THE ENTERONEPHERIC TYPE OF NEPHRIDIAL SYSTEM IN VARIOUS SPECIES OF THE GENERA *LAMPITO* AND *MEGASCOLEX* (OLIGOCHAETA).

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CONTENTS.

1. INTRODUCTION.

With recent advances in our knowledge and understanding of the structure and development of the nephridia in the family Megascolecidae, due largely to the remarkable work of Bahl (1919-1946), the classification of nephridia has undergone great changes. The old terms mega-nephridia and micronephridia have now given place to holonephridia and meronephridia and these are again divided into open or closed, and exonephric or enteronephric. Further, the meronephridia are of two kinds, mega-meronephridia and micro-meronephridia.

The enteronephric type of nephridial system has been described by Bahl in six genera of earthworms, *i.e.*, *Pheretima* (1919), *Lampito* (1924), *Woodwardiella* (1926), *Tonoscolex* (1941), *Megascolex* (1942), and *Travoscolides* (1946). Of these six genera *Megascolex* is the largest and includes about 117 species of which about 56 are Indian (Stephenson 1923); of these 56 Indian species, the nephridia of only twelve species have so far been carefully examined, and this examination has revealed that ten of them are enteronephric, while the other two are exonephric (Bahl, 1946). At the kind suggestion of Prof. K. N. Bahl, I undertook to examine the nephridia of as many of the remaining Indian species as could be made available to me, in order to find out if they were enteronephric or exonephric. Through the courtesy of Dr. B. N. Chopra,

Offg. Director of the Zoological Survey of India, I have been able to obtain specimens of three species of *Lampito* and twelve species of *Megascolex* from the Zoological Survey collection, and find that while all the species of *Lampito* are enteronephric, nine species of *Megascolex* are enteronephric and three are exonephric. Examination of the nephridial system of these species has proved a very laborious task, as all the work had to be carried out on preserved specimens, the preservation of which was not always satisfactory. I am deeply indebted to Prof. K. N. Bahl for his kind supervision and help throughout the course of this work as also for his painstaking criticism of my manuscript. My best thanks are due to Dr. B. N. Chopra for sending me specimens of all these species of *Lampito* and *Megascolex*.

2. ENTERONEPHRIC SPECIES WITH PAIRED OPEN MEGA-MERONEPHRIDIA.

Under this category are included three species, *i.e.*, *Lampito sylvicola*, *Lampito kumiliensis*, and *Lampito escherichi* var. *papillifer*, the nephridial system of which closely resembles that of *Lampito mauritii*, first described by Bahl (1924). The species *Megascolex sylvicola* was, in fact, first described as *Lampito sylvicola* by Michaelsen, but later in 1916 he fused the two genera and included all the species of *Lampito* within the genus *Megascolex*. With the discovery of the enteronephric character of the mega-meronephridia in these three species, there is a very good case now for the renewal of the name *Lampito*, at least as a subgenus of the very large genus *Megascolex*. As I have already mentioned (Vidyavati, 1945), Michaelsen emphasised the condition of the prostates and ignored that of the nephridia in the classification of the species of the sub-family Megascolecinae. It is time now to take into account the condition of the nephridia as well, and on the basis of the presence of enteronephric mega-meronephridia, the reinstitution of *Lampito* as an independent genus is fully justified.[1]

(i) **Lampito sylvicola** Mich.

In 1909, Michaelsen described the nephridial system of *Megascolex sylvicola* as follows :—" In each segment behind the clitellar region is found a pair of meganephridia besides a number of micronephridia. In the more anterior segments only micronephridia were seen." Since Michaelsen wrote his description before the enteronephric system was discovered, he did not examine the nephridial system in detail and so made no mention of the septal excretory canals and the supra-intestinal excretory duct. Bahl (1924) described the nephridial system in two species of *Lampito*, *L. mauritii* and *L. trilobata*, but did not examine this species.

[1] Since this paper was completed, Dr. Chopra has called my attention to a paper by Gates (*Rec. Ind. Mus.*, XL, 1938), who has definitely revived the generic name *Lampito* for these three species. He has described their nephridia but not so fully as I have done, as he was concerned with the entire general anatomy and not with the nephridia alone.

The nephridia are of three kinds :—(i) The first set comprises a pair of *septal mega-meronephridia*, one on each side of the nerve-cord, in almost all the segments of the worm behind the clitellum. These nephridia are large and prominent ; each of them has a pre-septal funnel and a post-septal body lying in the segment following the one containing the funnel ; they discharge their excretory products in each segment into a pair of septal excretory canals which in their turn empty themselves into a median longitudinal supra-intestinal excretory duct ; this duct runs all along the length of the intestine and opens into the intestinal lumen at segmental intervals ; these nephridia are therefore enteronephric. (ii) The second set includes the *integumentary micro-meronephridia*, which are found in all the segments of the worm except the first five, and co-exist with the nephridia of the first set in the post clitellar segments ; they open to the outside and are exonephric. (iii) The *pharyngeal tufted nephridia* forming the third set comprise a single pair of tufts in the fifth segment, one on each side of the gizzard ; the ductules of these nephridia run forwards in bundles and open into the pharynx in the third segment ; they are, therefore, enteronephric.

The excretory system of *Lampito sylvicola*, therefore, closely resembles that of *Lampito mauritii* described by Bahl (1924), but there are two points of difference which may be noted here. The first is the absence of vestigial funnels in *L. sylvicola*. Bahl (1924) writes, " A remarkable feature of the funnel in *Lampito mauritii* and *L. trilobata* is that, although the nephridium in these two species has a single funnel, there are one or more masses of cells (vestigial funnels) projecting from the ciliated tube following the funnel." These masses of cells are absent in *L. sylvicola*. The second point of difference is that in *L. mauritii* there are five pairs of pharyngeal tufted nephridia, while in *L. sylvicola* there is only a single pair of pharyngeal tufted nephridia.

Lampito kumiliensis Aiyer.

This species was instituted by Aiyer in 1929 who describes its nephridial system as follows :—" In the pre-clitellar region there are one pair of tufted nephridia in each segment. In the clitellar region there are four or five similar (but smaller in size) nephridial tufts on each side. From segment XXI onwards, in addition to these small nephridial tufts, there is a meganephridium on each side." The nephridial system of this species also closely resembles that of *Lampito mauritii* ; in fact, Aiyer himself says, " The present form is very closely related to *M. sylvicola*."

The nephridial system consists of :—(i) a pair of *septal mega-meronephridia* in each segment behind the 10th segment. These nephridia are enteronephric, being connected with a supra-intestinal excretory duct through a pair of septal excretory canals on each septum ; (ii) *integumentary micro-meronephridia* which are present in all the segments behind the 12th and co-exist with the mega-meronephridia behind the 20th segment ; these are exonephric, opening to the outside on the body-wall ; (iii) *pharyngeal tufted nephridia*, a single pair in the 5th segment,

opening by a pair of very short sheaves of ductules into the pharynx in the 4th segment and being, therefore, enteronephric ; in the other species the sheaves of ductules are not so short as they are here ; and (iv) seven pairs of *integumentary tufted micro-meronephridia* from 6th to the 12th segment, which are exonephric, opening to the outside by sheaves of long ductules in each segment.

The nephridial system of *L. kumiliensis* is, therefore, distinctly enteronephric and resembles that of *Lampito mauritii* ; but it differs in the fact that of the eight pairs of tufted nephridia, only the anterior single pair opens into the pharynx, while in *L. mauritii*, all the five pairs of tufted nephridia open into the pharynx. In this respect the tufted nephridia of *L. kumiliensis* resemble those of *M. cochinensis* (Bahl, 1942).

(iii) **Lampito escherichi** var. **papillifer** Steph.

Megascolex escherichi var. *papillifer* was instituted by Stephenson in 1915 who describes its nephridial system as follows :—" There are considerable tufts of micronephridia by the side of the alimentary tube in segments V-IX, and micro-nephridia are thinly scattered over the body-wall throughout. The remarkable feature is the presence, in addition, of a large nephridium on each side from segment XVII backwards ; *these have however no connection with the septa.*[1] On opening the specimen and pinning out in the usual way they appear as wavy or curled tubes, emerging on each side from under the intestine, and extending outwards on the body-wall for a distance equal to half the diameter of the intestine or less. Their ventral ends are, as a matter of fact, only just covered by the intestine in this position, as may be seen by drawing the intestine slightly to one side ; towards the posterior end of the body these nephridia are smaller though still easily visible to the naked eye ; they may here be absent on one or both sides or there may be more than one minute tuft." I find that Stephenson's description of nephridia is only partially correct since he has missed altogether the essential enteronephric character of the so-called meganephridia. He is mistaken when he says that the large nephridia have no connection with the septa ; in fact, these nephridia have distinct pre-septal funnels and septal excretory canals on the septa ; they are really large *septal mega-meronephridia* which are distinctly enteronephric. The *integumentary micro-meronephridia* are found in all the segments except the first ten and co-exist with the mega-meronephridia from the 17th segment backwards. They open to the outside and are exonephric. There are seven pairs of *tufted meronephridia* from 3rd to 9th segment, the first pair of tufts being present in the 3rd segment and not in the 5th as described by Stephenson (1915) ; this pair covers the nerve-ring in a dissection and is enteronephric as it opens into the buccal cavity, while the other six pairs are exonephric. The nephridial system of *Lampito escherichi* var. *papillifer* differs from that of *Lampito mauritii*, *L. kumiliensis* and *L. sylvicola* in the absence of a supra-intestinal excretory duct. Here each mega-meronephridium leads into its septal excretory canal which meets its fellow of the other side in

[1] The italicising is mine.

the mid-dorsal line and the common canal opens directly into the intestine. There is no connection from segment to segment through a continuous supra-intestinal excretory duct. This condition in *M. escherichi* is obviously primitive as the nephridial system is separate from segment to segment, although it is enteronephric, while in the other three species the enteronephridial system forms one continuous system over the greater part of the post-clitellar region.

3. ENTERONEPHRIC SPECIES WITH OPEN MICRO-MERONEPHRIDIA.

Under this category are included nine enteronephric species in which there are numerous septal micro-meronephridia in place of the paired meganephridia. The nephridial system of these species resembles that of *Megascolex cochinensis* described by Bahl (1942) and that of *M. travancorensis* described by myself (1945).

(i) **Megascolex insignis** (Mich.).

The species *Megascolex insignis* was instituted by Michaelsen in 1910 and was described again by Stephenson in 1916, but neither Michaelsen nor Stephenson seems to have examined its nephridia, since neither of them makes any mention of them. The nephridial system, according to my observations, consists of :—(1) *septal micro-meronephridia* which are present in the last forty-eight segments in a worm having a total of 98 segments. The structure of each nephridium resembles that of *Megascolex auriculata* (Vidyavati, 1945).and, like it, has a long terminal nephridial canal which runs in a zig-zag manner along the whole length of the posterior face of the septum. All the terminal canals of each side join one another to form a septal canal which meets a similar canal from the opposite side in the mid-dorsal line beneath the dorsal vessel to form one common canal ; this pierces the roof of the intestine and opens into the intestinal lumen, there being no typhlosole in this species, (2) *integumentary micro-meronephridia* which are found scattered on the body-wall in all the segments behind the 16th and co-exist with the septal meronephridia in the last forty-eight segments ; they are attached to the parietes, have no funnels and are exonephric ; (3) *pharyngeal tufted meronephridia* which form a single pair of large tufts in the 4th segment ; they open into the buccal cavity in the 2nd segment by means of a pair of sheaves of long canals ; (4) *integumentary tufted meronephridia* which are present in eleven segments, from the 5th to the 15th ; they are also without funnels and are exonephric and open on the body-wall by sheaves of canals. In the first nine segments (5th to 13th) the canals are long, but in the last two segments (14th and 15th) the canals of the tufted nephridia are short.

The nephridial system of *Megascolex insignis* is, therefore, distinctly enteronephric, although it is separate from segment to segment and clearly resembles that found in *Megascolex trivandranus, M. travancorensis* and *M. auriculata* (Vidyavati, 1945).

(ii) **Megascolex longiseta** (Mich.).

The species *Megascolex longiseta* was instituted by Michaelsen (1907 and 1909) who as usual did not examine its nephridial system, since he does not make any mention of it in his description. My observations are also incomplete, as I had only one already dissected and partially damaged specimen. As far as I can make out, the nephridial system of this worm consists of :—(1) *septal micromeronephridia* which are present in the last ninety-two segments, 20 to 25 in number on each side of the septum ; these nephridia possess pre-septal funnels and post-septal bodies and are enteronephric, discharging their excretory products into the intestine in each segment. In structure each nephridium is identical with that of *Megascolex cochinensis* (Bahl, 1942), consisting of a short straight limb and a long twisted loop ; the terminal canal is very long and runs in a zig-zag manner across the whole width of the septum to enter the septal excretory canal which runs close to the inner intestinal border of each septum. The two septal excretory canals of each septum meet in the mid-dorsal line just on the outer surface of the roof of the intestine and form a common excretory canal which immediately penetrates the shallow typhlosole and opens into the lumen of the gut in the mid-dorsal line ; (2) *integumentary micro-meronephridia* which are found scattered on the body-wall from the 15th to the 91st segment ; they are attached to the parietes, have no funnels and are exonephric ; (3) *pharyngeal tufted meronephridia* which form a pair of large tufts in the 5th segment and open into the pharynx by a pair of long sheaves of canals ; (4) *integumentary tufted nephridia* which are present in the 6th to the 14th segments ; they are also without funnels but are exonephric, opening on the body-wall by sheaves of canals.

The nephridial system of *Megascolex longiseta* is, therefore, distinctly enteronephric and closely resembles that of *M. cochinensis* and *M. cingulatus* (Bahl, 1942 and 1946), the only difference being that in the former the terminal excretory canals are longer and run in a zig-zag manner along the whole width of the septum while in the latter two species they are more or less straight.

(iii) **Megascolex varians** var. **insolitus** (Steph.).

The species *Megascolex varians* var. *insolitus* was instituted by Stephenson in 1915, who describes its nephridial system as follows :— " The excretory system is micronephridial. There is a large tuft on each side of the posterior part of the pharyngeal mass, but none on the body-wall in the region of the gizzard or in front ; from this point they are few till clitellum is reached. In the clitellar region they are thickly set, and behind this they form a transverse line in each segment behind the anterior septum." This description is obviously inadequate. As I find it, the nephridial system consists of :—(1) *septal micro-meronephridia* which begin from the 6th post-clitellar or 22nd segment and are present all along the rest of the body of the worm. These nephridia possess pre-septal funnels with very long necks each of which measures about 350 μ in length. The number of septal nephridia in each segment

is very small, there being only about ten nephridia on each side of a segment. These nephridia are enteronephric, discharging their excretory products into the intestine in each segment exactly in the same way as in *M. trivandranus* (Vidyavati, 1945). (2) *integumentary micro-meronephridia* which are found only in the four clitellar and the first five post-clitellar segments, *i.e.*, from segments XIV-XXII; they are attached to the parietes, have no funnels and are exonephric; (3) *pharyngeal tufted meronephridia* which form a pair of large tufts in the 5th segment and open into the buccal cavity in the 2nd segment; (4) *integumentary tufted meronephridia* which are present from the 6th to the 10th segment; they are without funnels and are exonephric, opening on the body-wall by long sheaves of ductules. Stephenson unfortunately missed altogether these integumentary tufted meronephridia.

The nephridial system of *Megascolex varians* var. *insolitus* is, therefore, distinctly enteronephric and closely resembles that of *M. trivandranus*, etc., the only special feature being that here the necks of the funnels are extremely long.

(iv) **Megascolex polytheca** (Steph.).

This species was instituted by Stephenson in 1915 who describes its nephridial system very briefly thus: "The excretory system is micronephridial." According to my observations the nephridial system consists of:—(1) *septal micro-meronephridia* which are present in the last 103 segments; these nephridia are enteronephric and resemble in their form and arrangement those of *Megascolex trivandranus* (Vidyavati, 1945); (2) *integumentary micro-meronephridia* which are found scattered on the body-wall from the 16th segment to one segment in front of that in which the septal nephridia begin; they are attached to the parietes, have no funnels and are exonephric; it should be noted that there are no integumentary nephridia in the last 104 segments; (3) *pharyngeal tufted meronephridia* which form a single pair of large tufts in the 5th segment; they open into the pharynx in the 2nd segment through a pair of sheaves of long canals; (4) *integumentary tufted meronephridia* which are present in ten segments, *i.e.*, from 6th to 15th; they are without funnels but are exonephric and open on the body-wall. The sheaves of canals of the first pair (of the 6th segment) extend over a long distance; some of the canals open on the 5th segment, while others open on the 4th, 3rd and 2nd segments; there are a few canals which extend even as far forward as to open on the first segment. The nephridial system of this species, therefore closely resembles that of *M. trivandranus* (Vidyavati, 1945).

(v) **Megascolex kavalianus** (Steph.).

The species *Megascolex kavalianus* was instituted by Stephenson in 1915 who describes its nephridial system as follows:—"The excretory system is micronephridial; the nephridia are relatively few and scattered, most numerous on the body-wall in the clitellar segments." According to my observations the nephridial system consists of:—(1)

septal micro-meronephridia which are present in the last 49 segments in a worm having a total number of 97 segments; these nephridia are enteronephric and resemble those of *M. trivandranus* (Vidyavati, 1945). As in *M. insignis*, each transverse row on each side of the nerve-cord contains only 10 to 12 nephridia but they are larger in size than those of *M. insignis*; (2) *integumentary micro-meronephridia* which are found scattered on the body-wall from 13th to the 48th segment and are attached to the parietes; they have no funnels and are exonephric; (3) *pharyngeal tufted nephridia* which form a single pair of large tufts in the 5th segment; they open into the pharynx in the 2nd segment by a pair of long sheaves of canals and are enteronephric; (4) *integumentary tufted nephridia* which are present in seven segments, from 6th to the 12th; they are also without funnels and open on the body-wall by long sheaves of ductules. The tufts in this species are very small and consist only of about ten to twelve nephridia, while in the other species the tufts are much larger and are at least double the size.

(vi) **Megascolex hortonensis** (Steph.).

The species *Megascolex hortonensis* was instituted by Stephenson in 1915 who just mentions that "the excretory system is micronephridial." The excretory system of this worm also consists of four sets of nephridia, *i.e.*, *septal micro-meronephridia*, *integumentary meronephridia*, the *pharyngeal tufted meronephridia* and *integumentary tufted meronephridia*. In a worm having 134 segments the *septal micro-meronephridia* with pre-septal funnels and post-septal bodies occur in the posterior 94 segments; they ultimately open into the intestine in the same way as do the septal nephridia of *M. trivandranus* (Vidyavati, 1945). The *integumentary meronephridia* occur from the 14th to the 48th segment. In the clitellar segments (XIV-XVI) they form a thick forest of nephridia and are distributed irregularly. In the post-clitellar segments they are few in number and are attached to the parietes, and are exonephric. The *pharyngeal tufted nephridia* occur in the 6th segment and open by long sheaves of ductules into the buccal cavity in the 2nd segment; these sheaves of ductules soon get embedded into the pharyngeal wall and run on it for about three segments before opening into the buccal cavity. Seven pairs of *integumentary tufted meronephridia* occur from the 7th to the 13th segment. They are exonephric and open to the outside by long wavy sheaves of ductules as in *M. trivandranus* (Vidyavati, 1945).

(vii) **Megascolex multispinus** (Mich.).

The species *Megascolex multispinus* was instituted by Michaelsen in 1897 who did not describe its nephridial system at all. The nephridial system consists of:—(1) *septal micro-meronephridia* which are arranged in transverse rows on the posterior faces of the septa in the last 53 segments in a worm having a total of 133 segments; they have pre-septal funnels and post-septal bodies and have long terminal canals which run along the whole length of the septa in a zig-zag manner and

meet dorsally with one another to form a single canal on each side of a septum, which, in its turn, meets a similar canal of the opposite side and opens into the intestine in the same manner as in *M. trivandranus* (Vidyavati, 1945); (2) *integumentary meronephridia* while are found in all the segments except the first four, and co-exist with septal meronephridia in the last 53 segments. In the clitellar segments ($\frac{3}{4}$ XIV—$\frac{1}{2}$ XVIII) they form a thick cluster, while in the post-clitellar segments they are scattered and are only a few in number; they are attached to the parietes and are exonephric; (3) the *pharyngeal tufted meronephridia* which form a single pair in the 6th segment and open into the pharynx by short ducts as in *Eutyphoeus nicholsoni* (Bahl, 1942). There are no integumentary tufted nephridia.

Megascolex multispinus is, therefore, distinctly enteronephric and differs from the other species of *Megascolex*, *e.g.*, *Megascolex trivandranus* and *M. cochinensis*, etc., in having no integumentary tufted meronephridia behind the pharyngeal meronephridia.

(viii) **Megascolex quintus** (Steph.).

The species *Megascolex quintus* was instituted by Stephenson in 1913 but he does not describe its nephridial system. As its nephridial system closely resembles that of *M. insignis*, I do not think it is necessary to describe it in detail. The four types of nephridia are :—(1) *septal micromeronephridia*, about 10 on each side of the nerve-cord in each segment; they occur in the posterior 50 segments in a worm having a total number of 133 segments; they open into the intestine in the same way as in *M. trivandranus*; (2) *integumentary meronephridia* which occur in the four clitellar and 66 post-clitellar segments; they are attached to the parietes and are exonephric; (3) *pharyngeal tufted meronephridia* which form one pair in the 6th segment and open into the pharynx by short ductules as they do in *M. multispinus*; (4) seven pairs of *integumentary tufted meronephridia* in segments VII-XIII; they open to the outside by short ductules of their own and are exonephric.

(ix) **Megascolex funis** (Mich.).

The species *Megascolex funis* was instituted by Michaelsen in 1887 who as usual does not describe its nephridial system. As its nephridial system closely resembles that of *M. cochinensis* (Bahl, 1942), I shall only mention its leading features. The *septal meronephridia* are present only in the posterior one-third of the body as in *M. travancorensis* var. *proboscidea* (Vidyavati, 1945); they open into the intestine and are enteronephric. The *integumentary meronephridia* occur in the clitellar and the anterior half of the post-clitellar segments, and are exonephric. The *pharyngeal tufted meronephridia* occur as a single pair in the 5th segment in front of the gizzard and open into the buccal cavity in the 2nd segment by a pair of long sheaves of ductules. The *integumentary tufted meronephridia* are present behind the 5th segment but as the anterior part of the worm was already dissected I could not ascertain th eir exact number.

The nephridial system of *M. funis* is, therefore, distinctly enteronephric and resembles that of *M. cochinensis* (Bahl, 1942).

4. Exonephric species.

Under this category are included those forms, the nephridial system of which is purely exonephric, there being no enteronephridia (except the pharyngeal). Bahl (1945 and 1946) has already described two exonephric species of *Megascolex* and it is interesting to add three more species to this category, but it may be noted that both the previously described exonephric species have only closed nephridia, while of the exonephric species described by me, one has open septal nephridia but is still exonephric.

(a) *Exonephric Species with Open Nephridia.*

(i) **Megascolex filiciseta** (Steph.).

This species was instituted by Stephenson in 1925 who describes its nephridial system as follows:—"The excretory system is micronephridial but its peculiarities merit a short description. In each segment the nephridia—one might almost say, the nephridium,—appear on either side as a bushy tuft attached by a narrow base, as numerous twigs springing from a common stem, or sometimes radiating from a common centre. The tufts of successive segments form a regular longitudinal series; *there is no connection with the septa.*[1] The tufts begin in front just behind the pharynx, where they are large structures lying at the sides of the oesophagus between the successive cone-shaped septa. Some distance behind the clitellum it may be possible to distinguish a dorsally (laterally as the parts lie in the dissection) directed loop which is rather larger than the rest; towards the posterior end the loop gains an increased prominence, but it still has no attachment to the septum; no funnels could be seen microscopically in tufts from either anterior or posterior regions, but I can scarcely regard this observation as conclusive." A careful examination of the nephridia has revealed that although Stephenson was correct in describing the nephridia as bushy tufts, he made a mistake in saying that the nephridia had no connection with the septa and that they had no funnels. In fact, the bushy nephridia are of four kinds:—(i) *septal meronephridia* which are found in the last 50 segments in a worm having a total of 111 segments; they possess pre-septal funnels and post-septal bodies but open to the outside by their short terminal nephridial ducts. Each tuft of septal meronephridia contains about 25 nephridia, each with its own pre-septal funnel. Both the funnels and the bodies of the nephridia are closely situated so as to form clusters. All attempts at finding out the septal excretory canals and the supra-intestinal duct were unsuccessful and I can, therefore, conclude that these nephridia are exonephric and resemble those of *Megascolex dubius* where also they occur in tufts throughout the body (Bahl, 1926); (ii) *integumentary meronephridia*, which are without funnels and are found in segments X to LXI; they

[1] The italicising i ∞ mine.

also form tufts and open to the outside and are exonephric (iii) *tufted meronephridia* with long ductules form *seven* pairs in segments III-IX ; of these, five pairs are exonephric while the other two are enteronephric. The first two pairs in the 3rd and 4th segments open to the outside in the first segment by sheaves of long ductules which run side by side. The next two pairs of tufts of the 5th and 6th segments open into the pharynx in the same manner as do the pharyngeal nephridia in the other species of *Megascolex*. The next three pairs of segments VII-IX again open to the outside by sheaves of long ductules. Although the nephridia are tufted throughout the worm, the tufts of the anterior seven segments are peculiar in that they have very long ductules. This worm shows an unique condition in having two pairs of tufted exonephridia in front of the pharyngeal enteronephridia and in having all its nephridia arranged in tufts.

(b) *Exonephric Species with Closed Nephridia.*

Bahl (1945 and 1946) has already described two exonephric species of *Megascolex* with closed nephridia, *i.e.*, *M. templetonianus* and *M. caeruleus* and with the two species listed below the total of such species now comes to four.

(i) **Megascolex nureliyensis** (Mich.).

This species was instituted by Michaelsen in 1897 and was described later also by Stephenson (1915), but neither Michaelsen nor Stephenson makes any mention of its nephridial system.

According to my observations, the first three segments of the worm have no nephridia. The fourth segment contains the pharyngeal tufted nephridia which have the same arrangement and distribution as described by Bahl (1945) in *Megascolex templetonianus* and open into the buccal cavity. Behind the fourth segment all the segments possess integumentary meronephridia which are quite small but are clearly visible under a binocular dissecting microscope. At a few places some of the integumentary nephridia are bigger than others. All the nephridia, whether pharyngeal or integumentary, are closed, there being no funnels on any of the nephridia. This species differs from *M. templetonianus* in having shorter pharyngeal nephridial ducts and in the absence of tufted meronephridia of segments VI to XII and also in the absence of phagocytic organs. The nephridial system of *M. nureliyensis* closely resembles that of *M. caeruleus*, as in both of them the tufted integumentary meronephridia are absent, the only nephridia present being the pharyngeal and the integumentary.

(ii) **Megascolex ratus** (Cogn.).

The species *Megascolex ratus* was instituted by Cognetti in 1911 and later Stephenson (1916) added a short note amplifying Cognetti's description, but he does not describe its nephridial system. There are only two types of nephridia here as in *Megascolex caeruleus* (Bahl, 1946);

i.e., (1) the *pharyngeal nephridia* which form a pair of big tufts in the 5th segment and open into the pharynx by a long sheaf of ductules on each side and (2) the *integumentary nephridia* which occur in all the other segments. They are very small in size and lie scattered over the body-wall and open to the outside and are exonephric. The nephridial system of this worm also resembles that of *Megascolex caeruleus*, but the phagocytic organs of *M. caeruleus* are absent in this species.

5. SUMMARY.

The enteronephric type of nephridial system had previously been found by Bahl in two species of *Lampito* and ten species of *Megascolex*. The results of this investigation extend the distribution of the enteronephric type of nephridial system over another three species of *Lampito* and nine species of *Megascolex*, but at the same time it has been found that three species of *Megascolex* are exonephric besides the two already known. Altogether five species of *Lampito* and nineteen species of *Megascolex* are now known to be enteronephric and five species of *Megascolex* to be exonephric. It may, therefore, be justifiably said that the genus *Megascolex* is largely enteronephric. On the basis of the nephridial system the genus may be divided into three groups : (1) *Megascolex* proper, in which there are septal meronephridia in the greater part of the post-clitellar region of the body and they are enteronephric, (2) the genus *Lampito* comprising *five* species in which the post-clitellar segments possess paired mega-meronephridia and they are also enteronephric, and (3) the exonephric species of *Megascolex* in which all the micro-meronephridia except the pharyngeal are exonephric.

The following species of *Megascolex* are enteronephric :—(1) *Megascolex ceylonicus*, (2) *M. sarasinorum*, (3) *M. cochinensis*, (4) *M. konkanensis*, (5) *M. travancorensis*, var. *ghatensis*, var. *proboscidea*, and var. *typicus* (6) *M. trivandranus*, (7) *M. auriculata*, (8) *M. cingulatus*, (9) *M. campester*, (10) *M. bifoveatus*, (11) *M. insignis*, (12) *M. longiseta*, (13) *M. varians* var. *insolitus*, (14) *M. polytheca*, (15) *M. kavalianus*, (16) *M. hortonensis*, (17) *M. multispinus*, (18) *M. quintus* and (19) *M. funis*.

All the species of *Lampito* are enteronephric :—(1) *L. sylvicola*, (2) *L. kumiliensis*, (3) *L. escherichi* var. *papillifer* ; (4) *L. mauritii* and (5) *L. trilobata*.

The following species of *Megascolex* are exonephric :—(1) *M. templetonianus*, (2) *M. caeruleus*, (3) *M. filiciseta*, (4) *M. nureliyensis*, and (5) *M. ratus*. Of these four species *M. filiciseta* has open meronephridia, while the other three have closed nephridia.

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