THE INTERNAL ANATOMY OF STOMOXYS.¹

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The dissections of the local variety of Stomoxys, which form the subject of this Note, were made at the suggestion of Professor Minchin, during his direction of the Royal Society's Commission on Sleeping Sickness in Entebbe, Uganda. The main object was to furnish some comparison between the internal anatomy of Stomoxys and that of Glossina, and the following Notes are based on Professor Minchin's description of Glossina palpalis.

Complete digestion of the human trypanosome seems to occur in forty-eight hours, in the alimentary canal of Stomoxys; but Lieutenant Gray, R.A.M.C., has found a limited percentage of these Stomoxys to be infected with a Herpetomonas.

I am much indebted to Professor Minchin for advice and assistance at every turn, without which these notes could not have been completed.

Digestive System.—The oesophagus emerges from the chitinous pharynx (which, with the mouth parts, has been described by Hansen) as a flattened tube, which gradually narrows and becomes cylindrical, running at first upwards and then backwards to reach the brain. The connectives of the brain are more vertical than in Glossina. On emerging from their constriction the oesophagus dilates gradually, and runs down to enter the ventral aspect of the proventriculus, which lies in the anterior third of the thorax.

The proventriculus is a mushroom-shaped viscus with a thickened border, and lies with its convexity pointing upwards and slightly forwards. Except from the inversion of its lateral edges, which gives to the proventriculus of Glossina a characteristic outline, the corresponding structure in Stomoxys is very similar in every way. The oesophagus enters the proventriculus a little in front of the centre of its concave ventral surface, and the duct of the sucking stomach running up from below appears to enter with it, though in reality it enters separately at a point immediately behind. As in Glossina, the oesophagus and the duct of the sucking stomach are in the same line.

The thoracic intestine arises from the convex dorsal surface of

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the proventriculus, at a point posterior to the entrance of the oesophagus on the ventral surface. From its origin the intestine runs down into the abdomen of the fly as a narrow tube of uniform diameter, until it reaches nearly to the lower border of the sucking stomach. At this point it dilates to several times its former diameter, its wall, at the same time, becoming thinner.

The abdominal intestine is proportionately shorter, less coiled, and more distensible than in Glossina; it is about three times as long as the fly itself. The dilated portion of intestine has three simple coils which lie superposed in the middle part of the abdomen, and then gradually narrows, continuing as a uniformly narrow tube down to the rectum. The narrow lower intestine has variable bends in its course, but is not coiled.

The rectum is a dilated cone-shaped portion of the intestine, the apex of the cone being towards the anus. Its walls are transparent, and through them are readily seen four long trumpet-shaped papillae, the narrow ends of which are inserted towards the anus. A single trachea enters the base of each "gland." Below the apex of the dilated cone the rectum is continued to the anus as a short narrow tube.

In the female this terminal portion of intestine runs within the ovipositor, the anus being situated between the last segment of the ovipositor and the terminal plate. In the male the ejaculatory duct passes over it dorsally from left to right, and runs anteriorly to enter the penis. The appendages of the alimentary canal are the Malpighian tubes, the sucking stomach, and the salivary glands. The Malpighian tubes arise from the narrow lower intestine. The proctodaeum, between their origin and the anus, comprises in length about one-fifth of the abdominal intestine. At their point of origin the intestine has a shallow linear constriction.

Two tubules arise on each side from a short common tube, and all four tubules are approximately of the same length. The two tubules arising from one side have thickened terminations, some four times greater than a salivary gland, and these thickened endings lie in the pericardal sinus. The tubules of the other side are of the same thickness throughout, and their ends lie amid the fat-body of the lower abdomen. Microscopically the tubules are of the usual type.

The sucking stomach is a thin-walled sac made up of one layer of flattened cells with occasional strands of unstriped muscle. It ends at the waist in a very fine duct which runs up ventrally to the thoracic intestine and enters the proventriculus immediately behind
The opening of the oesophagus. The alimentary canal and the ducts in the thorax lie in contact with each other in a narrow space between the lateral masses of thoracic muscles.

![Diagram of the alimentary canal of Stomoxys.](attachment:diagram.png)

**Fig. 1.—Alimentary Canal of Stomoxys.** Dorsal view. The thoracic muscles were removed, and the structures in the thorax separated and spread out, though their relative positions are otherwise maintained. In the abdomen the position of the coils of intestine has been very little disturbed. P., proventriculus; T.I., thoracic intestine; R., rectum; D.S.G., duct of salivary gland; S.G., salivary gland; S.S., sucking stomach; D.S.S., its duct; O., point of origin of Malpighian tubes; H., the dorsal blood vessel cut short at the heart.

The salivary glands are partly thoracic and partly abdominal. They are comparatively shorter and thicker than in Glossina.
the abdomen they are ventral to the sucking stomach, and from a
dorsal view only a knuckle of gland is exposed at the lower border of
this viscus.

The slightly bulbous ends of the glands lie under the upper
border of the sucking stomach, and are found by following up the
outer limb of the exposed angle of gland. Except for this angular
bend the glands are straight in their whole course, and even when
this is pulled out, they are not long enough to reach the hinder end
of the fly. The salivary glands run up through the waist of the
fly on either side of the duct of the sucking stomach and ventral to
the intestine, and continue with the same thickness to the front of
the thorax. At this point, in the neck of the fly, the glandular
portion ceases abruptly, to be continued as a very fine narrow duct.

At first this duct is made up of small flattened cells, but it
almost immediately acquires the structure of a small trachea,
becoming chitinised and having similar annular thickenings. At
the base of the brain the two ducts join and continue as a single
duct on the ventral surface of the chitinous pharynx, inside the
transparent membrane which wraps it round. The dilatation in the
common duct which Hansen has described and which he regards as
a storage chamber for the secretion, occurs about half-way in the
length of the common duct. The point of entrance of the duct
into the proboscis has been described by Hansen.

**Nervous System.**—This consists of the brain and the thoracic
ganglion, with the nerves arising from them. The nervous system
was not dissected in great detail, but the following nerves were
traced as described. The thick nerve to the ocelli arises from the
upper part of the back of the brain. The stout nerves to the
antenome arise from the front of each cerebral ganglion.

On either side of the front of the brain below the nerves to the
 antennae arises the slender pharyngeal nerve trunk, which shortly
divides into three. The outermost of these three branches divides
into two, one filament supplying the depressor muscle of the
pharynx, which arises from the postero-superior process, and the
other running down inside the pharynx in close relation to its
chitinous wall. The middle division of the pharyngeal nerve
joins its fellow of the opposite side on the wall of the oesophagus
as the latter enters the pharynx, the common trunk thus formed
splitting into four branches to the intrinsic muscles of the pharynx.
The innermost branch of each pharyngeal nerve joins a slender
nerve arising in the middle line. The nerve thus formed supplies
the pharyngeal muscles, but was not traced in detail.
The brain is connected with the thoracic ganglion by the connectives between which passes the oesophagus, and which join after this to form a long connecting band as in Glossina. The thoracic ganglion is somewhat pear-shaped, and is supported by the internal chitinous skeleton of the thorax, from the surfaces of which arise the wing and leg muscles. Six pairs of nerves arise from the thoracic ganglion and supply the thoracic muscles.

The abdominal nerve trunk continues from the posterior part of the ganglion running down in contact with the abdominal wall. It gives off three fine branches, which supply the abdominal muscles, and ends in the third segment of the abdomen by dividing into three. Each of these branches again divides to supply the generative organs, the outer two running to the ovaries or testes, and the middle one to the muscles of the ovipositor or penis.

Circulatory System.—This consists of the heart and its continuation, the thoracic aorta. The heart is a tubular organ of the same type as in Glossina, with chambers, ostia and alary muscles. The wall, too, is composed of similar giant cells. Though several stained preparations were made, it was impossible, owing to the fat body which obscured all detail, to count the chambers and cells in the heart wall. They seemed, from a comparison of all the preparations, to be reduced in proportion to the smaller number (four) of abdominal segments possessed by Stomoxys.

The dorsal aorta consists of paired cells, as in Glossina, and runs up on the dorsal surface of the intestine to end on the oesophagus in a similar mass of cells. On the surface of the proventriculus, to which it is bound down, it becomes expanded and flattened, narrowing again to its termination.

Male Generative Organs.—These are comparatively simple. The testes are a pair of smooth, oval, orange-brown bodies, with a shallow equatorial constriction. Their colour is due to a pigmented coat, as in Glossina, but there is apparently not the same tubular structure.

From the lower end of each testis arises a very fine duct, short and straight, which runs down to join the duct of the opposite side as the upper limbs of a Y. From this junction an exceedingly short length of common duct runs into the bulbous upper end of a tubular organ, which would seem to function as a vesicula seminalis.

This vesicula seminalis is a flexible tube, often lying with two U-shaped bends in its course. At its upper it is bulbous, gradually narrowing below this to end as an ejaculatory duct, which crosses
the rectum dorsally from left to right, to enter the penis in front of it; it does not thus encircle the rectum, as in Glossina. The hypopygium and penis are of the same type as in Glossina.

Female Generative Organs.—The sex of a Stomoxys can be easily ascertained by inspection of the hind end of the abdomen; but, unlike Glossina, the scutellar bristles are of the same length.
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in both sexes. The female generative organs are of the house-fly type. There are two ovaries, each consisting of some sixty ovarioles. The ovary is moored to the body wall by a profusely branching trachea, which arises from the pleural space, and ramifies among the ovarioles. In the natural position the ovaries lie with the long axis of the ovarioles pointing upwards towards the dorsal surface. Each ovariole contains never more than four ova in various stages of development.

![Diagram of female generative organs of Stomoxys](image)

**Fig. 3—Female Generative Organs.** The natural position of the parts has been considerably altered for the sake of clearness. Dorsal view. O., ovary; R.O., right oviduct; C.O., common oviduct; U., uterus; O.P., ovipositor; U.G., uterine gland; R.S., receptica seminis; R., terminal position of rectum cut short above.

The ovaries vary in size according to the degree of maturity of the lowest ova. In some flies they occupy more than half of the whole abdominal space. The ovarioles open into a wide tubular duct, which joins its fellows from the other ovary like the upper limbs of a Y. As a result of this junction is formed the
common oviduct, which runs down, forming a long third limb to the Y. Below the attachment of the uterine appendages the oviduct continues as the uterus.

The appendages consist of the uterine glands and the receptacula seminis. The uterine glands are two rather stout tubular organs, with slightly bulbous extremities. The bulbous end is firmly joined to the lateral oviduct by a very short double strand of connective tissues. Each gland ends in a short, fine duct, and these ducts enter separately the shallow constriction which forms the arbitrary division between the oviduct and uterus.

The receptacula seminis are two small, black, spherical bodies, each with a cellular socket resembling the fitting of an acorn cup. From this runs a very fine duct, which enters the division between the oviduct and uterus in the mid-dorsal line. The receptacula are attached to each other, but can be separated by dissection. The distal portions of the two ducts are quite separate, but later each duct enlarges slightly, and from this point on to its insertion is closely attached to its fellow. This portion can, however, be separated by dissection, and it is then seen that the ducts are distinct and enter separately.
The uterus is a tube of the same diameter as the common oviduct above, and runs down in the middle line into the ovipositor. The ovipositor consists of three cylindrical segments of thin chitin, which usually lie telescoped inside the abdomen. There is also a single external flap of dark chitin, which lies folded up on the ventral surface of the fly. When the ovipositor is extruded by squeezing the fly’s abdomen, the receptacula and uterus are pulled down with it, and can be seen through the transparent walls.

The upper segment of the ovipositor has three narrow ribs of dark chitin in its long axis, two dorsal and one ventral. The next segment is similar. The last segment has two dorsal plates only. The external flap, which is probably the third rib of the last segment, is, roughly, quadrilateral, and has two divergent prong-like processes arising from its free border.

The points of the chitinous ribs which strengthen the segments of the ovipositor project above the upper border of the segment, and to them are attached the muscles of the ovipositor. The narrowed terminal portion of the rectum enters the ovipositor on the dorsal surface of the uterus and runs down to the anal opening between the external plate and the last segment.