XX.—On *Hæmonais laurentii*, n. sp., a Representative of a little-known Genus of Naididæ. By J. Stephenson, D.Sc., Professor of Zoology, Government College, Lahore.

(MS. received January 13, 1915. Read February 15, 1915. Issued separately May 11, 1915.)

[Plate LXXIX.]

In the year 1900 BRETSCHER (1) published a short account of a new aquatic Oligochæte belonging to the family Naididæ, which was assigned by him to a new genus, *Hæmonais*, under the name *H. waldvogeli*. Its chief peculiarity lay in the complicated blood-vascular system, to an account of which BRETSCHER devotes about half of his description. No further account of any representative of the genus has since appeared.

Some months ago I was surprised to find, in Lahore, specimens which were certainly referable to the same genus as the Swiss worms, though manifesting a few differences, sufficient to distinguish them as a separate species. Since my first discovery of the present form I have had the advantage, which did not fall to BRETSCHER's lot, of being able to observe sexual individuals; and as the worms are remarkable in other respects than that of the vascular system, and since moreover the somewhat curt description which he gives is perhaps scarcely sufficient to satisfy legitimate curiosity in regard to a new genus, I give below a fairly complete account of the Lahore specimens.

My description of the vascular rings and their branches in the anterior part of the body differs somewhat from BRETSCHER's, mainly in being less detailed. At the time that I had the living worms under observation (in which alone the vascular system can be traced in detail), BRETSCHER's original paper was not available in Lahore; I was therefore unable to compare my specimens with his description. But I am inclined to doubt if much more could have been seen, with any degree of certainty, than is given below; the present species seems to be considerably larger, and therefore more opaque, than BRETSCHER's. It may be added that BRETSCHER does not note, for *H. waldvogeli*, the curious fact that the dorsal vessel is not actually dorsal, but runs along the left side of the intestine from the posterior end as far as segment vi.

Hæmonais laurentii, sp. nov.

A number of specimens of this species were obtained from the duck-pond in the Lawrence Gardens, Lahore, towards the end of March 1914.

The maximum length of the specimens when extended was about 20 mm. The anterior end of the animal tapers gradually; the prostomium is triangular, with a

rounded tip. There are no eyes. Many of the specimens were undergoing asexual multiplication; and of the others, some had only recently separated, as evidenced by the partially developed condition of the anterior ventral setæ.

Setæ.—There are no dorsal setæ in the anterior part of the body in the fully developed animal; they begin in segment xviii, xix, or xx; and each bundle consists of one hair- and one needle-seta. Minor variations in the constitution of the bundles occasionally occur; thus the hair-seta may be absent, or there may be two needles in a bundle.

The hair-setæ are about $150\ \mu$ long, and $3\ \mu$ broad at the base; they taper to a fine point. They are straight, or with a very slight sickle-shaped curve.

TEXT-FIG. 1.—Setæ of *Haemonais laurentii*. $\times 540$. a, anterior ventral; b, posterior ventral; c, single-pointed ventral; d, dorsal needle; e, single-pointed dorsal needle; f, genital seta.

The needles (text-fig. 1, d) are of the usual doubly-curved and double-pronged type. In length they are about $105\ \mu$, in breadth $4.5\ \mu$; the curves of the shaft are gentle, and the whole distal extremity is less hooked than in the ventral setæ. Of the two prongs into which the distal end forks, the distal is longer and may be slightly thinner than the proximal, but both prongs are absolutely much longer than those of the ventral setæ. The angle between the prongs is narrow. The nodulus is distal to the middle of the shaft, the proportion of the distal and proximal sections of the shaft being about 3 : 5.

There is a considerable amount of variation in these dorsal needle-setæ; thus the relative length of the two prongs to each other is variable, as also the position of the nodulus, which may be nearer the middle of the shaft than is indicated above. They are largest and most typical in the posterior part of the body, where they may reach $115\ \mu$ in length. But the most striking variation is the not infrequent absence of one of the two terminal prongs (text-fig. 1, e). It appears to be the distal prong which is missing; this is, usually at least, indicated by the presence of a slight "shoulder" on the shaft, as shown in the text-fig.

The ventral setæ, of the type usual in the Naididæ, occur in bundles of from two

to four. They are very variable, even in the same bundle, but may be divided into two groups, anterior and posterior. A similar distinction can be made in certain other genera, *e.g.* *Nais*, where the ventral setæ of segments ii-v differ in character from those behind; in this case, however, the change occurs much further back, and is gradual rather than sudden.

In the anterior part of the body the setæ (text-fig. 1, *a*) vary considerably in length—80, 98, or 104 μ , but are all comparatively slender, 3 μ ; the distal prong is slightly longer than the proximal, and about half as thick as the latter at its base; the angle between the prongs is neither markedly wide nor narrow. The nodulus is usually proximal to the middle of the shaft, but its exact position is variable even in the same bundle; thus along with setæ in which the proximal segment of the shaft bears to the distal the ratio 3 : 4, there may be one with the ratio 1 : 2, while in some cases the nodulus is only slightly proximal, or is actually at the middle.

There is no sudden change in the character of the setæ in passing backwards. In segment viii, in one instance, the length was 104 μ , the nodulus was at the middle of the shaft, and the prongs had the above relations. In segment x the length was 105–110 μ , prongs as above, nodulus at the middle or slightly proximal. In segment xv, however, one seta of a bundle of four had different characters: it was shorter, 78 μ ; noticeably stouter, 4 μ ; the proximal prong was both longer and thicker, $1\frac{1}{2}$ as long and twice as thick as the distal, and the nodulus was distal to the middle of the shaft (proximal segment : distal segment :: 7 : 5). Another seta in this segment presented intermediate characters—length 90 μ , shaft intermediate in thickness, prongs of equal length, proximal prong twice as thick as distal, nodulus distal to middle (proximal : distal :: 4 : 3).

Behind this the setæ were all of the stout type (text-fig. 1, *b*), *e.g.* in segment xvii—length 80–96 μ , breadth 4–4.5 μ , prongs equal in length or proximal slightly longer, proximal prong more than twice as thick as the distal at its base, nodulus distal, but its position variable (proximal segment : distal segment :: 5 : 4 or 3 : 2); there may be a slight “webbing” between the bases of the prongs.

A marked variation—the absence of the distal prong—occurs sometimes in the ventral as in the dorsal setæ. In some cases a slight “shoulder” on the shaft represents, as in the dorsal setæ, its normal place of origin; in other cases there is no indication of a second prong, and the seta ends distally in a simple stout hook (text-fig. 1, *c*).

Attention may be drawn to the fact that the variations in the position of the nodulus are not haphazard, but follow a definite rule. Careful preparations will show the setal bundles in most cases laid out flat, with the setæ in their natural order; and in such it can be seen that the nodulus is most distally situated in the outermost seta, most proximally in the innermost, and that there is a progressive change in the ratio between proximal and distal segments of the shaft as we pass from the outer to the inner seta; so that while this ratio may be 2 : 1 in the outer, it is perhaps 4 : 3

in the inner seta. This is shown in text-fig. 2, and the relative position of the bundles of opposite sides in text-fig. 3. I have described (3) a similar condition in the form which MICHAELSEN (2) has named *Aulophorus stephensoni*; and it occurs also in *Dero limosa* and *Aulophorus furcatus*. Since it is possible that it may occur more widely, it is evidently not sufficient, in describing the setæ of the Naididæ (on the minutiae of which the discrimination of species sometimes depends), to note the position of the

TEXT-FIG. 2.

TEXT-FIG. 3.

nodulus in a single arbitrarily selected seta of a bundle without reference to the condition in its fellows.

When an individual belonging to the Naididæ divides asexually, the zone of production of new segments (budding zone) in the middle of the animal's body splits in such a manner that a number of the new segments go to form the posterior end of one daughter individual, while the rest form the anterior end of the other. This

TEXT-FIG. 4.

latter group is commonly five in number (*cf.* STEPHENSON, 4), and it often happens that these five newly formed segments, constituting the head of the posterior zooid, bear no dorsal setæ. Hence in a number of genera the dorsal setæ commence on the sixth segment.

The above sequence of events takes place in the present species also; and it would accordingly be expected that the dorsal setæ should begin, as in *Nais* and some other genera, on the sixth segment. As a matter of fact they begin on or near the twentieth; and it is obvious, therefore, that in order to bring about this condition a considerable number of segments must shed their dorsal setæ about the time of the detachment of the posterior zooid. Text-fig. 4 will make this clear; it illustrates

the condition in the region near the budding zone soon after the first appearance of the latter. The budding zone is supposed to occur after the thirty-fifth segment of the original animal; and at this stage segments 36, 37, 38 . . . of the old animal (which will become vi, vii, viii . . . of the new) have dorsal setæ—the dorsal setæ of the hinder part of the original undivided animal. It is these which must fall off, if the new animal (B) is to resemble the parent in having dorsal setæ only from about the twentieth segment onwards.

This conclusion does not rest on inference only; the various stages of the shedding of the dorsal setæ can be observed by taking individuals which are approaching, and others which have lately passed, the actual division. Thus an animal was observed in which the budding zone had only recently appeared (the four new anterior bundles of ventral setæ at the head end of B had not begun to form); one bundle of dorsal setæ had already disappeared. In a specimen slightly more advanced (the four new bundles of ventral setæ beginning to show), the first, and the hair-seta but not the needle-seta of the second, dorsal bundle had disappeared. Actual separation takes place at about this stage, before the ventral setæ of the anterior end have attained their full development; in such a specimen, after separation, two dorsal bundles and the hair-seta of a third had fallen off, so that there was only a needle-seta in segment viii, while the dorsal bundles were complete from ix onwards. In another, apparently fairly recently separated specimen, the dorsal setæ began in xi, and here again in the first bundle the hair-seta had fallen out. In another specimen the dorsal setæ began in xiii, in another in xiv.

The setæ, too, leave traces behind them. In the specimen where setæ began in xi, there was present in x, at the former site of the setæ, a slight epidermal thickening, and, beneath this, remains of the cells of the setal sac and the setal muscle-strands. In ix the traces were more doubtful, and the setal muscles had disappeared; but in viii and vii the condition was as in x; no trace of muscles or sac could be seen in vi.

A little consideration will show that the ventral setal bundles have also to undergo alterations in connection with the separation of the posterior animal. In a well-developed specimen the ventral setæ are found to change their character, as has been described, about the fifteenth segment. A reference to the text-figure (text-fig. 4) will show, however, that the ventral setæ of the posterior animal B, from segment vi onwards, will at first be all of the posterior or stout type; since these segments are the 36th, 37th, 38th . . . of the original animal. The stout setæ of segments vi–xiv must therefore fall out and be replaced by setæ of the slender anterior type before the zooid B can be considered fully developed.

Indications of such a change were seen in the specimen already referred to, where one bundle of dorsal setæ had disappeared. Here the corresponding ventral bundle contained two setæ of the stout type and one of the slender, the latter presumably newly formed; the same was the case in the next segment; while in the one following this the complete setæ of the stout type were accompanied by the just-formed head

of a new seta of the slender type. We can therefore actually see the change in the character of the setæ taking place.

The *body-wall* and *muscular system* call for only two remarks. The first is that the cells of the lateral line are well seen in stained preparations as a very definite band of nuclei; the other, that a pair of muscular bands pass in each segment, one on each side, from the dorsal to the ventral setal sac. Each band consists of a single fibre which traverses the body-cavity in a vertical direction, and to which a nucleus is attached; in position they are comparable to similar bands in the Tubificidæ (for example, *Branchiura*, *Limnodrilus*, 5).

The *cœlomic corpuscles* are spherical nucleated bodies, very variable in size, their diameter being from 9 to 22 μ ; they contain a number of refractile, colourless granules. In sections they are well seen; and the cell-wall appears as a definite membrane, from which the contents sometimes have shrunk away (text-fig. 5, *a*). They originate mainly from the peritoneal lining of the dorsal body-wall. In the anterior segments of the body behind the first few, masses of such cells are con-

TEXT-FIG. 5.

spicuous, regularly segmental in their arrangement, in the free space dorsal to the gut; similar but smaller and less conspicuous aggregates may be seen also in the posterior part of the body. These masses apparently represent the origin of the cœlomic corpuscles; the individual corpuscles of the mass can sometimes be seen to be attached to the body-wall by protoplasmic bridges, by stalks, or by longer thread-like strands (text-fig. 5, *b*).

The *chloragogen pigment* has an unusual and characteristic distribution. In most Naididæ it extends forwards on the alimentary tube to about segment vi, or perhaps v, and there ceases. In the present species it extends forwards as far as the pharynx, the hinder part of which, in segment iv, it envelops (fig. 1, *chl.*ⁱⁱⁱ); in segment iii the pharynx is almost free from the pigment, which, however, again extends round the anterior end of the pharynx, immediately behind the level of the mouth, in the second segment (*chl.*ⁱⁱ). In the latter situation it forms a conspicuous aggregate behind the cerebral ganglion; and, further forwards still, a mass of brown pigment is to be seen in the prostomium (*chl.*ⁱ), anterior and ventral to the ganglion. This distribution rendered the animals capable of immediate identification amongst numerous others of different species.

The chloragogen cells on the intestine and surrounding the dorsal vessel may have in them very little of the pigment, which is much more densely aggregated in

the anterior part of the body. Here in many cases the cells which contain the brown particles are disintegrating; and in the prostomium and round the pharynx the cells have disappeared, leaving only loose aggregates of brownish-coloured grains.

The new segments produced in the budding zone at first contain no chloragogen. It begins to appear in the prostomium of the newly formed head soon after separation, and could be seen in an animal in which the dorsal setæ had disappeared as far back as segment xii.

The *alimentary canal* differs from that of many Naididæ, and reminds the observer of the condition in the Tubificidæ, in showing no obvious differentiation into œsophagus, stomach, and intestine. The pharynx, in segments ii-iv, is invested by chloragogen at both ends, but free in the middle (fig. 1). A transverse section through the middle of its length (fig. 2) shows that its lumen has here the shape of the letter T inverted ( )—in other words, there is a dorsal diverticulum with a median cavity which is narrow from side to side; the dorsal diverticulum and the dorsal wall of the main tube are heavily ciliated, while the ventral wall of the pharynx shows no cilia, and the cells are not so high.

On the sides of the pharynx are a number of gland-cells, arranged in groups of three, four, or more, the groups separated by muscular strands passing outwards from the pharyngeal wall to the parietes (figs. 1, 2). In a vertical longitudinal section which cuts the lateral wall of the pharynx tangentially (fig. 1) the arrangement of these groups of cells is well seen, and the appearance resembles that of the acini of an ordinary racemose gland in the higher animals. The individual cells are usually elongated, pyriform or fusiform, and are continued by means of a narrower neck into the epithelial layer of the pharynx, to which they thus properly belong. It is very possible, however, that some of the cells in this situation are of peritoneal origin and have no direct connection with the pharyngeal lining epithelium.

The œsophagus is narrow as far back as segment xii or thereabouts; it then begins to dilate, and the intestine may be said to be established in xiii or xiv. The intestine is characterised by being dilated in each segment and constricted at the septa. The histological characters of the epithelium also change: in the œsophagus the cells are long, but of rather unequal height, and groups of two or three are united together to form minute papilliform elevations; in the first part of the intestine the cells take up more of the eosin stain, are not on the whole so tall or so irregular, and have numerous spaces between their bases; but I am not satisfied that these differences are constant.

The anus is dorsal, and a strong ascending ciliary current is very obvious in the posterior part of the gut. The margin of the anus may be slightly puckered, and in the best-marked cases there is a slight eversion of the epithelial lining of the intestine, which appears as a dorsal and ventral lip at the anal orifice. The term "eversion" is in strictness not applicable, since the projections are epithelial only; there is no

folding of the intestinal wall, and the lips are due to the greater height of the columnar cells (fig. 3). The epithelium of the whole of the posterior part of the intestine is a tall, heavily ciliated layer, presenting very numerous folds on its surface; but here again the apparent folding is due to the inequalities in the height of the cells. The cells are of one kind only, with hyaline cytoplasm, and ovoid, fairly large nuclei, which stain only lightly. The whole layer has a distinctive homogeneous appearance, stains lightly with eosin, and cell-outlines are scarcely to be made out. Near the base of the layer are frequently to be seen oval or spherical vacuoles; these from their shape are intracellular, not (as are the spaces further forwards in a somewhat similar position) between the bases of the cells. The vacuoles may contain colourless or slightly yellow granular matter, which does not take the eosin stain (hence is not of the nature of the coagulum seen in the blood-vessels and -spaces). The appearance would lead one to suggest that it is an indication of intracellular digestion.

The epithelium changes its character at a short distance from the posterior end; in front of this the cells lose their thick fur-like covering of cilia and their homogeneous hyaline appearance; they do not stain appreciably with eosin, and many show a number of clear vacuoles, as if a quantity of secretion had been discharged; the lumen of the canal also becomes wider.

Vascular System.—The peri-intestinal plexus is not conspicuous in sections, and is only to be made out as a narrow chink here and there. The considerable spaces between the bases of the intestinal epithelial cells, previously mentioned, belong to the system, since, when, as sometimes, they contain granular matter, this stains red with eosin, like the coagulum in the blood-vessels.

The dorsal vessel passes along the left side of the intestine till it reaches segment vi, or dissepiment 5/6, when it becomes dorsal. Till this point it is closely related to the alimentary tube, and is invested by chloragogen cells or free chloragogen pigment. The ventral vessel, which is quite separate from the intestine, is formed by the union of two branches at the level of the setæ of segment ii.

Vessels are given off to the body-wall, on which they ramify, in most segments of the body. They can be seen as far forwards as segment iv, and backwards nearly to the posterior end. The parietal capillaries may be beautifully seen, towards the anterior end of the animal, as a regular network of longitudinal and transverse vessels, at right angles, marking out a series of regular rectangles on the inner side of the body-wall; the longitudinal capillaries are much closer together than the transverse; these latter are not segmental, there being more than one per segment but not more than two.

The *nephridia* are of the usual tubular and loosely coiled type, and begin in segment vii.

The *cerebral ganglion* is comparatively small, situated at the level of the mouth aperture, in front of the pharynx. Seen laterally, it is of rounded outline, not

elongated antero-posteriorly; sections show it to be markedly bifid in front and behind.

Asexual reproduction was taking place in a number of specimens; chains of more than two were not observed, and are probably not formed, since the posterior animal appears to separate at an early stage, some time before the complete development of the anterior ventral setæ and complete differentiation of the head end; n (the number of segments after which the budding zone forms) = 31, 33, or 36. Four seta-bearing segments, or five and a prostomium in all, are intercalated behind the actual line of separation to form the anterior end of the hinder animal.

Genital Organs.—All the specimens first obtained, and used in writing the foregoing account, were without sexual organs; but by a lucky chance an examination of other material from the same pond at a later date (May) showed a few specimens with well-developed sexual apparatus, as well as one or two in an earlier stage. In order to avoid possible injury or accidents, the specimens were examined only cursorily while alive; and having been fixed almost at once, were subsequently investigated by means of longitudinal and transverse sections.

The gonads appear before the rest of the reproductive apparatus, and disappear entirely before this has reached its full development. In the specimen in which they were seen no other portion of the genital system was present. The *testes* (fig. 1) consisted of paired masses of cells, of considerable size, in segment v, springing by a narrow base from the posterior face of septum 4/5 close to its attachment to the ventral body-wall. The *ovaries*, smaller in this specimen than the testes, were similarly situated in the next posterior segment.

In fully developed specimens the *clitellum* extends over the posterior half of segment v, segments vi and vii, and a small part of viii—nearly three segments altogether. The epithelium (figs. 4, 5, 6) consists of much-elongated cells which show a coarsely reticular structure, the meshes of the network constituting the boundaries of clear spaces with non-staining contents; the nuclei are in two layers, one on the surface, the other at the base of the cells. The clitellum is absent from a transverse strip between the male apertures (fig. 5).

The *sperm-sac*, a backward out-pushing of septum 5/6, extended as far as segment ix in a specimen which was not fully mature. In a later stage, when the accumulation of ova behind it has increased, and, when, perhaps, its contents have been partially discharged, it may be practically confined to segment vi.

The *male funnels* lie in the anterior part of the sperm-sac. They are cup-shaped, with everted ciliated margin; the mouths look upwards and backwards. The funnels touch each other at their inner borders in the middle line, dorsal to the alimentary canal. The wall of the sperm-sac fuses with the outer surfaces of the funnels (fig. 4).

The *vas deferens* is short and stout, with a slightly twisted course and a considerable lumen; it descends to enter the atrium towards its upper surface. Its diameter is

about 30 μ . The lining epithelium is approximately cubical, or in other cases much flattened, the tube being swollen out into an elongated, thin-walled empty chamber (e.g. right side in fig. 5).

The *atrium* (fig. 5) is comparatively small, ovoid in shape, with its long axis vertical, in length 100 μ and in breadth 70 μ . It is lined by a tall, non-staining epithelium, the cells showing a multitude of minute granules thickly scattered in a clear groundwork. The low cells of the vas deferens are continued some little way into the swelling of the atrium, and then give way abruptly to the columnar cells of the type described. The muscular coat is well marked, especially the layer of circular fibres as seen in a vertical section. The peritoneal investment shows a few small cells; but there is no "prostate." The lumen may contain spermatozoa, or may be empty.

The *ejaculatory duct* is rather shorter than the atrium. It is lined by narrow, closely packed columnar epithelial cells; it has a well-marked muscular investment, and is surrounded by numerous small peritoneal cells.

Turning to the female organs which are present in the fully mature animal, the *ovisac*, which as usual encloses the hinder part of the sperm-sac, is an out-pushing of septum 6/7, which may extend as far back as the hinder end of segment ix. Numerous blood-vessels are seen in sections closely applied to its inner surface (these may, of course, all be the coils of a pair of very tortuous loops). The ovisac does not merely cause a backward bulging of the septa (7/8, 8/9) posterior to it; these, as seen in longitudinal sections, maintain their transverse direction between the body-wall and ovisac, and fuse intimately with the periphery of the latter.

The female *funnels* were not seen in any of the stages. They may possibly be represented by a layer of peritoneal cells which occurs, in one specimen, over a limited area on the anterior face of septum 6/7 near its attachment to the ventral parietes; these cells are small, and consist of little else than nuclei. *Oviducts* were not seen at all.

The *spermathecae* (fig. 6) are in segment v. They are a pair of ovoid sacs with their long diameter vertical, and in size measure (maximum) 140 μ by 105 μ ; they are thus, compared with these organs in some other genera of the Naididæ, relatively small. Their epithelial lining is of very irregular height, the cells being of all forms, from a much elongated columnar down to cubical; in this way are formed a number of irregular projections into the cavity; the nuclei are peripherally situated. There is a well-marked muscular coat, on the outside of which are a few scattered peritoneal cells (fig. 6, *p.c.*); the nuclei of these latter are not flattened, and the cells may be attached by a comparatively narrow, almost stalk-like, base. The lumen was empty in all the specimens. The duct (fig. 6, *d.*) is narrow and short; it is lined by a regular columnar epithelium, and has a strong muscular investment. The aperture is remarkable as being at about the level of the middle of segment v, not, as usual, in furrow 4/5; it is at the edge of the clitellum.

Genital setæ (text-fig. 1, *f*) are found in the sixth segment in the fully mature

animal to the number of one to three on each side. These are $110\ \mu$ in length, and stout, $4\ \mu$ in diameter. They were not seen to project from the surface, and were revealed only in sections, where their distal ends were found to be at the level of the superficial epithelium. The shaft is slightly curved, and the distal end is strongly hooked and bifid. The two prongs of the fork are short, and equal in length, but the proximal of the two is very much thicker, at least three times as thick as the distal. The nodulus is markedly distal to the middle of the shaft, less than a quarter (approximately $\frac{2}{3}$) of the length from the distal end.

The *alimentary canal* also undergoes changes in the sexual animal similar to, though on the whole not (in these specimens) as marked as, those which occur in *Dero limosa* (cf. *post*, p. 785). The description which follows relates for the most part only to the most advanced stage of sexual maturity; this has not quite been reached in the specimen from which figs. 4, 5, 6 have been drawn.

The mouth opening persists; but the pharynx disappears as a distinctive structure, and the anterior part of the alimentary canal forms a narrow tube lined by a low epithelium or by cells with no regular epithelial arrangement. In what is perhaps an earlier stage of degeneration there is seen, dorsal to the alimentary tube in the region formerly occupied by the pharynx, a considerable mass, with nuclei but without cell-limits, from which muscular strands radiate towards the parietes. This mass, though now separated from the wall of the tube, apparently represents the dorsal diverticulum in this region, previously described.

The lumen is still present in segment iv, but disappears in v; narrowing, the oesophagus becomes in vi merely band-like, and smaller in transverse section than the ventral nerve cord; indeed, it may almost disappear altogether, and in certain sections it could hardly be recognised if it were not for the investment of chloragogen granules. As far back as segment ix it continues very narrow, approximately $10\ \mu$ in diameter (exclusive of the chloragogen investment); there is no lumen, and the solid cord is hardly more than one cell thick; small vacuolar spaces are seen here and there, though the cells do not seem to be in the last stage of degeneration. Behind this level it gradually widens, and the lumen reappears in segment xi.

In the posterior part of the body the lumen is well marked, though filled with non-staining granular matter. The epithelium is low, scarcely more than cubical, but is not markedly degenerate.

Parasite.—In an early sexual individual a relatively huge sporozoan parasite was found to be occupying the coelomic cavity about the middle of the animal's length. It was somewhat twisted, but its length was estimated at not less than $\cdot 8$ mm., perhaps as much as 1 mm.; in breadth it was $\cdot 09$ – $\cdot 12$ mm. Other stages were seen in several specimens here and there in the alimentary wall; and in all specimens with a well-developed sperm sac this latter contained very numerous small spherical bodies about $20\ \mu$ in diameter, with ill-defined nuclei, presumably belonging to the same life-cycle (fig. 5, *p.*).

The characters which distinguish the present species from *H. waldvogeli*, previously described by BRETSCHER, appear to be the following:—The ventral setæ of segment viii are not here thicker than those of other segments, as BRETSCHER found them in his species; the shaft of the dorsal setæ is considerably less curved than in *H. waldvogeli*, and the prongs are here markedly unequal in length (contrast with BRETSCHER's fig. 12); less important points are the greater size (up to 20 mm.) of the present species (*H. waldvogeli* 5–12 mm.), and the fact that the ventral setæ may be as many as four per bundle (*H. waldvogeli* 2–3 per bundle). I am uncertain what value to attach to the difference in the position of the first nephridium (in *H. waldvogeli* in segment iv, ix, or x, in the present species in vii).

The remarkable features presented by these worms may be summarised as follows:—

(1) The variability of the setæ; the change in the character of the ventral setæ on passing backwards, and the fact that the change is established gradually, and at a level much behind that which is usual in the Naididæ.

(2) The distribution of the dorsal setæ, and the way in which the peculiarity comes about—by the falling out of certain setal bundles in the anterior part of the body.

(3) The distribution of chloragogen pigment, which extends on to the pharynx and even reaches the prostomium.

(4) The form of the pharyngeal cavity, and the pharyngeal gland cells.

(5) The characters of the posterior intestine and the anus.

(6) The presence of parietal capillary vessels, and the situation of the dorsal vessel on the left side.

(7) The atrophy of the alimentary canal in the fully mature sexual individual.

BRETSCHER points out the resemblance of the highly developed vascular system to that of Tubificids. Other Tubificid marks are seen in the comparative absence of differentiation in the alimentary canal behind the pharynx; and in the vertical muscle of the setal bundles, which passes between the dorsal and ventral bundles of the same side of a segment. But there is, of course, no doubt that the genus belongs to the Naididæ, in virtue of the occurrence of asexual multiplication and the characteristic position of the gonads.

Within the Naididæ, the genera *Dero*, *Aulophorus*, and *Branchiodrilus* are recalled by the position of the dorsal vessel and the presence of parietal capillaries. The limitation of the dorsal setæ is reminiscent of *Chætogaster*, where the dorsal bundles have entirely disappeared throughout the body; there is, however, no reason for assuming a direct relationship, and the comparison is of interest only as showing an intermediate condition, which, if it were to progress, would eventuate in the total absence of the dorsal setæ which is characteristic of *Chætogaster*. The closest relationships of *Hæmonais* are quite possibly to *Nais* itself, where five segments are intercalated at the time of fission to form the head of the second animal, and where (as presumably originally in *Hæmonais*) the dorsal setæ begin on segment vi.

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EXPLANATION OF PLATE.

All figures drawn by the help of Zeiss's Abbé drawing apparatus, and with magnification 190. The great swelling of the genital region in the sexual animal is obvious.

REFERENCE LETTERS.

An., anus; *at.*, atrium; *c.g.*, cerebral ganglion; *chl.*, chloragogen granules; *chl.*^I, those in the prostomium; *chl.*^{II}, those behind the cerebral ganglion and over the interior end of the pharynx; *chl.*^{III}, those around the posterior end of the pharynx; *clit.*, cells of the clitellum; *c.m.*, circular muscle fibres; *d.*, duct of spermatheca; *d.v.*, dorsal vessel; *e.p.*, unmodified epithelium between the male pores; *lip*, lip of everted intestinal epithelium at the anus; *l.m.*, longitudinal muscle fibres; *in.*, indifferent cells in the region of growth; *p.*, parasite in sperm-sac; *p.c.*, peritoneal cells; *ph.*, pharynx; *ph. d.*, dorsal diverticulum of pharynx; *ph. gl.*, gland cells on pharynx; *œ.*, œsophagus; *sp. s.*, wall of sperm-sac; *spth.*, spermatheca; *spz.*, spermatozoa (the heads are represented by the black lines; the non-staining tails, not individually visible, are represented by the shading on the dorsal side of the heads); *t.*, testis; *v. def.*, vas deferens; *v.n.c.*, ventral nerve cord; *v.v.*, ventral vessel.

Fig. 1. *Hæmonais laurentii*; longitudinal section through anterior end, rather to one side of the middle line.

Fig. 2. The same; transverse section through middle of pharyngeal region. The dorsal and ventral sides are distinguished by the dorsal vessel and ventral nerve cord respectively; the distortion of shape is probably due to the specimen having been examined under a coverslip in cedar oil before being sectioned.

Fig. 3. The same; longitudinal section through hinder end. The shaded mass ventral to the gut is a thick aggregation of indifferent cells, here not individually represented, from which new segments are being produced.

Fig. 4. The same; transverse section through the seminal funnels.

Fig. 5. The same; transverse section through the region of the atria.

Fig. 6. The same; transverse section through the spermatheca. The spermathecal pores are at the anterior limit of the clitellum; owing to the specimen having been slightly curved dorsoventrally, it was impossible to get accurately transverse sections throughout the series; the present one being slightly oblique shows the clitellum dorsal to the situation of the pores, but not ventrally.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.