

ON THE NEPHRIDIA AND COELOMODUCTS OF SERPULIMORPHA AND CIRRATULIDAE.

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I. INTRODUCTION.

Goodrich (1900, 1945) gave a new orientation to the study of nephridia and genital ducts, particularly in the Annelida. Since the publication of Goodrich's work, there have been, however, very few investigations in this field, and there are still some problems that require elucidation. Our knowledge of the thoracic organs of the Serpulimorpha is incomplete, especially in regard to their form and structure. Besides the thoracic organs, paired segmental organs with wide funnels are noticed in the abdomen and in some instances in the thorax also (Evenkamp, 1931), but their homology and relation to the thoracic organs are uncertain.

The present paper is a study of the morphology of the thoracic organs and also of the posterior segmental organs in the different species of the Serpulimorpha. A study of the segmental organs of the Cirratulidae is also included, as they recall to some extent features noticed in the Serpulimorpha. The segmental organs of the Cirratulidae have an additional interest. In the Cirratulid *Dodecaceria concharum* (= *Dodecaria concharum*), the posterior segmental organs, as shown by Caullery and Mesnil (1898), are formed entirely from the coelomic epithelium and are independent of the nephridial component. Such a condition is of rare occurrence in the Polychaeta and warrants a detailed study.

II. MATERIAL AND METHODS.

The specimens studied in the present investigation are (1) *Dasychone cingulata* Grube, *Mercierella enigmatica* Fauvel, *Sabellaria spinulosa* Leuckart and the Cirratulid *Audouinia anchylochaeta* Schmarda. Specimens of *Dasychone cingulata* were

obtained from Madras harbour, where they are found in abundance on the boulders. *Mercierella enigmatica* was obtained from the Ennore backwaters near Madras. It lives in calcareous tubes which are coiled at the base and attached to the oyster shells. *Sabellaria spinulosa* was obtained in a collection of specimens dredged from the sea near Madras. *Audouinia anchylochaeta* was obtained in large numbers in the Madras harbour.

The worms were narcotized by treatment with an 8% solution of magnesium chloride. The narcotized worms were dropped into the fixative and immediately afterwards cut into small pieces. Bouin's fluid, Bouin Duboscq, and Susa's fluid gave the best results. The sections were cut 8μ to 12μ thick and stained in Heidenhain's iron haematoxylin and counterstained with eosin.

III. PREVIOUS WORK.

Among the earlier zoologists Claparédé (1873), Haswell (1884) and Meyer (1887) investigated the nephridial system of the Serpulimorpha and described the thoracic organs and the abdominal segmental organs as well. But to Goodrich (1900), belongs the credit of demonstrating that the nephridia of the Serpulimorpha are of the mixonephridial type and that the internal ciliated funnels are of the nature of coelomostomes. More recently Evenkamp (1931) described in detail the thoracic organs and the posterior segmental organs in the Sabellid worms *Euchone papillosa* and *Laonome kroyeri* and showed that they were remarkable in having a net-like formation in the thoracic region and in the occurrence of segmental organs functioning as gonoducts. The investigations of Thomas (1940) and Segrove (1941) support in general the conclusions of the earlier authors. Meyer (1887) observed that the thoracic organs in *Sabellaria alveolata* resemble those of the Sabellidae and Serpulidae, and open to the exterior by a common median duct. But according to Dehorne (1908) the thoracic organ of *Sabellaria alveolata* is independent of its fellow and opens by a separate dorsolaterally situated nephridiopore. Dehorne (1908) has pointed out the resemblance between the thoracic organs of the Sabellaridae and the anterior nephridia of the Cirratulidae. The nephridia of the Cirratulidae were described by Claparédé (1869), Cosmovice (1879) and Cunningham (1887). Caullery and Mesnil (1898) observed that in *Dodecaceria concharum*, besides the anterior nephridia there are segmental organs with large funnels which develop late during the epitokous phase from the coelomic epithelium and serve for the exit of the genital products. In the atokous forms such structures are absent. According to Goodrich (1900) the anterior pair of nephridia and the posterior segmental organs are of the nature of mixonephridia, with the nephridial portion predominant in the anterior pair, but reduced in the posterior segmental organs which are characterized by prominent coelomostomes.

IV. NEPHRIDIA AND COELOMODUCTS.

(a) *Dasychone cingulata*:

The nephridial system in *Dasychone cingulata* consists of an anterior pair of thoracic organs and a series of large-funnelled segmental organs occurring both in the thorax and abdomen. On dissecting the worms, the thoracic organs are seen as thin-walled, much lobulated and sac-like structures, situated on either side of the oesophagus and extending through the first six or seven segments of the thorax (Fig. 1a). The thoracic organ belongs to the first thoracic segment and consists of four parts:—First the ciliated funnel which extends into the head segment and reaches a point close to the brain and immediately behind a band of muscles of the head segment (Fig. 1b). The funnel is asymmetrical and its position is similar to that found in the Serpulid *Psygmodranchus protensus*. It is lined with flattened and

prominently ciliated epithelium. The cytoplasm stains homogeneously and the cell-limits are not distinct, the nuclei occurring at intervals along the margin of the funnel. Succeeding the funnel, is a narrow canal which forms the beginning of the descending limb of the thoracic organ (Fig. 1c and Ph.m. 1). It runs backwards and gradually widens. The wall of the canal is formed of a single layer of columnar cells with rounded nuclei and a number of chromatin bodies. The cytoplasm is granular, showing dark-staining bodies, probably of excretory nature. The ciliation in the canal is less dense than in the funnel. The descending limb passes into a sac-like ascending limb which occupies a major portion of the space between the oesophagus and the body wall (Fig. 1c and Ph.m. 1). The walls of the ascending limb are folded inwards and the folds present an irregular net-like appearance in sections. The epithelium lining the ascending limb is composed of much flattened cells, with vacuolated cytoplasm and long flagelliform cilia, not unlike those in the glandular sac of the thoracic organs of *Eupomatus elegans* (Haswell, 1884). The beat of the cilia in the canals appears to be reversible, and it is possible that the current of water flows in both directions in the canals. The ascending limb passes anteriorly into a narrow duct which runs at first laterally, and then dorsally to the corresponding part of the opposite side, with which it unites to form a median duct. The median duct runs dorsal to the brain and opens to the exterior at the base of the branchiae. The terminal part of the duct is short and is lined with flattened cells. A thin coelomic epithelium covers the outer surface of the thoracic organ in the different regions.

The segmental organs are paired and provided with large funnels and short ducts. They occur in the thorax from the second thoracic segment onwards along with the thoracic organs, and also in all the abdominal segments. The form, structure and position of the segmental organs differ from those of the thoracic organs. Each segmental organ lies ventrolaterally close to the septum and opens into the coelom by a large funnel ventral to the dorsal longitudinal muscles. The greater part of the segmental organ is formed by the funnel which narrows into a short canal opening to the exterior ventrally to the parapodium. The funnel and the duct lie in one and the same segment. The lining of the funnel is composed of cubical ciliated cells having oval, or rounded nuclei with prominent nucleoli and chromatin. The cytoplasm of the cells stains uniformly and there are no excretory granules. The cilia are densely arranged and arise from basal granules arranged in a row in the cell bodies (Fig. 1e). A fold of connective tissue extends from the septum and supports the outer wall of the funnel on the side adjacent to the septum. The lining of the duct does not present any special features. The duct may be regarded as a continuation of the base of the funnel. In some cases the genital products were noticed in their passage to the exterior through the funnel and duct.

(b) *Mercierella enigmatica* :

Mercierella enigmatica agrees with other Serpulids in having the thoracic nephridia reduced to a single anterior pair situated in the first setigerous segment. Each thoracic organ consists of a narrow ciliated funnel leading into a U-shaped tube, the ascending limb of which joins its fellow of the opposite side to form a median tube opening to the exterior at the anterior end. The funnel (Fig. 1f) is V-shaped in sections with thin walls, the cells of which are much flattened and thickly ciliated. The funnel is continued into a narrow canal which gradually widens out into a sac-like structure forming the ascending limb of the organ (Fig. 1f). The walls of this sac-like expansion are composed of columnar ciliated cells. The cilia are long and flagelliform, similar to those described in the ascending limb of *Dasychone Cingulata*. Accumulations of dark-staining granules, probably of an excretory nature, are found in the cells. Externally the sac is covered by a thick fibrous coat. In front, the sac narrows into a duct which joins

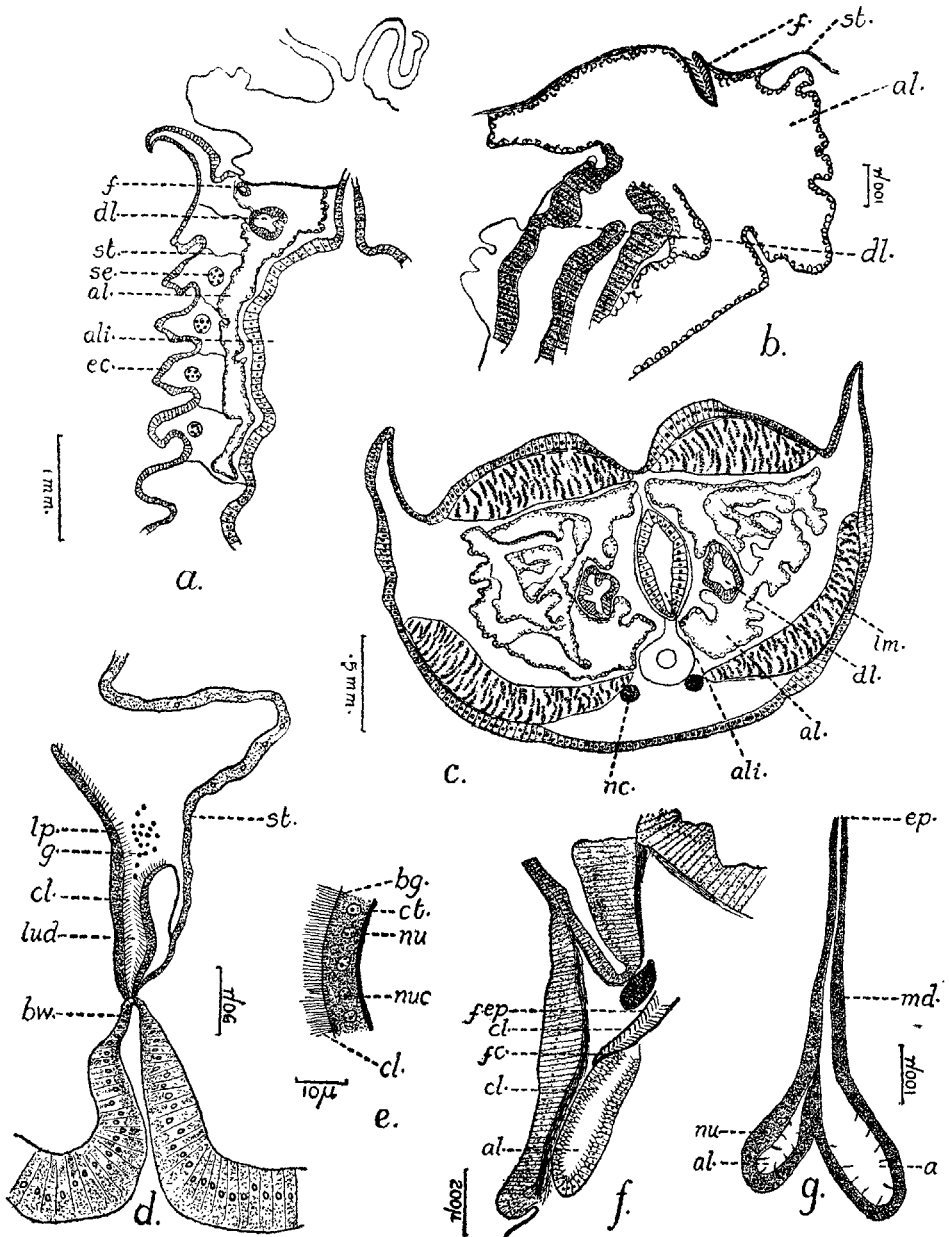


FIG. 1.

All figures have been drawn with camera lucida.

Dasychone cingulata :

- a. Thoracic organ of *Dasychone cingulata* as seen in a horizontal section of the anterior end of the worm.
- b. The ciliated funnel of the thoracic organ as seen in a horizontal section of the worm.
- c. Transverse section of the worm passing through the thoracic organs. Both the descending and the ascending limbs of the organ are seen in the section.
- d. Gonoduct of the thorax as seen in a horizontal section of the worm.
- e. A portion of the wall of the gonoduct.

Mercierella enigmatica :

- f. Longitudinal section of the ciliated internal funnel of the thoracic organ.
- g. The terminal portion of the thoracic organs of either side which join together to form a common duct as seen in horizontal sections of the worm.

(Key to lettering—see page 39.)

with its fellow of the opposite side to form a median duct (Fig. 1g), leading to the exterior. The lining of this canal is composed of flattened cells, having a few cilia and without excretory granules or other special inclusions.

The paired segmental organs which function as gonoducts are confined to the abdomen and do not extend into the thoracic segments. The most prominent part in each segmental organ is a large trumpet-shaped funnel opening ventrolaterally, above the ventral bundle of longitudinal muscles (Fig. 2a). The lips of the funnel are unequal and composed of cubical cells with long cilia, and without any special inclusions. The funnel is continued into a duct which loops round the longitudinal muscles and passes to the external pore (Ph.m. 2) which is situated ventrally, and somewhat towards the median line. The lining of the duct is similar to that of the funnel. Genital products are sometimes found in the duct. The external aperture is closed by a thin membrane which is probably ruptured by the accumulation of the genital cells at the aperture, as has been recorded in the case of the Sabellids, *Laonome kroyeri* and *Euchone papillosa* (Evenkamp, 1931). The general structure and disposition of the segmental organs recall those of *Pomatoceros triqueter* (Thomas, 1940).

(c) *Sabellaria spinulosa* :

The general lay-out of the nephridial system of *Sabellaria spinulosa* resembles that of the Sabellids and Serpulids. The thoracic organs are formed in the first three segments of the thorax, lying on either side of the oesophagus. They form U-shaped loops, the outer limbs of which are short, narrow, and lie in close proximity to the body wall, while the inner limbs are expanded into wide sac-like structures (Fig. 2b). The outer limb opens into the coelome by a ciliated funnel with unequal lips which is situated at the dorso-lateral border of the segment, close to the longitudinal muscles. The funnel is lined with flattened cells bearing long cilia and leads into a narrow canal which forms the commencement of the descending limb. The cells lining the descending limb are narrow, with rounded nuclei and granular cytoplasm and bear a sparse coating of cilia. The ascending limb, which forms the inner loop of the thoracic organ, expands into three superposed sac-like structures closely surrounding the oesophagus (ph.m. 3). The cells lining the sacs are characteristically vacuolated and possess basally situated nuclei. The sacs of the two sides in each pair remain separate anteriorly, and end blindly. There is no median duct as is seen in the thoracic organ of Sabellids and Serpulids. Posteriorly, the dorsal sacs of the thoracic organ appear to open into each other, dorsal to the oesophagus. Dehorne (1908) regarded the external opening of the thoracic organs to be situated above the parapodia of the second segment. My observations fail to confirm the presence of any such external opening. A careful study of the sections shows that a lateral extension of the thoracic organ enters the parapodial cavity of the second segment and reaches the branchia where it ends blindly (Ph.m. 3). Anteriorly also there is no evidence of a common median duct leading to the exterior. The close association of the sac-like expansions of the ascending limb with the oesophagus in this species seems significant. The walls of the sac and the oesophagus are thin and it is possible that they allow diffusion of substances into the lumen of the oesophagus. The absence of a definite external pore would lend additional support to this view. The absence of a common median duct may be explained as a secondary reduction. Paired segmental organs occur in all segments behind the 8th segment. The funnel is wide and the duct connected with it is short (Fig. 2c). The opening of the funnel lies ventrolaterally below the parapodia. Both the funnel and the duct lie in the same segment. The epithelium of the funnel as well as the duct is composed of a single layer of cells possessing a dense covering of long cilia, and a uniformly staining cytoplasm with round nuclei. There is no histological difference between the funnel and duct.

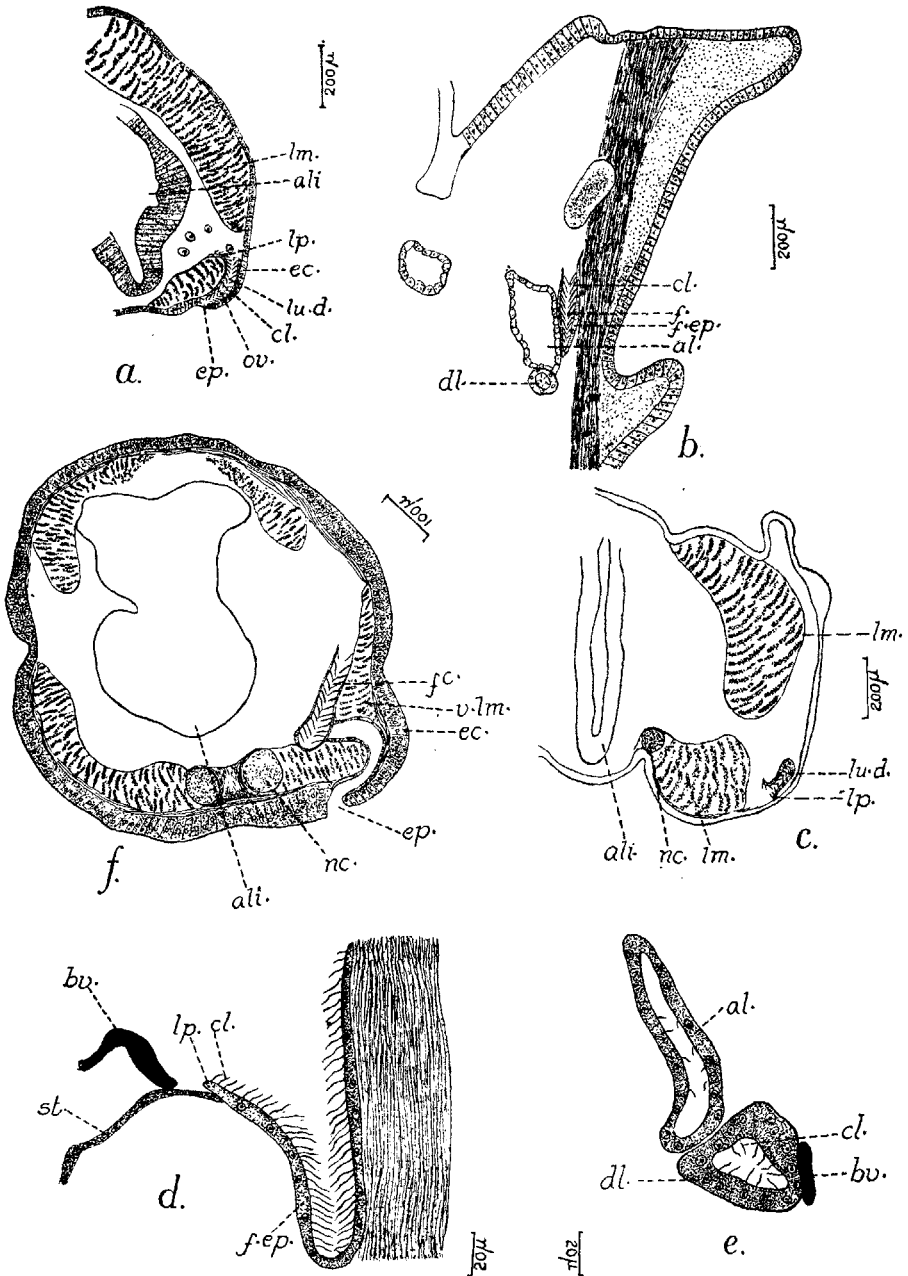


FIG. 2.

All figures have been drawn with camera lucida.

Mercierella enigmatica: a. Abdominal segmental organs which serve as gonoducts as seen in a transverse section of the worm passing through the abdominal region.

Sabellaria spinulosa: b. Longitudinal section of the internal ciliated funnel of the thoracic organ. c. The posterior segmental organ of the abdomen as seen in a transverse section of the worm.

Audouinia anchylochaeta: d. A longitudinal section of the internal ciliated funnel of the anterior nephridium. e. A section of the ascending and descending limbs of the anterior nephridium. f. The terminal part of the nephridial canal and the nephridiopore which lies ventrolaterally as seen in a transverse section of the worm at its anterior end.

(Key to lettering—see page 39)

(d) *Audouinia anchylochaeta* :

The nephridia in this species are reduced to a single anterior pair situated in the first two setigerous segments. There are no other segmental organs. Each nephridium is in the form of a slender U-shaped structure, with the two limbs closely applied to each other. The funnel of the nephridium, which is provided with unequal lips and a dense coat of cilia, lies in front of the septum between the second achaetous segment and first setigerous segment (Fig. 2*d*), and opens into the coelom in the former segment. The epithelium lining the funnel is thin and formed of a single layer of ciliated cells. The cell limits are not clearly defined, and the nuclei are found at intervals. The cilia are long and prominent in the region of the funnel but gradually become short as the funnel passes into the descending limb which has an almost straight course as it passes backwards. It is lined by cubical ciliated cells, with prominent round nuclei and cytoplasm showing a number of concretions which stain dark in iron hæmatoxylin. The cilia are few and in the more distal parts of the limb they are fewer still. The descending limb of the nephridium extends behind into the second setigerous segment where it turns forwards, forming a bend which leads to the ascending limb. The cells of the limb are flat, but otherwise similar to those of the descending limb. Near the anterior septum of the first setigerous segment, the ascending limb bends abruptly at a right angle and curves to the ventral wall of the body where it opens to the exterior by the nephridiophore (Fig. 2*f* and Ph.m. 4). The walls of the terminal part of the nephridial canal from the point of its curvature from the main body are very thin, and the cells much flattened, with small nuclei and reduced cilia. The nephridiophore is a small oval aperture in the ventral epidermis, close to the ventral longitudinal muscles (Fig. 2*f* and Ph.m. 4). A thin, coelomic epithelium with oval nuclei covers the nephridium.

In segments other than the first two setigerous segments, no trace of segmental organ is found. In mature specimens the posterior segmental compartments, from the twelfth segment backwards, are filled with reproductive elements but there are no gonoducts for their liberation to the exterior.

V. DISCUSSION.

A comparison of the thoracic organs in *Dasychone cingulata*, which are described in this paper, with those of other Sabellids shows that they bear no resemblance to any one particular type. In their extension into a greater part of the thorax, they resemble those of *Spirographis spallanzanii*, and in the expansion of the outer loop to form a sac-like structure they resemble those of *Euchone papillosa*, and in the position of the funnel they resemble those of the Serpulid *Psygmodbranchus protensus*. The thoracic organs of the Sabellidae show a variety of form and structure. In the Serpulidae the thoracic organs show a wider range of variation, and two distinct types have been described:—(1) In forms like *Psygmodbranchus protensus* the thoracic organ is typically U-shaped with an open internal funnel and common median duct at the anterior end, and (2) in forms like *Eupomatus elegans* (Haswell, 1884) and *Filograna implexa* (Faulkner, 1930) the thoracic organs are not U-shaped, but are sac-like structures continued on each side into a duct which joins its fellow to form a median canal leading to the external pore. The absence of the descending limb and the position of the funnel in the case of the second type are other differences. In other respects the two types are quite similar. It is probable that the second type is derived from the U-shaped thoracic organ of the first type by the suppression of the descending limb. With regard to the thoracic organs of the Sabellaridae, there has been much uncertainty. Meyer's view is that the thoracic organs of Sabellaria agree in all respects with those of the Sabellidae and Serpulidae, but this view is untenable in the light of the work of Dehorne (1908). The observations

made in this paper show that the thoracic organs of *Sabellaria* differ from those of the Sabellidæ and Serpulidæ.

The anterior nephridia of *Audouinia anchylochaeta* are similar to the type described in other species of Cirratulidae in all essential features. They resemble the thoracic organs of the Serpulimorpha in being restricted to a single pair, in their U-shaped form, and in the position and structure of the internal ciliated funnel. But they differ from the nephridia of Cirratulidae in the nature and position of the external opening, a feature which Dehorne (1908) emphasized as indicating an affinity with the Sabellaridæ.

The anterior nephridia of *Audouinia* are very much like the nephridia of *Scalibregma inflatum* Ashworth (1902). In both, the nephridium is U-shaped opening into the coelom by a small pre-septal funnel leading to the nephridial loop which opens to the exterior by the nephridiophore situated in the segment just behind the one in which the funnel opens. But unlike the arrangement in *Scalibregma*, where the nephridia are arranged in segmental pairs numbering about 40, a single pair is found in *Audouinia* although in other Cirratulidæ the nephridia occur in the posterior segments also. These posterior nephridia differ, however, from the anterior pair in possessing larger funnels and shorter ducts. This difference may be explained as due to the specialization of the posterior nephridia for an exclusively reproductive function (Goodrich, 1900).

Goodrich (1900, 1945) pointed out that the thoracic organs are homologous with the mixonephridia, but it is not known in many instances whether the mixonephridium is formed from a metanephridium or a protonephridium. Faulkner (1930) observed that the thoracic organs of *Filograna implexa* are metanephridial like those of Nereidæ and Capitellidæ, while according to Malaquin (1908), they are protonephridial. The morphological evidence based on the study of the adult animals alone is insufficient for the determination of the homology of the nephridial system, but a comparison of the arrangement of the nephridial system in *Poecilochaetus serpens* (Allen, 1904) with that in the Serpulimorpha and Cirratulidæ, suggests that the thoracic organs are metanephridial. In *Poecilochaetus*, the nephridia occur in most of the body segments, and are metanephridial in the anterior segments, till the sixteenth segment, and mixonephridial in the posterior segments. This arrangement represents a generalized condition from which the more specialized types found in the Serpulimorpha and Cirratulidæ could be derived. The arrangement found in *Dasychone cingulata* resembles to some extent that occurring in *Poecilochaetus*, as the thoracic organs belonging to the first segment and the gonoducts occurring in the second segment onwards form a complete segmental series with the thoracic organs specialized for an excretory function and the remaining for a genital function. The absence of segmental organs in the thorax functioning as gonoducts in the other species of the Serpulimorpha is probably due, as suggested by Evenkamp (1931), to their degeneration consequent on the absence of genital products in the thorax. Similarly the single pair of nephridia in *Audouinia anchylochaeta* may be the last surviving representative of an originally complete series, the others having disappeared owing to loss of function. The posterior segmental organs of the Serpulimorpha are more or less uniform. The prominence of the funnel and the shortening of the duct are their characteristic features. Goodrich (1900) has pointed out that the posterior segmental organs in the Serpulimorpha are mixonephridia in which the nephridial part is reduced. A comparison of the shape and structure of the segmental organs in the different species shows that the nephridial part has been reduced in varying degrees in the different species. The condition in *Dasychone cingulata* suggests a more pronounced reduction of the nephridial part than in other species studied. If the reduction of the nephridial part is complete, the segmental organ which consists only of the coelomostome and a duct arising from it would result. This is exactly the condition described by Caullery and Mesnil (1895) in *Dodecaceria concharum*. But in this form the authors observed that the genital funnels arise

late, only during the epitokous phase, and open to the exterior to convey the genital products. The late appearance of the coelostomes is a feature not unknown in other Polychaets. Goodrich (1900) pointed out that in the Syllidae, in the immature condition, the segmental organs consist only of the metanephridia which open by nephrostomes, but in mature specimens large ciliated funnels develop and become grafted on to the nephrostome. The occurrence in *Dodecaceria* of genital funnels of the nature of coelostomes without a nephridial component is of unusual interest from the point of view of the general theory of the relationship between the coelomoducts and nephridia. Such independently functioning coelomoducts have been recorded only in the family Capitellidae which retain the primitive relationship between these two sets of organs, while in all other families with the exception of the Nereidae in which the coelomoducts have become degenerate, these two organs are intimately associated. In *Dodecaceria concharum* genital funnels which function independently are found. This condition though apparently similar to that found in the Capitellidae is not identical with it. In the Capitellidae both coelostomes and nephridia occur independently in every segment and function as the genital ducts and excretory organs respectively. On the other hand, in *Dodecaceria concharum*, the occurrence of the coelostomes independently of the nephridia appears to be due to the reduction of the nephridial part in the mixonephridium, tending to a complete disappearance of the nephridial component. Such a condition, as pointed out by Goodrich (1945), is probably secondarily acquired and does not show the primitive independence between the coelomoducts and the nephridia. The segmental organs functioning as gonoducts in *Dasychone* point to their resemblance in their shape, structure and position to the genital funnels described by Caullery and Mesnil (1898). Possibly like their counterparts in *Dodecaceria*, they represent only the coelostomes in which the nephridial part has been completely reduced.

The absence of the posterior segmental organs in *Audouinia anchylochaeta* is possibly due to the animal having a different mode of shedding the genital products. The degeneration and disappearance of the coelomoducts in correlation with the loss of their function as genital passages are known in a number of Polychaets. The condition seen in *Clistomastus* (Goodrich, 1900) is an instance illustrative of this feature. 'In *Clistomastus* where the generative cells escape through the rupturing of the body wall the genital funnels are found only in a more or less rudimentary state.' In *Audouinia anchylochaeta* it is likely that the genital products are shed by the rupture of the body wall and therefore it is probable that the genital funnels have been secondarily suppressed. A similar instance is seen in *Prionospio cirrifera* (Aiyar, 1939) in which the nephridia are reduced to three pairs at the anterior end. The absence in this species of posterior mixonephridia which are found in the allied members of the family recalls the condition seen in *Audouinia anchylochaeta*.

VI. SUMMARY.

1. The nephridia and coelomoducts of *Dasychone cingulata*, *Mercierella enigmatica*, *Sabellaria spinulosa*, and *Audouinia anchylochaeta* were studied and their morphology is discussed.

2. In *Dasychone cingulata* there is a single pair of thoracic organs. Each is U-shaped and opens internally by a ciliated funnel. The two ascending limbs of the thoracic organs join together to form a median passage opening to the exterior by a dorsal pore. A feature of the ascending limb is the sac-like expansion, whose walls have a number of ingrowths, thus presenting the appearance of a system of canals inside the sac. Segmental organs with large funnels and short ducts occur in the second thoracic segment in the thorax and in all segments of the abdomen.

3. In *Mercierella enigmatica* the thoracic organ, which is U-shaped, opens internally by a small funnel. The thoracic organs of both sides join together to form a median duct which opens dorsally. Wide-funnelled segmental organs occur in the abdominal segments, but are absent in the thorax.

4. In *Sabellaria spinulosa* the thoracic organ does not appear to possess an external opening. The ascending limb is expanded into three superposed sac-like structures which surround the

oesophagus. The descending limb and the funnel are similar to those in serpulids like *Psygmobranchus protensus*.

5. In *Audouinia anchylochaeta* there is only a single pair of U-shaped nephridia opening internally by a ciliated funnel in the second achaetous segment and extending posteriorly to the second or third setigerous segment.

The external openings are situated ventro-laterally in the first setigerous segment. The posterior segmental organs are absent.

6. It is suggested that the posterior segmental organs in the different species of *Serpulimorpha* are of the nature of mixonephridia in which the nephridial part is reduced to varying degrees, while the anterior thoracic organs are probably metanephromixia.

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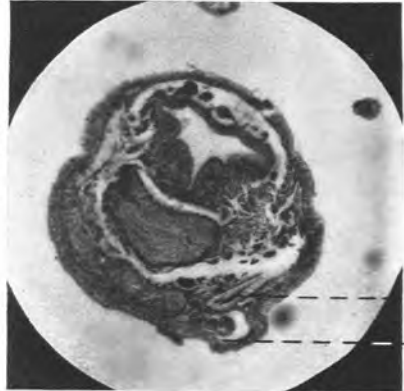
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KEY TO LETTERING.

<i>al.</i>	.. ascending limb of the thoracic organ.	<i>f.ep.</i>	.. funnel epithelium.
<i>ali.</i>	.. alimentary canal.	<i>fe.</i>	.. funnel canal.
<i>bg.</i>	.. basal granules.	<i>g.</i>	.. genital products.
<i>bv.</i>	.. blood vessel.	<i>gl.c.</i>	.. gland cells.
<i>b.w.</i>	.. body wall.	<i>lm.</i>	.. longitudinal muscles.
<i>c.ep.</i>	.. coelomic epithelium.	<i>lp.</i>	.. lip of the funnel.
<i>cl.</i>	.. cilia.	<i>lud.</i>	.. lumen of the gonoduct.
<i>cm.</i>	.. circular muscles.	<i>md.</i>	.. median duct of the thoracic organs.
<i>ct.</i>	.. connective tissue sheath.	<i>nu.</i>	.. nucleus.
<i>dl.</i>	.. descending limb of the thoracic organ.	<i>nu.c.</i>	.. nucleolus.
<i>dl.m.</i>	.. dorsal longitudinal muscles.	<i>nc.</i>	.. nerve chord.
<i>ec.</i>	.. ectoderm.	<i>ov.</i>	.. ova.
<i>eg.</i>	.. excretory granules.	<i>st.</i>	.. septum.
<i>ep.</i>	.. external pore.	<i>se.</i>	.. setae.
<i>f.</i>	.. funnel.	<i>vo.</i>	.. vacuoles.
<i>fb.</i>	.. fibrous sheath.	<i>v.lm.</i>	.. ventral longitudinal muscles.



1.



4.



2.



3.

PHOTOMICROGRAPHS: (Ph. m.)

Dasychone cingulata :

1. Transverse section of the worm showing the thoracic organs.

Mercierella enigmatica :

2. The gonoduct in a transverse section of the worm.

Sabellaria spinulosa :

3. Transverse section of the worm showing the ascending and descending limbs of the thoracic organ.

Audouinia anchylochaeta :

4. The terminal part of the nephridial canal and the nephridiopore in a transverse section of the worm.