „
Opisthorchis noverca orbiculata	5 „ „
Fasciolopsis buski	7 „ „
Gastrodiscoides hominis	55 „ „

Paryphostomum surfrartyfex (Lane, 1915).

Artyfechinostomum surfrartyfex, Lane, 1915.
Euparyphium surfrartyfex, Baylis, 1929.
Echinostoma surfrartyfex, Faust, 1929.

Lane (1915) described this parasite under the name *Artyfechinostomum surfrartyfex*, the material being obtained from a girl in Assam who was treated with an anthelmintic. The identity and the taxonomy of this parasite have baffled many workers in the past, including veteran helminthologists like Odhner and Leiper. This was primarily due to the fact that the criticism levelled against Lane was not based on actual observation of the material. Faust (1929) was the only author who published his observations and criticism after examining the co-type material deposited in the Indian Museum, Calcutta.

The abundant material obtained from about sixteen pigs at Calcutta was found on examination to be specifically identical with that obtained

by Lane from a girl in Assam. The present opportunity is, therefore, utilised to revise the description of the parasite and to attempt to settle the existing controversy in regard to its taxonomy.

Lane (1915) had remarked that the rarity of infection in man by this parasite was due to the fact that its normal host was some animal other than man. The occurrence of this parasite in pigs has fully justified Lane's remarks. With regard to *E. malayanum*, Leiper had suggested that the normal hosts of the parasites in the Malay States might be dogs or cats, but the fact that an allied species is normally a parasite of pigs in India points to the probability of the same ungulate being its normal host in Malaya also.

Description.—The shape of the body is very variable. In young forms and in some of the adults the body has parallel sides, the anterior end being tapering and the posterior rounded. Some are broadest at the posterior end, which is notched in the centre in some cases, while in others this notch may be absent. Some have an elliptical shape, and some are broadest near the anterior end in the region of the ventral sucker. As noticed by Faust (1929, p. 182, fig. 86) some examples show a constriction in the region of the ventral sucker and in some cases, on account of this constriction, somewhat indistinct shoulders are produced. A few are broadest at some distance from the posterior end as figured by Faust. Lane states that the anterior end is bent ventrally and is convex dorsally. This condition is not a normal one, but is brought about, in the majority of cases, by the action of preservatives. The different shapes of the body described above may also have been a result of the action of the preservative. The whole of the ventral surface and the anterior part of the dorsal surface is covered with spines, which are very broad at the bases and appear to be like scales.

The worms measure 4·2—10·7[1] in length and 1·2—2·9 in breadth. The mouth is subterminal. It is surrounded by a somewhat oval oral sucker measuring 0·15—0·37 × 0·13—0·15. This sucker is surrounded by a kidney-shaped collar which is continuous dorsally and open ventrally. The ventral opening of the collar is not bridged over by an isthmus of musculature. The collar has 39—42 spines on it, disposed in a dorsally unbroken single row. The number of spines on the collar is subject to much variation, this being due to the fact that some spines are often lost. In one specimen only could I count the maximum number, 42. In rare cases it was difficult to make out any spines on the collar. In regard to the disposition of these spines on the collar, which has been so much emphasised in the taxonomy of this group of flukes, a few remarks based on the observations of several specimens are necessary. Lane (1915) gave two figures of the arrangement of the collar spines. In one (fig. 3) they apear to be disposed in a single irregular line and in the other (fig. 2) their arrangement appears to be in two distinct rows. Faust (1929) also gave a figure (fig. 86 A) of the arrangement of these collar spines, from which they appear to be disposed in a single irregular row. In one comparatively young form that I examined, the collar spines were arranged in a single regular row. This variation in the

[1] All measurements in millimeters.

arrangement of collar spines was also observed in a species of *Paryphostomum* described by me elsewhere. It is evident from the above that the disposition of the collar spines is not a good criterion for distinguishing one genus from the other, and, in my opinion, it should not be used even as a specific distinction, governed as it is by the influence of the fixatives and the consequent contractions induced by them. One fact, however, which appears to be constant in this species is that one of the collar spines on each side on the ventral surface is much larger than the others and measures 0·066×0·027, while the other spines on the collar measure approximately 0·05×0·017 Behind the oral sucker there is a short pre-pharynx. The pharynx is, as usual, globular and muscular and measures 0·18—0·35 in diameter. The oesophagus is fairly short and measures in larger specimens about 0·31 in length. The intestinal caeca are simple and pass along the sides to the posterior end of the body, ending 0·26—0·38 from the posterior end. The " faint sacculations" at the posterior ends of the caeca referred to by Lane are not a constant feature, but are brought about by the action of the preservatives. The ventral sucker is a very large and prominent structure and is drawn out posteriorly. It measures 0·5—1·33×0·48—1·0 and is situated at about one-fourth the length of the body from the anterior end.

The nerve band is situated immediately posterior to the oral sucker.

The excretory bladder is Y-shaped and the excretory pore is situated slightly in front of the posterior end on the ventral surface.

The testes are deeply-lobed bodies, lying one behind the other, usually in the posterior half of the body, but occasionally a portion of the anterior testis may lie in the anterior half. The anterior testis measures from 0·49×0·53 to 1·6×1·91 and the posterior one from 0·54×0·43 to 1·77 ×1·76. In adult specimens the difference between the dimensions of the anterior and posterior testis is not so much marked, but in comparatively young forms the anterior one appears to be distinctly larger. The vasa efferentia pass anteriorly from the testes between the uterine coils and the intestinal caeca and meet together slightly posterior to the cirrus sac. This latter is a very long structure measuring 0·85—1·88 in length and extending 0·23—0·38 behind the ventral sucker. It contains at its posterior end a tubular vesicula seminalis measuring in a large form about 1·36 in length ; this is followed by a pars prostatica measuring 0·33 long. The cirrus is a long structure and remains coiled inside the cirrus sac. Not unusually it is everted, when it measures 5—6·3 in length. Special efforts were made to detect the presence of spines on the cirrus, but no spines could be observed. The cirrus is either without spines or the spines have dropped off as suggested by Lane (1915, p. 979). The presence or absence of spines on the cirrus, like the arrangement of spines on the collar, should not be considered to be of any systematic value. The genital pore is situated between the intestinal fork and the ventral sucker.

The ovary is an oval body in young forms, but in adults it assumes various shapes, presumably due to the action of the preservative. It lies on the right side in front of the testes and measures 0·16×0·12—0·67×0·47 The shell gland measures 0·225—0·63 in diameter. A Laurer's canal is present. The small receptaculum seminis referred

to by Faust (1930, p. 183) has not been detected by me. More than two dozen specimens were examined and only in one or two cases a portion of the uterus near the ovary was found to be filled with sperms, as is usually the case. It is likely that Faust mistook this portion of the uterus containing sperms for a definite receptaculum seminis. It may be remarked here that the absence of a receptaculum seminis is a feature characteristic of the family to which the present form belongs (Echinostomidae). The uterus is fairly long and the coils are dense and are situated between the shell gland and the posterior border of the ventral sucker. The ova measure 0·058—0·075×0·09—0·113 (or 0·125 according to Faust). The vitellaria are very extensive, extending from the middle or posterior border of the ventral sucker to the posterior end of the body. Behind the testes they meet dorsally in the median line.

As remarked at the beginning of this note the taxonomy of this worm has baffled many workers in the past. Although in the beginning Leiper and Odhner were led to consider it as identical with *Echinostoma malayanum* Leiper, 1911, of late there is unanimity of opinion in regarding *surfrartyfex* as a valid species. With regard to the question of assigning the species to one of the genera of Echinostomidae there still exists divergence of opinion. Lane (1915) placed it under his new genus *Artyfechinostomum*. The other genera suggested from time to time to include it are *Echinostoma* and *Euparyphium*. To me, however, it appears that the genus to which it can most appropriately be assigned is *Paryphostomum* Dietz, 1909. Before attempting to justify my view it will be instructive to compare in a tabular form the genera under consideration.

Table II.

	Echinostoma Rudolphi, 1809.	*Euparyphium* Dietz, 1909.	*Artyfechinostomum* Lane, 1915.	*Paryphostomum* Dietz, 1909.
Collar	United ventrally by a bridge.	United ventrally by a bridge.	Not united ventrally by a bridge.	Not united ventrally by a bridge.
Collar spines	Double row, not interrupted dorsally.	Double row, not interrupted dorsally.	Single row, not interrupted dorsally.	Double row, not interrupted dorsally.
Ventral sucker	Circular	Circular	Drawn out posteriorly.	Drawn out posteriorly.
Vitellaria	Extend from slightly posterior to ventral sucker to the posterior end of the body.	Extend from slightly anterior to testes to the posterior end of body.	Extend from hinder end of ventral sucker to the posterior end of body.	Extend from hinder border of ventral sucker to the posterior end of body.
Testes	Not much lobed	Not much lobed	Deeply lobed	Deeply lobed.
Cirrus sac	Extends up to the centre of ventral sucker.	Does not extend posterior to ventral sucker.	Extends posterior to ventral sucker.	Extends posterior to ventral sucker.
Cirrus	Without spines	Spinose	Without spines	Without spines.
Vesicula seminalis	Coiled	Coiled	Not coiled	Not coiled.

It will be evident from the table given above that the species *surfrartyfex* on account of its collar being without a ventral bridge, the cirrus sac extending posterior to ventral sucker, the vitellaria extending

from the posterior end of ventral sucker to the posterior end of body and the vesicula seminalis not being coiled cannot be included in either the genus *Echinostoma* or *Euparyphium*. Regarding the genera *Artyfechinostomum* and *Paryphostomum*, it will be seen that the former differs from the latter only in having a single row of collar spines instead of a double row, but the variable nature of the rows of spines in the different individuals of the same species has already been discussed and, therefore, much importance cannot be attached to this point of difference. It is, therefore, suggested that according to the law of priority the genus *Artyfechinostomum* should be regarded as a synonym of *Paryphostomum* and the species should henceforth be designated as *Paryphostomum surfrartyfex* (Lane).

The genus *Paryphostomum* has not been so far assigned to any of the three sub-families of Echinostomidae. Führmann (1928) listed it along with many other genera which, on account of their abnormal characters, could not be included in any of the sub-families. The genus *Artyfechinostomum* which, as I have shown, should be considered to be a synonym of *Paryphostomum*, has, however, been included by Führmann in the sub-family Echinostominae ; but the facts that in it the head collar is not united ventrally by a bridge, the cirrus sac extends beyond the ventral sucker and the vesicula seminalis is not coiled go against this. Lane (1915) had, however, assigned it correctly to the sub-family Himasthlinae. The difficulty experienced in assigning *Paryphostomum* to the sub-family Himasthlinae is the fact that the genus was originally defined as having, among other characters, two rows of spines on the head collar and a spinose cirrus. It has been already shown that these characters, variable as they are, cannot be given any taxonomic importance. Leaving these two characters out of account, there is no difficulty in including *Paryphostomum* in the sub-family Himasthlinae. In the light of the facts brought forth here it is necessary to emend the definitions of the sub-family Himasthlinae and the genus *Paryphostomum*. I therefore suggest the following diagnoses for them.

Himasthlinae (Odhner, 1911), Bhalerao, 1931.

Diagnosis.—Echinostomidae : Body armed with spines. Head collar not united ventrally by a bridge. Cirrus sac, when present, extending posterior to ventral sucker. Cirrus long, straight when everted. Pars prostatica present. Vesicula seminalis tubular, not coiled.

Paryphostomum (Dietz, 1909), Bhalerao, 1931.

Diagnosis.—Himasthlinae : Body long, slightly flattened. Head collar kidney-shaped, beset with a single or double, dorsally unbroken row of spines. Ventral sucker large and very powerful, elongated posteriorly like a funnel, situated at the first quarter of the body. Intestinal fork immediately anterior to ventral sucker. Testes much lobed, median, one behind the other. Ovary spherical or ellipsoidal (transversely), situated on the right side, anterior to testes. Vitellaria extending from the middle or posterior border of ventral sucker to the posterior end of body, meeting dorsally with each other in the central line posterior to testes. Uterus with few or more coils. Adults in the intestine of mammals, birds and reptiles.

Type-species.—*P. radiatum* Dujardin.

Opisthorchis noverca Braun, 1903.

Distomum conjunctum, Lewis and Cunningham, 1872.
Opisthorchis caninus, Barker, 1911.
Paropisthorchis caninus (Barker, 1911), Stephens, 1912.

About a dozen specimens from two pigs in Bengal and numerous specimens of the same species from two dogs at Muktesar (U. P.) were available for study. The first record of the occurrence of these flukes was made by Lewis and Cunningham (1872) from the liver of a native dog at Kasauli (Punjab). McConnell (1876, 1878) obtained them from two Mohammadans at post-mortem examinations. They were formerly thought to be identical with *Distomu conjunctum* Cobbold. Braun (1903) designated them as *Opisthorchis noverca*. Barker (1911) pointed out that McConnell's flukes and those of Lewis and Cunningham were different. The former he named *Amphimerus noverca* and the latter *Opisthorchis caninus*. Stephens (1912), who examined material from the liver of pariah dogs sent to him by Lt.-Col. Christophers, described them as the species *caninus* and placed them under his new genus *Paropisthorchis*. Leiper (1913) showed that *O. caninus* was a synonym of *O. noverca*. He further remarked that the character of the vitellaria does not justify its being placed in the genus *Amphimerus*. Morgan (1927), who examined some more material, confirmed the opinion of Leiper. Verma (1927), however, regards *O. noverca* and *O. caninus* as two distinct species. *O. noverca* is supposed to have the vitellaria extending past the ovary, while in *O. caninus* they are described as not extending posterior to the ovary. On examination of a large number of specimens both from pigs and dogs I cannot but confirm the opinion of Leiper and Morgan. Various grades of the posterior extension of the vitellaria are observed. In some cases they stop at a distance slightly anterior to the ovary, but specimens are not lacking in which they are seen to extend to the level of the ovary, to the anterior border or middle of the anterior testis, and even to the hinder border of the posterior testis. In view of these observations there appears to be no justification at all ıor regarding *O. caninus* as a distinct species from *O. noverca*.

Barker (1911) had included the species *O. noverca* in his new genus *Amphimerus* along with the species *A. ovalis* Barker, 1911, *A. interruptus* (Braun, 1901), *A. lancea* (Diesing, 1850), *A. pseudofelinus* (Ward, 1901) and *A. speciosus* (Stiles and Hassall, 1894). The genus *Amphimerus* is characterised by the possession of vitellaria which are divided into two distinct regions : one anterior to the ovary and the other posterior to it, extending beyond the posterior testis. In none of the specimens that I examined was the typical condition present. Granting that this character is not variable, it is very doubtful whether it alone is sufficient to form the basis of a separate genus. Morgan (1927) is also equally sceptical regarding this point, but he concludes with the remark that there is every justification for retaining the genus. In my opinion this character alone can hardly justify the separation of some species into a different genus.

This species and some others are characterised by the possession of a process, called the pedicel, on which the genital opening and the ventral

sucker are borne. Leiper (1913) dismisses the structure by describing it as a mere " functional " process. In the specimens from dogs I found this structure to be present in more than one hundred individuals that I examined, but among the specimens from pigs this structure was quite prominent in some, while in others it was found to be either absent or very insignificant. Leiper appears to be right in regarding it as " functional." Stephens (1912) has attached too much importance to this structure and has suggested the genus *Paropisthorchis* for the species from dogs possessing the process. I agree with Leiper in regarding the genus *Paropisthorchis* as a synonym of *Opisthorchis*, since, as will be seen from the above, the process does not serve as a good specific character even.

I experienced considerable difficulty in observing the cuticular spines in the case of specimens from pigs, while in those from dogs they were prominent.

In examining the specimens from both pigs and dogs I was struck with the fact that some specimens have distinctly lobed testes, while in others they were perfectly round. This fact was also noted by Stephens (1912). This difference in different individuals is so prominent that I propose to divide the species into two varieties accordingly as the testes are round or lobate. For the forms with round testes I suggest the name *O. noverca* var. *orbiculata*, nov. and for those with lobed testes I suggest the name *O. noverca* var. *lobata*, nov.

The ovary has three main oval lobes, but usually there is a tendency for one or more of these lobes to be divided into two or three lobules.

Table III gives some of the measurements of the material at my disposal.

Table III.

Length of body	2·1—6·41.
Breadth of body	1·43—1·92.
Length of pedicel	0·60—0·61.
Oral sucker.	0·37 diameter.
Ventral sucker	0·164 diameter.
Pharynx	0·26 diameter.
Anterior testis	0·3 × 0·13—0·475 × 0·63.
Posterior testis .	0·32 × 0·23—0·64 × 0·49.
Ovary .	0·38 × 0·24.
Receptaculum seminis	0·22 long.
Eggs	0·02—0·027 × 0·011—0·012.

Fasciolopsis buski (Lankester, 1857).

Gastrodiscoides hominis (Lewis and Cunningham, 1876).

These two species were not actually sent to me, but Dr. Maplestone has reported to me their occurrence in the Bengal pigs. The intensity of their infection is given in Table I at the beginning of the paper.

I wish to express my indebtedness to Lt.-Col. R. B. S. Sewell for having gone through the manuscript.

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