XXIX THE POSSIBLE OCCURRENCE OF *SCHISTOSOMA JAPONICUM*, KATSURADA IN INDIA.

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(With Plate XXV).

During the past few months I have been engaged in investigations directly or indirectly connected with the introduction into India of the African and Mesopotamian forms of the human-infecting Schistosomes. These investigations are a continuation and elaboration of those begun by Mr. S. W Kemp;[1] in the course of them I have undertaken the systematic examination of large numbers of freshwater molluscs in various parts of India and have discovered numerous cercariae hitherto unknown. Most of these belong to groups that have little interest to others than zoologists, but quite recently I have discovered in one of the tanks in the Calcutta area a cercaria that is a true Schistosome and that seems likely to have considerable practical importance from a medical point of view. I have therefore decided, having found it possible to give a full description, not to delay publication of my results in this respect.

The cercaria is, as far as it is possible to judge from the very detailed description and clear figures published by Cort,[2] and the further particulars given by Faust[3], morphologically indistinguishable from that of *Schistosoma japonicum*, Katsurada, a very important parasite of man in China and Japan.

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This type appears to be a true Schistosome and is almost identical, if not absolutely so, with *Sch. japonicum*. The cercaria is a small one and is a feeble swimmer, as viewed in a watch glass. It appears to move tail first, dragging the body behind it, by vigor-

[1] Kemp and Gravely, *Ind. Journ. Med. Res.* (in the press).

[2] Cort, W. W. "The cercaria of the Japanese blood-fluke, *Schistosoma japonicum*, Katsurada." *Univ. Californ. Publ. Zool.*, Vol. XVIII, No. 17, pp. 485-507, 3 figures in text: Berkeley, 1919.

[3] Faust, E. C. "Notes on South African cercariae. *Journ. of Parasitology*, Vol. V, No. 4, p. 164: Urbana, 1919.

ous lashing of the tail. Under a cover slip it only makes feeble progress owing to the fact that its anterior end appears to be not a true sucker but an organ devised for penetrating the host tissues. The body is frequently bent from side to side and is capable of a very great degree of extension and retraction. Furthermore, the anterior end forms a protrusible snout which is sometimes thrust out to form a round papilla and from time to time is retracted within the anterior end of the animal, thus forming a depression which at first sight might be thought to be the cavity of an anterior sucker. The animal has a marked tendency to shed its tail while under observation.

Owing to the extreme degree of extension and retraction of the animal it is difficult to get the exact measurements in the live state. So far as my observations go the measurements of the cercaria are as follows :—

When the body is extended it measures 0·196 mm. in length × 0·025 mm. in breadth and when contracted 0·090 mm. × 0·050 mm. The tail seems to be capable of a certain degree of extension and varies in length in different specimens from 0·186 to 0·221 mm. The furcal rami are short and are capable of extension and contraction, having in a contracted condition a wrinkled appearance. They vary in length from 0·071 to 0·096 mm. The body is comparatively transparent and in consequence it is very easy to make out the details of the structure. The whole of its surface is covered by minute spines which extend as far forward as the limit where the body-wall joins the sides of the anterior sucker-like structure. The tail is rather more sparsely covered with spines that appear to be slightly hooked and are comparatively large and both furcal rami are armed with spines along the margins. The anterior sucker-like structure is pyriform in shape and measures 0·043 mm. by 0·032 mm. when the animal is in the state of retraction but during the extension of the body this pyriform mass becomes considerably longer and narrower. Behind the point where the body-wall joins the anterior " sucker " the wall of this latter organ is thick and is provided with a strong layer of circular muscle-fibres. Internally the great bulk of the organ is filled with a granular mass, the head gland, while laterally and posteriorly are a number of small parenchymatous cells, also granular in appearance: the ducts from the cephalic glands, of which there are five on each side, enter this pyriform structure on its ventro-lateral aspect and pass forwards to open at the tip of the protrusible snout. Each duct is tipped at its orifice by a hollow conical spine of which there are ten in all. The acetabulum is small and is situated about $\frac{1}{4}$ the distance from the posterior end of the body, its external opening is Y-shaped, the two limbs of the Y pointing forwards and one limb backwards: it measures in diameter 0·014 mm. Its external surface is covered with a number of fine spines and it is capable of some degree of protrusion and retraction but normally forms only a small projection on the ventral aspect.

The most obvious feature in the body is the large group of five pairs of cephalic glands that occupy the posterior ½ to ⅔ of the body. These glands are pyriform in shape and each cell has a wide and conspicuous duct that runs forward to enter the head gland as noted above. These cells appear to be of two kinds. The anterior two pairs are coarsely granular while the posterior three pairs are finely granular, and each possesses a large and conspicuous nucleus. Cort (*l.c.*, p. 501) makes no mention of any such differentiation in the cephalic gland cells of *Sch. japonicum.* He states that all five pairs of cells possess acidophilic cytoplasm, as is also the case in the present species. The ducts belonging to the two groups of cephalic gland cells can also be distinguished; those from the three posterior pairs are large and lie ventrally in a **U**-shape, while those from the anterior two pairs are small and are situated side by side in the opening of the **U** on the dorsal side.

The alimentary canal is extremely reduced. The mouth opens ventrally by a small orifice situated far forward just in front of the junction of the body-wall with the head-gland. A narrow intestine passes backwards as far as the anterior two pairs of cephalic glands and there is no trace whatever of any pharynx.

The excretory system is of the typical Schistosome type and agrees exactly with Cort's description of the excretory system in *Schistosoma japonicum.* Three pairs of flame cells are situated in the body. Of these the anterior pair is situated laterally, external to the ducts of the mucin-gland canals about midway between the head-gland and the anterior pair of cephalic gland cells. The second pair of flame cells is situated in the interval between the coarsely granular and finely granular cephalic gland cells, rather to the lateral side; while the posterior pair of flame cells is situated opposite the last pair of cephalic glands. A small excretory bladder is situated at the extreme posterior end of the body and from this two wide canals pass forwards and outwards, reaching as far forward as the anterior margin of the acetabulum; they then curve backwards and divide into anterior and posterior branches. The main canal is in two places somewhat dilated and each dilation contains a vibratile flagellum of the same type as the flagella of the flame cells but longer and narrower. The presence of these extra vibratile structures is important as one is very liable at first sight to confuse them with true flame cells and thus to consider the number of flame cells to be five pairs instead of three. The anterior and posterior "collecting tubules" each divide into two branches running to the flame cells. The second branch from the posterior "collecting tubule" leaves the body and passes into the tail to the fourth pair of flame cells that is situated on either side of the caudal excretory tube close to the root of the tail. The caudal tube enters the posterior end of the bladder by a typical "islet" opening: at the posterior end of the tail the tube bifurcates, a branch passing along each fork to open to the exterior in a cup-like depression situated at the extreme tip of the ramus.

The genital gland forms a mass of small round cells situated ventrally and immediately behind the posterior margin of the acetabulum. In addition to this group of cells there is along the posterior and lateral border a series of five or six large round cells with clear protoplasm and a small granular nucleus. It would seem probable that these large cells represent the rudiments of the testes, while the central mass of small cells represents the rudiments of the ovary.

The cercariae develop in elongate sausage-shaped sporocysts. In some cases, however, the sporocysts appear to be more or less oval or pyriform. Each sporocyst contains two or three mature cercariae; occasionally some of the cercariae appear to become encysted either in the sporocyst or in the substance of the liver outside. In these cases the cyst is of an elongate oval shape and has a thin clear wall, the cercaria lying within the cyst in a partially extended state and not, as is the case in most encysted forms, curled up into a spherical ball. The cercariae appear to reach the full development within the sporocyst before leaving it to enter the host's liver tissue. The liver of an infected snail is of a yellowish brown colour and has a mottled appearance owing to the sporocysts appearing on the surface.

The host. The cercariae develop in either *Planorbis exustus*, Desh. or in a form of *Limnaea amygdalum*, Troschel, in a tank in Russa Road South, Tollygunge, Calcutta.

	Present species.	*Sch. japonicum.*
Size.		
Body.	90 — 196 μ × 50 μ.	100 — 210 × 66 μ.
Tail trunk.	186 — 221 μ × 25 μ.	150 μ × 20 μ.
Furca.	71 — 96 μ.	75 μ.
Oval sucker.	32 μ × in transverse diam. × 43 μ in length.	33 μ in transverse diam. × 54 μ in length.
Mucin glands.	5 pairs of pyriform cells with large nuclei and with granular acidophilic cytoplasm; the anterior two pairs coarsely granular and the posterior three pairs finely granular.	5 pairs of pyriform cells with large nuclei and granular acidophilic cytoplasm. Cort makes no mention of any difference in the various cells.
Mucin ducts.	Very thick.	Very thick.
Duct openings.	At anterior end of protrusible snout; capped by five pairs of hollow, piercing spines.	At anterior end of protrusible snout; capped by five pairs of hollow, piercing spines.
Germ cells.	Clustered mass of cells just behind antabulum along the postero-lateral margin 5-6 large round cells with granular nuclei.	Clustered mass of cells just behind antabulum.
Parthenita.	Sporocyst.	Sporocyst.

In the accompanying table, adapted from Faust (*l.c.*, p. 167), I have given the main characters of the present type and of the cercaria of *Schistosoma japonicum* in parallel columns. The present form appears to be very slightly smaller as regards the body and a trifle longer in the tail, but owing to the degree of contractility

possessed by the animal these differences are of so slight a character as to be negligible and the difference in shape between my examples and the figure given by Cort of *Sch. japonicum* is of no importance in so protean an animal; the differentiation of the cephalic gland cells in the Indian form into coarsely-granular and finely-granular cells is a physiological rather than a morphological difference.

The occurrence of animal-infecting forms of Schistosome in India has been known since the researches of Montgomery [1]—and the finding of a cercaria, stated to be that of *Schistosoma spindalis*, Montgomery, has been recorded by Glen Liston and Soparkar,[2] but as no details of structure are given by these authors it is impossible to compare their specimens with the present form.

The final test of the identity of this form with that of *Schistosoma japonicum* lies in the similarity or otherwise of the adults and experiments are now being carried out to obtain the fully-grown sexual stage of this parasite.

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[1] Montgomery. "Observations on Bilharziosis among animals in India." *Journ. of Trop. Vet Sci.*, Vol. I, p. 16, 1906.

[2] Glen Liston and Soparkar. "Bilharziosis among animals in India. The life-cycle of *Schistosomun spindalis*." *Ind. Journ. of Med. Res.*, Vol. V, p. 567, 1918.