A CONTRIBUTION *to the* MORPHOLOGY *of the* AMPHINEURA. By Dr. A. A. W. HUBRECHT, Leyden.

IN August, 1881, I was invited by the editor of this Journal to furnish him with a few diagrams concerning the anatomy of the Amphineura, and with a short explanatory text indicating the actual state of our knowledge about this class of animals. Different engagements have obliged me to postpone the fulfilment of this wish till now. I am not sorry for this delay, now that it enables me to mention the latest researches upon *Chiton*, by Mr. A. Sedgwick, which have thrown a welcome light on the difficult subject of the renal organs of the class.

I will limit myself to a very brief statement of what appears to me to be known, surmised, uncertain, or unknown with respect to the following heads:—*a*, integument; *b*, nervous system; *c*, intestine; *d*, circulatory and respiratory apparatus; *e*, reproductive and excretory organs. As it is not my intention to enter into a full discussion of the different views of the several authors and their respective merits, I will merely summarise those statement which appear to me to be the most worthy of credit. A list of the different authors, to which reference is made in the text by means of a different number prefixed to each of them, will, however, be given at the end of this paper.

A. *Classification.*—The systematic arrangement of the AMPHINEURA and the names adopted for the subdivisions are the following:

Mollusca.

Class.	*Order.*	*Family.*	*Genus.*
Amphineura	Solenogastres	Chætodermata	Chætoderma.
		Neomeniæ	Neomenia.
			Proneomenia.
	Chitones		Chitonellus.
			Chiton.
			Cryptochiton.
			&c.

V. Jhering (8) originally regarded the AMPHINEURA as a separate phylum of the Vermes; Spengel (20) afterwards clearly showed that they will henceforth have to be regarded as a class of Molluscs. *Chætoderma* and *Neomenia* were linked together by Gegenbaur under the name of Solenogastres, which is better chosen than v. Jhering's designation of Aplacophora; the latter, moreover, ranks as a class with v. Jhering. The families of

Chætodermata and Neomeniæ instituted by v. Jhering can be retained. As to the generic names, the manuscript name of *Solenopus*, Sars, which was given to the specimens in the Bergen Museum, but which was never published, and which Korén and Danielssen (11) nevertheless retain for *Neomenia*, Tullberg, will once for all have to be abandoned, when it is remembered that as early as 1826 the name *Solenopus* was pre-occupied in zoology, C. J. Schönherr having in that year assigned it to a genus of Curculionidæ, Coleoptera on p. 268 of his work 'Dispositio methodica,' &c. Up to the present day the genus *Chætoderma*, Lovén (14), counts one species (*Chætoderma nitidulum*, Lovén = *Crystallophrysson nitens*, Möbius); *Proneomenia*, Hubr. (7) one (*P. sluiteri*); *Neomenia*, Tullb. (28), eight, *Neomenia carinata*, Tullberg, *Neomenia affinis*, *dalyelli*, *incrustata*, *margaritacea*, *borealis*, *sarsii* (all Koren and Danielssen's), and *Neomenia gorgonophila*, Kowalevsky. *Neomenia corallophila*, Kowalevsky, has not been described as yet, although it is mentioned in his explanation of plates (13). I agree with v. Jhering in thinking it probable that Koren and Danielssen's species will perhaps come to be reduced in number when these investigators have examined their specimens more in detail; external shape and size must be looked upon as very misleading specific characters in these animals. *Neomenia sarsii* and *N. gorgonophila* will perhaps prove to be Proneomenias.

Of the great number of species and genera amongst the Chitones every text-book on conchology can give evidence; it would lead us too far to enter into any details in this respect. Especially of the genus *Chitonellus*, as will be shown below, a more detailed examination of the different species promises to yield interesting results.

B. *Integument.*—In all the AMPHINEURA a thin cellular layer, which rarely appears to exceed one cell in thickness (3, 7, 11, 13, 18, 22), is applied upon the muscular tissue of the body-wall, and fulfils the function of matrix for the integument. In *Chiton* it is also continued upon those membranous portions of the body-wall which are found in the duplicatures containing the shells.

The integument furnished by this matrix is composed of two elements:

a. A cuticular substance of varying thickness (thickest probably in *Proneomenia*).

b. Calcareous elements deposited within this cuticle, and either forming spicules only (Solenogastres), or spicules and plates or shells (Chitones).

Structures which may to a certain extent be regarded as transitional between the two are the horny or chitinous bases of certain spicules (18), and still more those horny hairs or setæ

which are sometimes developed in the cuticle side by side with the calcareous spicules, and which may in certain species (*Chiton pallasii*) attain a rather considerable size.

The calcareous spicules, both in the Solenogastres and the Chitones, are of very different sizes and shapes (3, 7, 13, 18, 22). In *Proneomenia* they are of the most uniform shape throughout the whole of the integument (7); in *Chiton* they present the greatest degree of diversity (16, 18).

For certain genera it has been proved that the spicules remain attached to the cellular matrix, even when situated high up in the cuticle close to the outer surface, by a string of cellular tissue (7, 18). A cellular capsule encloses their base in *Proneomenia;* in this they find their origin when it still forms part of the subjacent cellular matrix; they appear to be lifted and the string to grow in length, together with the increase in thickness of the cuticle, which pushes them outwards passively. Similar radial outgrowths of the cellular matrix, which, however, appear to be in no direct connection with the spicules, are figured by Kowalevsky for *Neomenia gorgonophila* (13). Very numerous radial hollow tubes in the shells of *Chiton*, first noticed and figured by Marshall (15), are, moreover, filled during life by strings of tissue, which are direct radial prolongations of the cellular matrix,[1] and have great analogy to the funicles above mentioned (7, 18).

The genus *Chitonellus* is characterised by its inconspicuous dorsal shells, calcareous spicules being distributed in a very regular way in the rest of the skin. This genus was long looked upon as representing a reduced stage in comparison with *Chiton;* different details of its organisation (branchiæ, foot, &c.) show the inconsistency of this proposition, and of all Chitones it must certainly be looked upon as the more primitive and the more closely related to the Solenogastres (8). A study of the exact structure and growth of its shells is a great desideratum, especially if very young stages of *Chitonellus*, which at present are so exceedingly scarce in zoological collections, are available.

Two words may here be added concerning the foot, which makes its appearance in the Solenogastres as a median ventral folding of the integument, not covered by chitinous cuticle and spicules, but ciliated (4, 7, 13), and extending in *Neomenia* and *Proneomenia* from close behind the mouth down to the anus. In *Chætoderma* (4) it is only developed in the posterior half of

[1] I have been able to examine sections through the decalcified shells of *Chiton* made by Doct. Phil. J. F. van Bemmelen, and have satisfied myself that they show the peculiarities alluded to above very clearly. This gentleman being at present occupied in investigating more fully the integument of the Chitones, I here refrain from further details, for which I refer to his paper, which will be shortly forthcoming.

the body, and I think there is more probability of this representing a reduced than an incipient stage of the foot-fold of the other genera.

In *Chitonellus* the foot is undoubtedly less differentiated (8) than it is in *Chiton*, where it must certainly already be regarded as homologous with the foot of Gasteropods, &c.

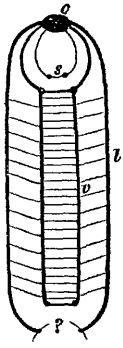
c. *Nervous system.*—The most conspicuous feature of the nervous system of the AMPHINEURA is the presence of four longitudinal nerve-trunks, united together into one in front of or above the pharynx. The fact of the presence of nerve-cells, intermixed to a considerable extent with the fibrous nerve-matter along the whole course of these trunks, shows that centralisation has not yet by any means reached its limit in this class, but that the whole of the longitudinal stems may, to a certain extent, be looked upon as representing the central nervous system. An anterior cerebral thickening appears to be more marked in the Solenogastres (3, 6, 7, 22) than in the Chitones (1, 8, 20). A posterior coalescence of the four longitudinal stems, or of two of them, into a ganglionic swelling situated above the rectum has been demonstrated with certainty in *Chætoderma* (3, 6), *Neomenia* (4), and *Chiton* (8*a*, 20). In *Proneomenia* there is as yet only probability of its existence (7); it will have to be looked for carefully in the first specimens that come to hand.

The ventral longitudinal stems are united by transverse commissures in *Chiton* (8, 20), *Neomenia* (4, 22), and *Proneomenia* (7). The first of these commissures thus closes a ring round the pharynx, which may be called the œsophageal ring. Ganglionic swellings at the point where the ventral stems commence their backward course, and are united by this first commissure, may be called the infra-œsophageal ganglia. A second, more delicate, nerve-ring round the pharynx has been demonstrated with certainty in *Chiton* (8, 20), *Neomenia* (4), *Proneomenia* (7), and *Chætoderma* (4, 6); it may be termed the sublingual nerve-ring, and carries a ganglionic swelling—the sublingual ganglion.

The transverse ventral (pedal) commissures are placed at regular intervals, and in *Neomenia* (4) and *Proneomenia* (7) have been shown to take their course partly through the ventral longitudinal blood-sinus. In the latter genus smaller ramifications have been seen to take their origin from these commissures. In *Chiton* similar ramifications from the ventral commissures appear to give rise to a plexus-like arrangement of nerve-tissue in the foot (5).

In *Chætoderma* similar transverse ventral commissures between the longitudinal stems, although specially looked for, have not as yet been found, and may with a certain amount of probability,

FIG 1.



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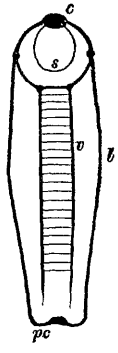
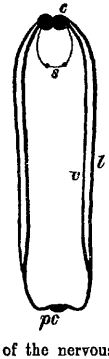


FIG 3.



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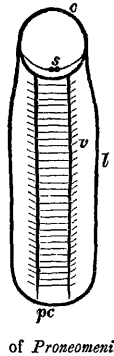


FIG. 1.—Diagram of the nervous system of *Proneomenia*. *c*, cerebrum, *l* lateral, *v*, ventral longitudinal stems; *s*, sublingual commissure. It requires further confirmation[1] whether or not at ? there is a posterior commissure between the two lateral stems.

FIG. 2.—The same of *Neomenia*, copied from Graff (4). Letters as in Fig. 1. *pc*, posterior commissure of the lateral stems.

FIG. 3.—The same of *Chætoderma*, reconstructed out of the descriptions of Graff (3), and Hansen (6). Letters as in Fig. 2.

FIG. 4.—The same of *Chiton*, copied from Spengel (20). Letters as in Fig. 2.

In all these diagrams the nerves for the head springing from the cerebrum as well as the peripheral branches are omitted.

[1] Later investigations have already shown such a commissure to be present in *Proneomenia*. See the postscript to this article.

indeed, be said to be absent. It remains a matter of some doubt whether in this genus the nerve-ring which is present round the pharynx (4, 6) is comparable to the œsophageal (4) or to the sublingual ring. I hold the latter view to be the more probable. The four longitudinal stems in *Chætoderma* unite, in the hinder part of the body, into two lateral stems, which afterwards coalesce posteriorly in the way above mentioned (3, 6).

It appears to me that the nerve-system of *Chætoderma* must be looked upon, not as a more primitive stage, but as a reduction from an arrangement which was originally more in accordance with that of the other Solenogastres. An additional argument for this view will hereafter be gathered from the structure of the intestine and liver.

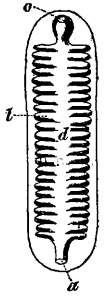
Finally, it must not pass unnoticed that in *Proneomenia* the commissural system offers an increase in complication (7), in so far as a series of transverse commissures is present on both sides, uniting the lateral with the ventral longitudinal stems. From these commissures peripheral branches also originate.

In how far these different facts might eventually be grouped, so far as to throw some light on the phylogeny of certain groups of invertebrates, or of the nervous system in general, has already been more fully discussed by me elsewhere, and may here be safely passed over in silence.

D. *Intestine*.—The intestine is simplest in *Neomenia* and *Proneomenia*, somewhat more complicated in *Chætoderma*, and has attained a far higher degree of specialisation in *Chiton*. A muscular pharynx is present both in the Solenogastres and in the Chitones. In *Neomenia* it is capable of partial protrusion (22). It is internally lined by a chitinous cuticle applied upon a layer of columnar cells, and is variously folded. The cavity containing the radula is in open communication with it. In accordance with the size of the radula this cavity is very considerable in the Chitones, very small in *Proneomenia* and *Chætoderma*, apparently absent in *Neomenia*. Shape and situation of the radula of *Chiton* have been fully described by different authors (16, 18*a*, 21). In 1877, when v. Jhering (8) for the first time defined the AMPHINEURA as a separate group (which, however, he erroneously separated from the Molluscs), he regarded the presence or absence of a radula as one of the chief distinctive characters between the two subdivisions of the Chitones and the Solenogastres (his Placophora and Aplacophora). This distinction broke down when the discovery of *Proneomenia* (7) showed that in the Solenogastres the radula was not always absent, and that there was even more probability in favour of the view that it was undergoing regressive metamorphosis in this group than that it had not yet been started. The chitinous tooth, which in

Chætoderma occupies a corresponding position (3, 6), is another argument in favour of this view. I feel very much inclined to look upon it as a stage of simplification of a radular arrangement rather than as a primitive more simple structure, from which, by gradual differentiation, a radula might be derived. It was elsewhere insisted upon (7) that the complicated structure of the radula in *Proneomenia* forbids an interpretation in the latter sense of the link which connects these structures in the different genera of Solenogastres. In *Neomenia* all remains of a radula may safely be said to have disappeared in the specimens that have hitherto been examined; none of the different authors

FIG 5.



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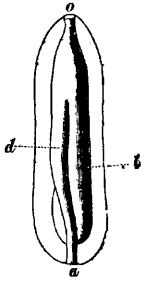


FIG 7.

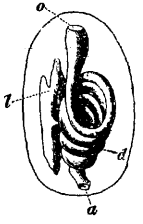


FIG. 5.—Diagram of the digestive tract of *Neomenia* and *Proneomenia*, reconstructed from the descriptions of the different authors (7, 13, 22). *o*, mouth; *a*, anus; *d*, ciliated median portion of the intestine; *l*, lateral cæca, on which the hepatic functions partially devolve.

FIG. 6.—The same of *Chætoderma*; reconstructed after the description of Hansen (6). *o* and *a*, as in Fig. 5; *d*, posterior narrowed portion of the intestine; *l*, liver.

FIG. 7.—The same of *Chiton*. *o* and *a*, as in Fig. 5; *d*, the coiled intestine; *l*, liver.

(4, 7, 10, 22) have at least succeeded in discovering any trace of it.

The slit in the pharynx of *Proneomenia* which gives access to the small radular cæcum, at the same time serves to evacuate the products of two long cylindrical parallel glands, situated under the intestinal epithelium, which converge towards this slit. These glands are regarded as salivary glands (7). They are absent in *Neomenia;* nor has anything of the sort as yet been noticed in *Chætoderma*. In *Chiton* salivary glands have been described (16), but these would appear to occupy a dorsal position with respect to the pharynx. Whether the latter are nevertheless comparable to those of *Proneomenia*, or whether we shall rather have to look upon the so-called pharyngeal sacs (Schlundsäcke, Middendorf) as the homologue of the tube-shaped glands of the latter genus, will have to be inquired into carefully.

The part of the intestine which follows upon the pharynx is simplest in *Neomenia* and *Proneomenia*. In both genera it occupies the greater part of the space available within the muscular tunic after deduction of the genital gland. It is straight, and on both sides provided with very deep folds, which might be compared to as many (hepatic) cæca. Ciliation has been noticed along the median ventral and dorsal line. The rectum, which posteriorly passes below the pericardium and in the midst of the renal and genital excretory ducts, is narrowed and provided with cilia all over the surface.

In *Chætoderma* a subdivision of this part of the intestine has taken place, which appears to me to be very well interpreted by Hansen (6), who regards the posterior cæcum-like portion, opening out into the principal cavity, which is terminated by the mouth and anus, as the incipient stage of a separate liver. This stage has been very far surpassed in the Chitones, where the more or less primitive intestinal arrangement of the Solenogastres is replaced by an intestinal tract, which is comparatively narrow, considerably bent upon itself and coiled, and into which a well-separated, dendritically-shaped liver opens. On this head the difference between the two subdivisions of the AMPHINEURA is, as may be seen, considerable.

Only in the Chitons the posterior opening of the rectum opens directly to the exterior; in *Neomenia* and *Proneomenia* its contents are first evacuated, together with those of the excretory and genital organs, into a sort of common cavity or cloaca, the external opening of which serves for both systems. In *Chætoderma* there is no true cloacal cavity, but the infundibulum into which the rectum and the nephridia open, and in which the branchiæ are placed, nevertheless has a certain analogy with it (fig. 8).

E. *Circulatory and respiratory apparatus.*—In all the genera of AMPHINEURA a heart, situated dorsally, close to the posterior extremity of the body, a median dorsal and a median ventral blood-vessel, are the principal parts of the circulatory apparatus. Paired auricles to the heart are present in the Chitons; their presence in *Neomenia* and *Proneomenia* is not yet put beyond all doubt, but still rendered very probable. The dorsal vessel is the direct anterior continuation of the heart. The latter is situated in a cavity in which blood is never found, which may best be compared to the body-cavity, and to which the inappropriate name of pericardium has been given. It is closed on all sides, with the only exceptions hereafter (p. 228) to be mentioned. The longitudinal vessels open out anteriorly amongst the tissues, the circulation being lacunar for a very great portion (around the intestinal folds *f. ex*). A part of the lacunar circulation in the foot of the Chitons will most probably have to be regarded as the equivalent of the ventral blood-vessel of the Solenogastres, which similarly lies below the horizontal muscular diaphragm. For details about the circulatory apparatus of *Chiton*, reference may be given to Middendorff's researches (16); suffice it to say that here, as in the Solenogastres, the blood is pumped by the heart out of the gills and driven forwards along the median dorsal vessel towards the genital gland and the head.

As to the respiratory apparatus very different degrees of development are present amongst the AMPHINEURA. In *Proneomenia* special branchiæ were vainly sought for, and if a tuft of hollow threads in one of the folds of the pharynx must not be looked upon as such—functionally at least—we are forced to the conclusion that respiration takes place all along the wall of the intestine and the foot, and perhaps more especially in the rectum.

Both in *Neomenia* and *Chætoderma* retractile branchiæ have been demonstrated at the posterior extremity of the body. They are tuft-like in the former (11), distinctly paired in the latter genus (6), where the anal opening lies between them.

In *Chitonellus* they are no longer paired, but are numerous and stretch between the foot and mantle, to the right and left of the anus, about as far as half way along the body, each branchial process having to be looked upon as a unit in comparison to the gills of the Prosobranchia (2, 20). In the genus *Chiton* the lateral branchial series are even extended further forwards, reaching as far as the head. Hand in hand with this marches a complication in the circulatory apparatus.

F. *Excretory and generative organs.*—This apparatus and its different modifications in the various genera and species of the AMPHINEURA perhaps requires more than any other renewed and careful investigation. A few years ago the confusion was even

far more considerable; but still, notwithstanding the light which has been thrown upon this subject by the researches of Hansen, Sedgwick, and others, different details as yet only repose upon insufficient evidence (strengthened though it may be by ingenious speculations), and should be re-examined whenever specimens of these very rare species are available.

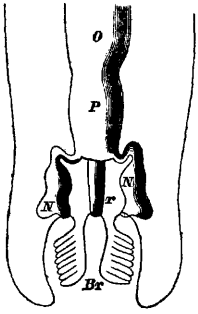
In the following short account I will try to give a fair valuation of the statements of the different authors, at the same time endeavouring to hold myself free from any preconceived opinions on the subject.

If we except Graff's account of the genital organs and the oogenesis of *Chætoderma* (3), which, however, has afterwards been criticised and corrected by Hansen (6), all authors unanimously place the genital gland of the different genera of Amphineura in the median line of the dorsum, immediately below the integument, and with only the median dorsal blood-vessel superior to it. The genital gland stretches throughout the greater part of the length of the animal, is more or less symmetrical, and was found in *Proneomenia* (7) to be regularly split up ventrally into two halves, and to have a multilobate appearance. The sexes are separate in the Chitons (10, 19) and in *Chætoderma* (6), whereas *Neomenia* and *Proneomenia* appear to be hermaphrodite (7, 11). The latter genus, however, has as yet never been examined in the fresh state.

With respect to the way along which, in the Chitones, the genital products travel outwards, certain divergent opinions have to be recorded in succession. According to the researches of Cuvier (1), Middendorf (16), von Jhering (10), and Sedgwick (19), there are two ducts, a left and a right one, which leave the genital gland on the dorsal surface, close to its posterior extremity, and strike for the branchial furrow, into which they open between a pair of the posterior branchiæ. This passage is coiled in the female, straight in the male (19). I have myself been able in sections to further confirm the presence of the same arrangement in *Chiton marginatus*. Dall (2) has noticed certain different modes of egress for the genital products, and mentions the presence, in some species, of a simple genital pore, in others of a fenestra, *i.e.* of a slit which is divided by bridges of tissue into from two to seven openings. Not finding an oviduct in the latter case, he is inclined to suppose that the eggs are set free in the body-cavity, and from thence pass outwards through these fenestræ. These observations are in great need of further confirmation.

Before passing on to the genital apparatus of the Solenogastres I hold it to be appropriate to mention the renal or excretory apparatus of the Chitones, as these two systems, which

FIG 8.



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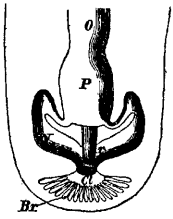
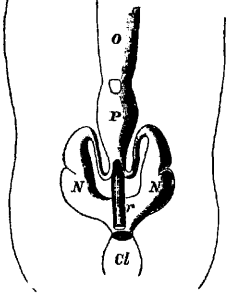


FIG. 8.—Diagram of the genital and excretory system of *Chætoderma*, seen from above. Reconstructed after the description and figures of Hansen (6). *O*, genital gland; *P*, pericardium; *N*, Nephridia; *r*, rectum; *Br*, branchiæ, situated with the openings of *N* and *r* in the infundibulum.

FIG. 9.—The same of *Neomenia carinata*. *O*, *P*, *N*, *r*, and *Br*, as in Fig. 8. *Cl*, cloacal cavity, into which *r* and *N* open out.

In this figure and in the foregoing the exact mode of communication between *O* and *P* could not be represented, this having not yet been satisfactorily settled.

FIG 10.



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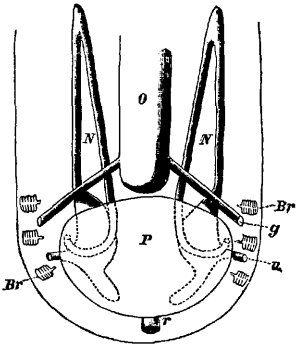

FIG. 10.—The same of *Proneomenia*. Letters as in Fig. 9.

FIG. 11.—The same of *Chiton*. For the greater part copied from Sedgwick (19). Letters as in Fig. 9. *g*, genital opening; *u*, exterior opening of Nephridia.

are separate in this subdivision of the AMPHINEURA, appear to be in close connection with each other in the Solenogastres.

Our knowledge of the nephridia of *Chiton* has only very lately been thoroughly established by Sedgwick (19). They are double, and open into the pericardium at one end, into the pallial groove between the branchiæ at the other. From the pericardium the duct bends forwards towards the head, makes a very sharp turn backwards again, enlarges to a kind of bladder, from whence a short duct leads outwards at a very short distance behind the exterior opening of the genital ducts. Numerous fine branches and delicate ramifications (not represented in the woodcut) are in direct communication with these ducts, and form the mass of the renal organs.[1]

It needs no further inquiry whether the kidney, with a single, posterior, median opening, such as it was described by v. Jhering (10), is really to be found in any existing species of *Chiton*, as Dr. Brock of Göttingen kindly writes to tell me that v. Jhering has lately withdrawn this view as reposing on an erroneous observation, and has been convinced of the presence of lateral renal openings (prior to Sedgwick's exhaustive researches).

We have now to consider the other subdivision of the AMPHINEURA, the Solenogastres. A direct communication between the ovary and the pericardium has been demonstrated in *Proneomenia* (7) and *Chætoderma* (6). In *Neomenia carinata* its presence is probable in the highest degree (22), although neither here nor in *Chætoderma* have the ducts been separately made out.

In the second place the different genera of Solenogastres are provided with a system of ducts and passages by which the pericardium communicates with the exterior. These ducts, or parts of them, are considered by the different authors on grounds for which we refer to the original papers (6, 7) as renal organs. There can be no serious doubt about their homology with those of the Chitones. And so the Solenogastres exemplify a primitive stage, in which the pericardium (body-cavity) receives the oviducts, on the one hand, and on the other communicates with the exterior by means of the nephridia. This latter communication persists in a very large number of Molluscs; the former, however, has been given up, but it is exceedingly instructive and remarkable that (as a remnant of it) in the most primitive genera of different classes of Molluscs (*Dentalium, Patella, Fis-*

[1] I may here add that these recent observations of Sedgwick's have been fully confirmed by Mr. J. F. van Bemmelen, who dissected a large species of Chiton from the Indian Ocean, and showed me his preparations, which I found to correspond in all important respects with Sedgwick's account.

surella, Spondylus) there is a direct discharge of the genital products into the cavity of the kidney. In the next stage the genital and urinary ducts open out upon the same papilla (*Pinna, Mytilus*); in the remaining majority the separation has become even more complete, and the external openings more distant; the primitive arrangement, in which ovary, pericardium, and nephridium lead into one another in an unbroken order of succession, being retained in the Solenogastres alone.

A reserve has to be made with respect to the male genital products of *Neomenia carinata*. These are evacuated along separate lateral ducts, provided with calcareous penes, and connected, according to the observations of Koren and Danielssen (11)—which have not yet been repeated—by separate vasa deferentia with the hermaphroditic gland.

Similar penes are absent in *Proneomenia*, and although only two specimens have as yet been examined, it seems improbable that they will afterwards be detected in others, as the specimens under observation appeared to be true hermaphrodites, and not simply females, both ova and spermatozoa occurring in parts of the ducts (7). Nor has a similar arrangement been observed in *Chætoderma* or in the Chitones.

It will be apparent from the foregoing, that further careful observations on the male genital ducts of *Neomenia carinata*, which Koren and Danielssen confess to have only imperfectly made out (11), as well as on the exact mode of communication between the genital gland and the pericardium in this genus and in *Chætoderma*, are very much wanted. Furthermore, a comparative histology of the renal organs, marked *N* in the woodcuts, will have to be made. It must be remarked that in *Chætoderma* (fig. 8) these organs open to the exterior separately, whereas they coalesce into a single duct, with only one median opening, in *Proneomenia* and *Neomenia* (figs. 9 and 10).

The different accessory glands of the genital apparatus, which have been described as such (7, 11), are here passed over in silence, because in the present stage of our knowledge a comparison of these with each other would be premature. The examination of specimens in the fresh state will alone enable us to form a sound judgment on these points.

Nor are structures, such as the presumed byssus-like glands of *Proneomenia* and *Neomenia* (7), the foot gland, &c., here taken further notice of, because our knowledge is not yet far enough advanced to admit of a fruitful comparison.

In order to facilitate comparison of the woodcuts (1—11) inserted in this paper, with the different illustrations given by the several authors on the Solenogastres of the genital and excretory organs, &c., of these animals, I have added the following key to

the figures of Graff (3), Hansen (6), Tullberg (22), and myself (7).

	Graff (3).	*Hansen.* (6)	*Tullberg* (22).	*Hubrecht* (7).
The genital gland . .	*u*, fig. 14	*gk*, Pl. III and IV	*u*, *v*, *w*, Pl. I	H G, Pl. III and IV, fig. 51.
The communication between this and the pericardium	...	fig. 3, Pl. IV	...	fig. 38, 46, and 47.
The pericardium . .	...	*pc*, Pl. IV and V	*x*, fig. 6	*Per*, fig. 39; *P*, fig. 46.
The nephridium connecting the cavity of the pericardium with the exterior	*Ks* (interpreted as "Kiemen-säcke" = branchial sacs), figs. 15 and 16	*sk*, Pl. IV and V	*q*, *r*, fig. 6; *a*, *b*, fig. 29	*d*, *A*, *R*, d^1, A^1, R^1, figs. 32, 38, 39, and 46.
The dorsal blood-vessel	*el* (interpreted as oviduct), figs. 4, 5, 6, 7, 12, 13, and 32	*vd*, Pl. I, II, and III; *cr*, IV and V	...	*ds*, Pl. I, III, and IV.
The ventral blood-vessel	*b*, figs. 4, 5, and 6	*vv*, Pl. I—IV	*n*, figs. 6 and 7	*vs*, Pl. I—III.
The liver	*zb*, *bgl*, fig. 14	*l*, Pl. III and IV		*tf*, fig. 14; ff^1, fig. 48.

Of the figures given by Möbius (17), 11 represents one of the branchia; whereas 10 either stands for the œsophagus (cf. Hansen, Pl. I, fig. 2, *o*) or for the liver (cf. id., Pl. IV, figs. 1 and 3, *l*) of *Chætoderma*.

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(23) *E. Brandt*, "Ueber das Nervensystem von *Chiton fascicularis*," 'Bull. Akad. Pétersb.,' t. xiii, 1869, p. 462.

Postscript.—While the foregoing paper was passing through the press an article appeared in No. 103 of the 'Zoologischer Anzeiger,' written by Kowalevsky and Marion, in which anatomical details are furnished concerning certain Neomenia-like animals which these authors have obtained at Marseilles, and which is announced as being preliminary to a more elaborate paper with accompanying illustrations.

The paper is of a very revolutionary tendency, proposing no less than to look upon Tullberg's description of *Neomenia carinata* as having been erroneously inverted. Tullberg is said to have described (1) as *posterior* "lateral glands" what are in reality *anterior* salivary glands; (2), as calcareous penes what is in reality a radula; (3), as supra-rectal "egg-bag" what is an intestinal diverticulum above the pharynx; (4) as branchiæ alongside of the anus what are pharyngeal fringes; (5), as a protrusible pharynx what are no less than oviducts and a uterus, with their respective internal intercommunicating cavities.

In the following number of the 'Zoologischer Anzeiger,' I exposed the reasons upon which my utter disbelief in the hypothesis of these two distinguished authors was founded. I will not enter in detail into this controversy, nor give a translation of my refutations in the 'Zoologischer Anzeiger,' as I have reason to suppose this periodical within easy reach of any reader of this article. It may suffice to refer the reader to the comparisons drawn in the foregoing pages, and to remind him that personal investigation of *Neomenia carinata* (which was neglected by Kowalevsky and Marion) has enabled me to confirm the results of Tullberg's observations—as has already been done before by Koren and Danielssen, and by Graff—in all important points, and thus to conclude (1) that the lateral glands are not salivary glands; (2), that calcareous penes are present and not to be confounded with a radula; (3) that Tullberg's "egg-bag" is the pericardium, and not an alimentary diverticulum above the pharynx; (4) that a posterior tuft of branchiæ s present; (5)

that the protrusible pharynx corresponds very well to the figure which Tullberg gives to this region.

Finally, I suggested that the animals with which Kowalevsky and Marion have been experimenting at Marseilles must be referred to *Proneomenia* rather than to *Neomenia*, especially because the results of their careful anatomy fully confirm the different statements made in the foregoing pages concerning the first-named genus.[1]

[1] Simultaneously with this proof-sheet I receive a letter from *Professor A. F. Marion*, at Marseilles, in which he authorises me to say that he has changed his mind with respect to the Marseilles specimens, in so far as he agrees with me in regarding the genera *Neomenia* and *Proneomenia* as perfectly distinct, and his specimens as certainly belonging to the latter genus. This being the case we may henceforth declare *Proneomenia* to be in the possession of a posterior commissure of the lateral nerve-trunks, and the point of interrogation in fig. 1, on p. 221, may safely disappear; as Professor Marion moreover writes to tell me that one of his Marseilles species of PRONEOMENIA is in the possession of such a commissure, entirely corresponding to that of the other AMPHINEURA.