SPERM TRANSFER IN CERTAIN DECAPODS.

By E. A. Andrews,

Of the Johns Hopkins University, Baltimore.

Among the Crustacea it is common for the sperm to emerge from the males enveloped in more or less secretion from the deferent ducts. Thus are formed sperm masses, which are enveloped by secreted coverings; these are transferred to the females by the aid of special appendages and constitute the "spermatophores." These spermatophores are received by the females chiefly in three ways—either the spermatophores are fastened merely upon the outside of the shell or they are directly introduced into the oviducts, or they are placed within some special spermatheca or receptacle not used for any other purpose. This latter case, the employment of a spermatheca, is rare, but it is especially deserving of study and explanation.

While the crayfish of the genus *Astacus* applies spermatophores over the surface of the shell of the female, the crayfish of the genus *Cambarus* fills a special receptacle within which the sperm may lie dormant for months. In the lobster there is a similar receptacle, but it is a space between elevations of the shell, while the receptacle in *Cambarus* is a pit within the shell.

A peculiar receptacle known as the "thelycum" is found in certain prawns, the Peneidæ. Outside these few decapods a receptacle is known in the remarkable mountain shrimp of that group of primitive Eumalacostraca, the Anaspidacea.

To Dr. W. T. Calman belongs the credit of pointing out the importance a comparative study of these organs may have in the proper classification of the Crustacea. Any additional cases of the occurrence of such median spermatheca would be welcome, but their great importance should make one very critical in asserting to their reality. In his recent account of the Anaspidacea, Geoffrey Smith has described a like receptacle in the deep-sea prawns of the group Eryonidea, and asserted the fundamental nature of this spermatheca as a decapod character.

It is the object of the present paper to describe the sperm receptacle in certain of the Peneidæ, and further to show how very doubtful is the existence of any spermatheca in the Eryonidea.

Just as the "annulus ventralis" of the female and the specialized pleopods of the male *Cambarus* were well known as specific characters before it was known that both these sets of organs were essential as sperm receptacles and organs to fill the receptacles, so also in the prawns of the family Peneidæ it was well known that the females possessed remarkable structures, called the thelyca, and the males peculiar united appendages, the petasma, before it was known that here also we have useful receptacles and transferers of sperm.

The following description will show what the thelycum is in three of these prawns, with reference to its use as a sperm receptacle.

In *Peneus setiferus* (Linnæus), *P. brasiliensis* (Latreille), and *Parapenæus constrictus* (Stimpson) the thelycum is found to be a more or less simple cavity on the ventral surface of the thorax between the fourth and the fifth pairs of legs, made by anterior and posterior scales or elevations of the shell that inclose the sperm-containing space. The posterior outgrowth from the sternum of the fifth legs is more or less divided into right and left lobes, and it grows forward to overlap the anterior outgrowth which extends back from the sternal region between the fourth legs.

In specimens of *Peneus setiferus* obtained in March at New Orleans, Louisiana, when small, as well as in large specimens up to 180 mm. in length obtained in April at Hampton, Virginia, and in the Baltimore markets in November, the thelycum is so simple as to suggest immaturity, yet the presence of mature sperm in the April males along with minute young eggs in the females suggests that the males may have been about ready to transfer the sperm to the thelycum, where it would await the maturing of the eggs.

Figure 1 shows part of the underside of a female with the third, fourth, and fifth left legs removed from the left side. The oval opening of the oviduct is represented upon the base of the third right leg. Between the fifth legs two scales (*Sc*) with a wide groove between them project forward over a depressed area. These scales may be regarded as arising from a common transverse plate some 3 mm. wide. Each scale is some 1.5 mm. long, and its anterior edge is very abrupt, as seen in the lengthwise section, fig. 2 (*Sc*).

The depressed area anterior to the scales is partly overhung by a wide shelf, figs. 1 and 2 (*S*), which is somewhat bilobed and has its posterior overhanging part decidedly bent toward the general shell of the sternal region, so that there is formed a concealed recess in which dirt frequently collects. Several specimens have dark, necrotic areas on the shelf, as if the results of injury (possibly in conjugation?). In the November specimens curious remains of minute organisms, apparently stalked protozoa, are found attached to the shell under the above-mentioned shelf. The shelf is depressed right and left, so that its middle stands up as a rounded boss, fig. 1 (*S*).

The depressed area between the scales and the shelf is especially hollowed out in a rounded area some 2 mm. wide on the median line under the shelf and continuing back from that; the shelf being 3 mm. wide, but overhanging only 1 mm. The posterior edge of this central pit or saucer is shown as a break in the shell line in fig. 2 between the

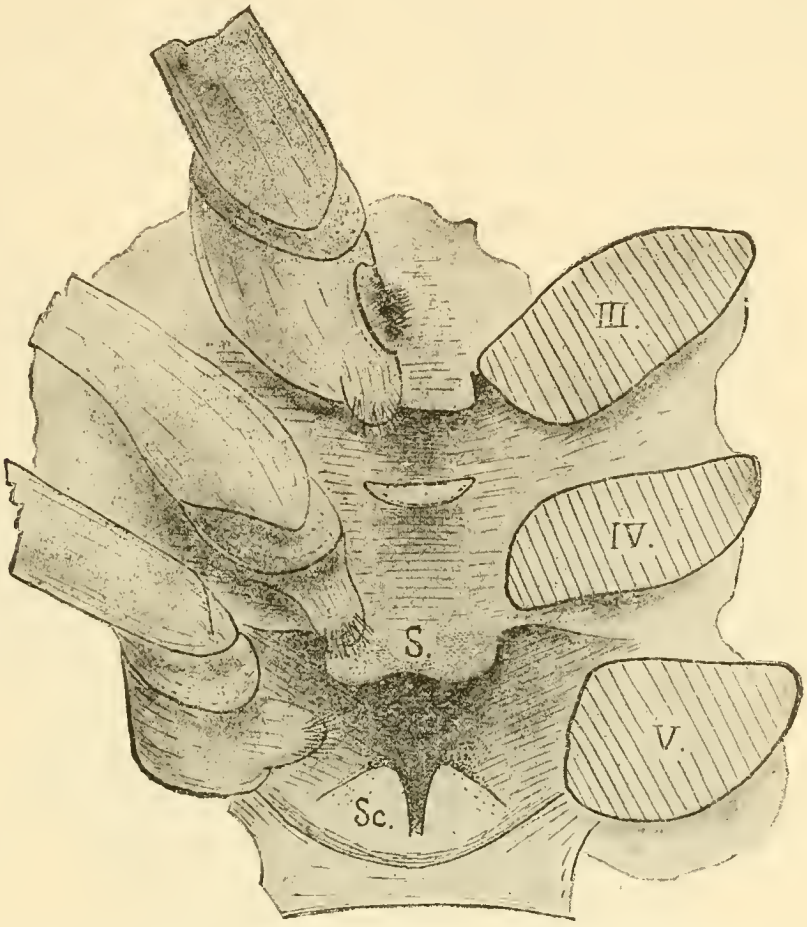

FIG. 1.—PART OF VENTRAL SIDE OF THORAX OF PENEUS SETIFERUS WITH BASES OF LEGS III, IV, V, *S*, SHELF; *Sc*, SCALES, FORMING BOUNDARIES OF THE SIMPLE THELYCUM.

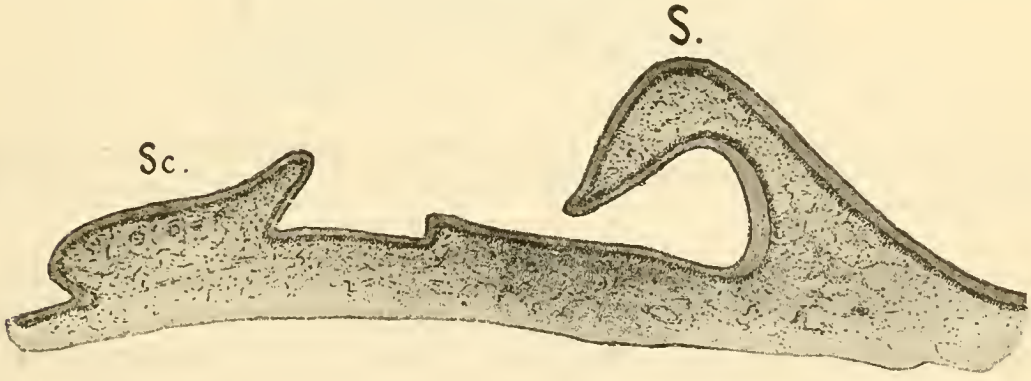

FIG. 2.—LONGITUDINAL MEDIAN SECTION OF THELYCUM OF PENEUS SETIFERUS, VENTRAL SURFACE ABOVE. *S*, SHELF; *Sc*, SCALE.

shelf (*S*) and the scales (*Sc*). The depressed saucer is bounded on the sides by faint ridges which tend to meet one another posteriorly as the rim of the saucer, causing the above change of level in the shell as seen in section.

In the males there is neither shelf nor scales, but there is a pronounced median keel along the area that is depressed in the female. Some faint suggestion of such a keel is seen in the female also.

If this thelycum is complete in this state, we may suppose the more important part is the overhanging shelf under which the sperm might be deposited, while the scales might have merely the value of holdfasts for the petasma of the male. However, nothing was found out as to the mode of functioning in this species.

A second species, *Peneus brasiliensis*, has a similar thelycum with sperm within it.

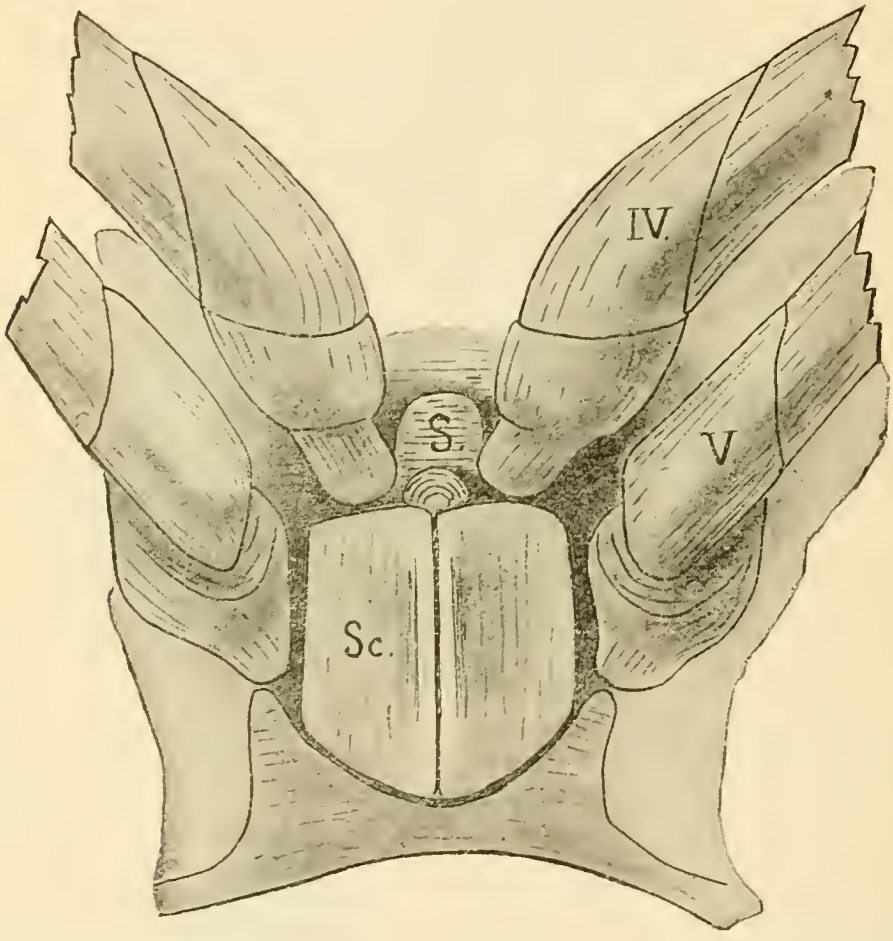

FIG. 3.—SURFACE VIEW OF THELYCUM AND ADJACENT PARTS OF THORAX OF PENEUS BRASILIENSIS. IV AND V BASES OF LEFT FOURTH AND FIFTH THORACIC LEGS; *S*, BASE OF SHELF-BEARING SPINE; *Sc*, CLOSED SCALE.

In large specimens, 110 mm. long, fig. 3, there is a shelf and two scales to form the thelycum, but the proportions are very different from what they are in *P. setiferus*. The shelf (*S*) is largely concealed by the scales (*Sc*) which run forward like two great doors, leaving only the median boss of the shelf showing between the fourth legs, while all the depressed region is overarched and concealed. However, in young specimens 60 mm. long the two scales are very widely separated along the median line, and anteriorly they cover the shelf only at its sides, so that the shelf appears not only as a high boss that runs back as a spine between the scales, but also as

two lateral lobes, one of which runs back under the anterior part of each scale.

A cross section between the fifth legs in one of the young females, fig. 4, shows the scales as thick outgrowths of the shell arising from the body at the sides and overarching a wide space, but not meeting one another at the middle line. The young individual is thus intermediate between the adults of *P. setiferus* and *P. brasiliensis* in having the scales much more extensive than in the former and much less so than the latter.

When the spermatophoral mass is present within the thelycum, the internal relations of the organ are more complex and less easy to understand, since parts of the sperm envelope may be mistaken for parts of the thelycum. When the scales were dissected off from museum specimens, the secreted mass that incloses the sperm was seen as a large flat bag-like mass stuck to the shelf as if a part of it. The scales themselves were thick fleshy plates, fig. 4, hollowed out

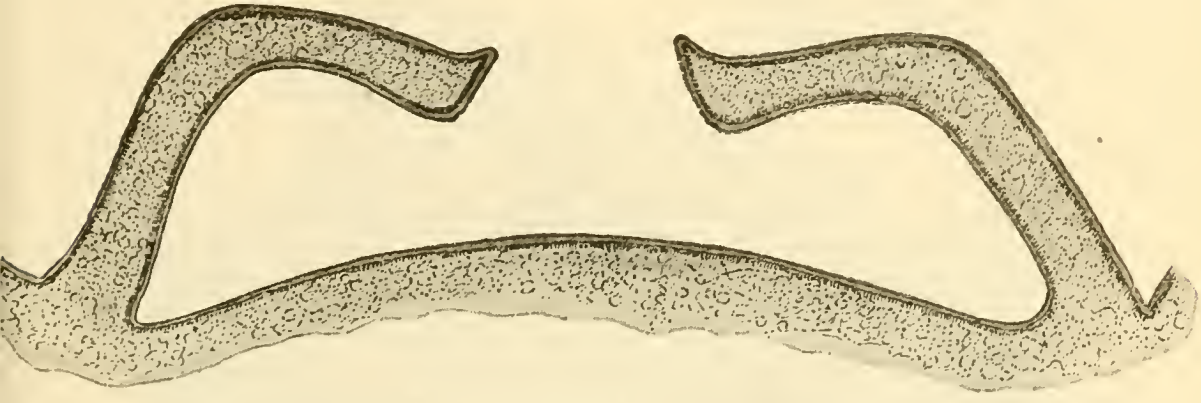

FIG. 4.—CROSS SECTION OF THELYCUM OF A YOUNG PENEUS BRASILIENSIS, SHOWING SCALES RIGHT AND LEFT.

on their dorsal faces to receive corresponding elevations of the spermatophoral mass. The edges of the plates are flattened where they join one another.

The entire shelf is somewhat Y-shaped; each lateral part has a deep groove to receive the downward bent anterior edge of the scale, so that the space inclosed by the scales is very tightly shut off from the external water. In the lengthwise section, fig. 5, this groove on the scale (*S*) is seen with the edge of the scale (*Sc*) resting in it. The space inclosed by the overarching shelf and the overgrown scales is filled by the spermatophoral mass. This consists of a secretion that breaks into thick lamellæ in the preserved specimen and which incloses the sperm, indicated by the dark central mass.

The entire spermatophoral mass has a marked median keel between the right and left scales and a large right and a left wing. The inclosed sperm is chalky white before staining and is completely enveloped by the secreted mass, so that it would be well cut off from the water as well as entirely concealed within the spermatheca or

space between the scales and shelf of this thelycum. The sperm consists of innumerable minute spheroidal cells, each showing a large refractive body.

The important fact is thus established that a large mass of spermatozoa is contained within the thelycum much as sperm is contained in the annulus ventralis of *Cambarus*. How this is introduced is at present conjectural, though the anatomy of the petasma of the male leaves little doubt that this compound organ transfers the sperm. The way the secreted mass fills the cavity of the thelycum indicates that it is run in when soft and subsequently "sets" more or less. The place of entry is doubtless the posterior part of the slit between the scales, for series of cross sections show that here the secreted mass comes to the surface as a fine narrow edge. In life there may have been a continuation of the spermatophoral mass through this cleft into the outside water, which might represent the mass described by Spence Bate in other species.

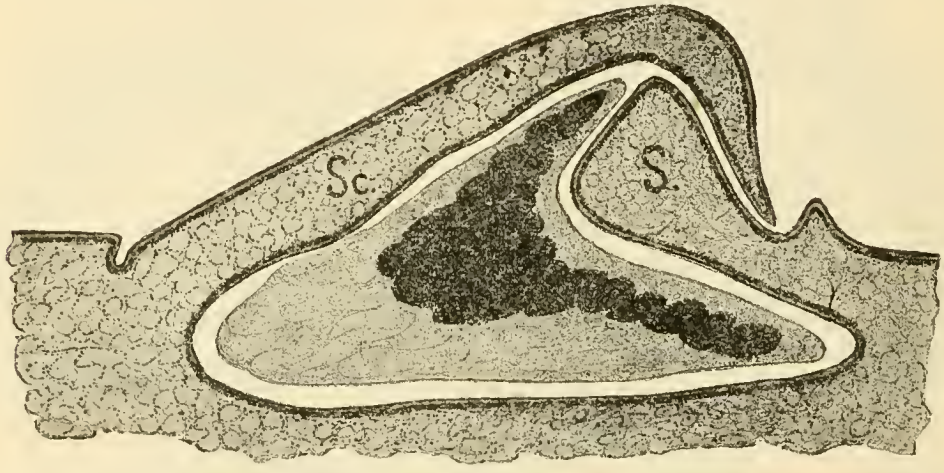

FIG. 5.—LONGITUDINAL SECTION OF THELYCUM OF A MATURE PENEUS BRASILIENSIS, SHOWING THE DARKLY STAINED SPERM ENVELOPED IN A LIGHT SECRETED MASS AND ENCLOSED BY THE SCALES (*Sc*) OVERLAPPING THE SHELF (*S*).

But this raises the question, how far are these sperm-containing secreted masses within the thelycum to be regarded as spermatophores?

If a spermatophore is a bag or receptacle of secreted matter that is fashioned by the male and then transferred with little change to the female, the mass that fills the thelycum in *P. brasiliensis* can scarcely be regarded as a true spermatophore, though it is doubtless of the same essential nature. As the mass is some 4 mm. wide, 6 mm. long, and 3 mm. deep in a female 110 mm. long, and as it fills all the cavity of the thelycum as if run in when essentially flowing or liquid, it would appear more like a secretion of the male deferent duct conducted by the petasma than a true preformed spermatophore formed and to some extent made firm within the male duct and then merely manipulated by the petasma. Better

preservation of material would be necessary to decide how far the mass about the sperm was run in against the shell as a liquid or in how far it existed outside the thelycum as a spermatophore with its walls already formed.[a]

In a third prawn, *Parapenæus constrictus* Stimpson, specimens 65 mm. long present a thelycum as figured in figure 6. The scales are here evidently an anterior continuation of a transverse plate between the fifth legs. The shelf (*S*) passing back from between the fourth legs disappears under the scales.

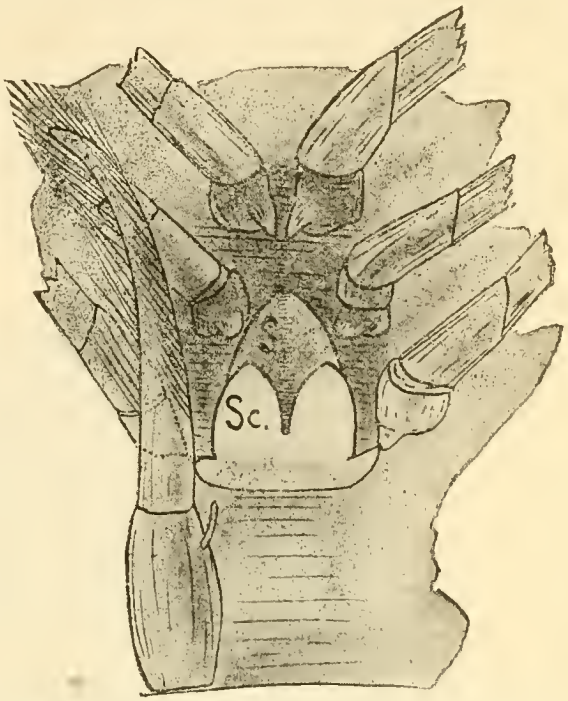

FIG. 6.—PART OF VENTRAL SIDE OF THORAX OF PARAPENÆUS CONSTRICTUS, SHOWING BASES OF LEGS, ONE OF THE FIRST PLEOPODS, AND THE SCALES (*Sc*) AND SHELF (*S*) OF THE THELYCUM.

In this figure of the female the right first pleopod is included to show the minute endopodite. In the male the region of the thelycum of the female is occupied by two ridges: A transverse ridge between the fourth legs in place of the female shelf and a longitudinal ridge, expanding as a T-shaped mass, representing the scales of the female.

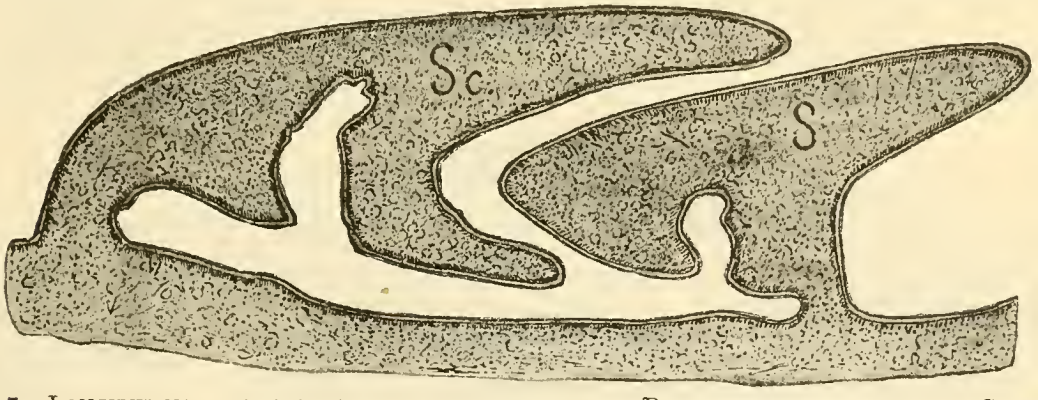

FIG. 7.—LONGITUDINAL, LATERAL SECTION OF THELYCUM OF PARAPENÆUS CONSTRICTUS. *S*, SHELF AND *Sc*, SCALE; OVERHANGING A BRANCHED CAVITY.

Returning to the female thelycum, it may be noted that the scales and the shelf are both sparsely covered with short bristle-like setæ.

[a] Five specimens obtained alive at Montego Bay, Jamaica, Aug. 22, 1910, measured 90, 100, 120, 120, 160 mm., and each possessed a well-formed thelycum. The scales were translucent enough to show the curved sperm mass under each and soft enough to be readily separated by forceps so that the male might introduce a large spermatophore. When dissected the sperm was in a bag on each side which had a stiff lateral edge and might well be formed in the petasma. The shelf projected into the thelycum as a median and two lateral spines. The sperms were spheroidal, with one stiff process. In one specimen a soft gelatinous mass projected from under the scales forward over the shelf some distance into the water.

The internal anatomy of this seemingly simple thelycum is unexpectedly complex. While in a median longitudinal section the shelf is seen to pass down into the general level without overhanging and to be covered over by the scales with but a small simple cavity between, yet in a section to one side of the median line, fig. 7, we find the shelf overhangs posteriorly a space which is continued both forward and backward to end in branching chambers. In cross sections these chambers (figs. 8, 9, and 10) are repeated right and left. In

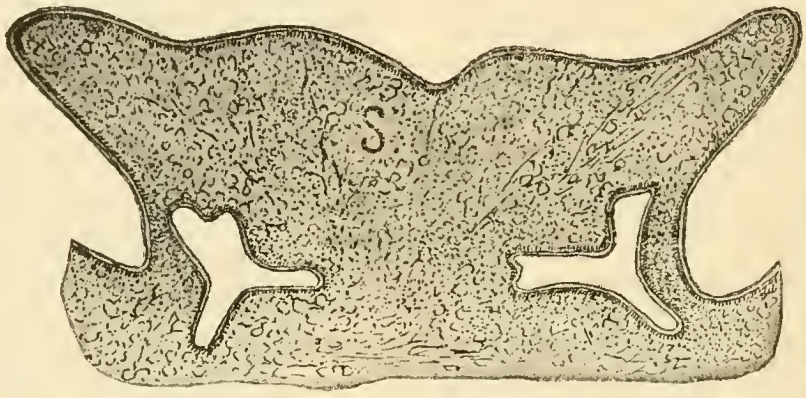

FIG. 8.—CROSS SECTION OF ANTERIOR PART OF THELYCUM OF PARAPENÆUS CONSTRICTUS, SHOWING THE SHELF (*S*) PENETRATED BY LATERAL CAVITIES RIGHT AND LEFT.

fig. 8, which is across the anterior part of the shelf, the chambers are two large separate cavities in the substance of the shelf. Each has its horizontal and vertical portion, and each leads back in other sections to the common narrow cavity between the shelf and the scales. Again the section, fig. 9, through the posterior part of the scales shows two large cavities hollowed out in the substance of the scale plate and expanding as horizontal and vertical portions. These

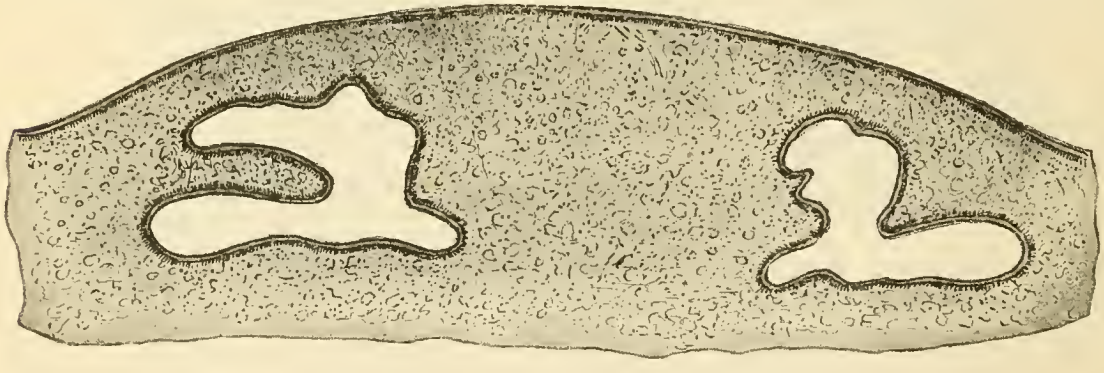

FIG. 9.—CROSS SECTION POSTERIOR TO THAT SHOWN IN FIG. 8.

chambers run forward to open into the common median cavity, as shown in fig. 10, which is cut across the middle of the thelycum and shows the two scales (*Sc*) overarching the shelf (*S*); the space between the shelf and scales passes on each side as a tube to expand as the chambers seen in fig. 9. The entire cavity into which the sperm mass might be thrust in under the scales is thus seen to be somewhat H-shaped, with the anterior horns converging and branched in the

substance of the shelf while its posterior horns diverge widely and branch in the substance of the scale plate. The middle of the H-shaped cavity is also somewhat prolonged posteriorly between the beginnings of the posterior horns.

No specimens were found with sperm in the thelycum, but its structure seems well adapted to hold sperm masses.

The above fragmentary observations suffice to show that in some of these prawns, the Peneidæ, the thelycum is used as a spermatheca and that it is morphologically a space inclosed more or less by outgrowths from the shell.

Turning now to another group of Decapods, the Eryonidea, in which a spermatheca is said to occur, we find in specimens in the collections of the U. S. National Museum no sign of a spermatheca,

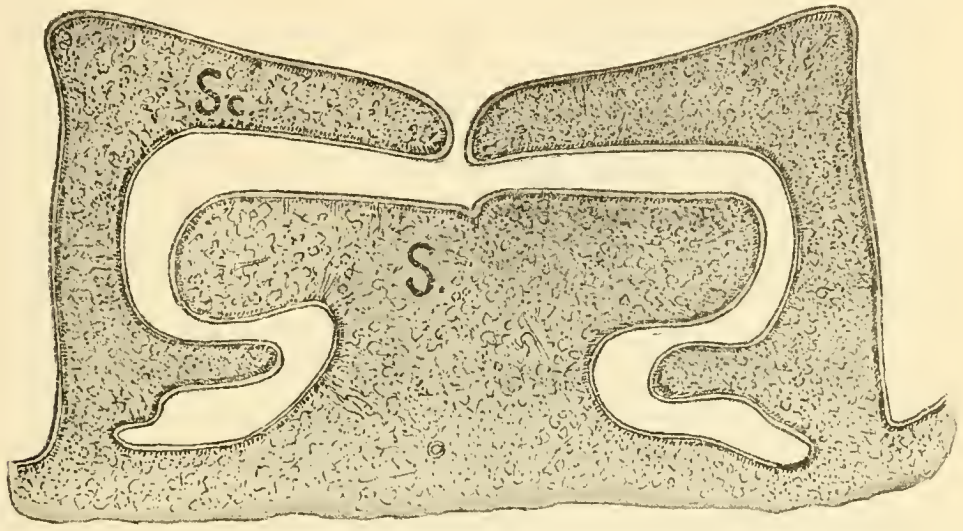

FIG. 10.—SECTION ACROSS THE MIDDLE OF THE THELYCUM, POSTERIOR TO THE SECTIONS SHOWN IN FIGS. 8 AND 9, WITH THE SHELF (*S*) OVERARCHED BY THE SCALES (*Sc*).

but, however, a well marked spermatophore mass applied to the surface of the sternum of the female in the region of the thelycum of the Peneidæ.

In *Polycheles granulatus* the sternum of the female is composed of three well-marked plates in the region to be studied, one between the fourth legs, one between the fifth, and a third somewhat posterior to the fifth legs. Laterally these plates are marked off from one another by grooves, but along the median region they form one continuous shell that is depressed so that the anterior part rises up markedly above the posterior part. There is no indication of any elevated ridges or plates at all comparable to the thelycum and no holes or cavities that could function as a sperm receptacle. The same general structure and absence of any receptacle was seen in specimens labeled *Willemoesia inornata*, *Eryoneicus indicus hawaiiensis*, and *Eryoneicus cæcus*.

In the young or smaller specimens of *Polycheles suhmi* and *P. sculptus* the same is true, but in older or larger specimens there are

some individuals with structures in this region that may have been mistaken for receptacles, though they are really only large spermatophores. Thus in *Polycheles suhmi* the depressed smooth shell between the fourth and fifth legs has fastened firmly to it a yellow brown flat mass which looks like two flattened tubes side by side. Each has a small opening near the anterior tip. They are fused into a common mass posteriorly and expanded laterally to make the entire outline rather triangular. This mass is really two spermatophores. The first pleopods of the female are here markedly differentiated as flat setose brushes which would seem well made to glide over the surface to which the spermatophores are attached and to keep it clean before they were attached. That the above masses are spermatophores is supported by the fact that in the males there is in some cases a similar dark brown mass, of flat form projecting far out of the opening of the deferent duct on the base of each fifth leg, like a hardened secretion which was in process of emergence to be transferred to the female to form the above spermatophoral mass.

In the males of *Polycheles granulatus, P. agassizii, P. sculptus,* and *P. sculptus pacificus* Faxon there are, in some specimens, similar colored projections from the male orifices. That these masses could be transferred from the male to the female seemed evident from applying the two sexes together when the projecting secretions of the male could be brought to the long, spoon-shaped male pleopods in such a way as to make it plausible that these spoons serve somewhat as do the homologous pleopods of the crayfish to conduct the sperm, or the spermatophores, from the male to the female.

The demonstration of the spermatophore nature of the masses found upon the female is, however, to be found in the following description of their structure and probable male origin as seen in specimens of *Polycheles sculptus.*

A female from *Albatross* station 2394, Gulf of Mexico, in 420 fathoms, has between the fourth and fifth legs, as represented in fig. 11, a large triangular or trefoil-shaped mass which proves to be not a spermatheca or female receptive organ, but a pair of fused spermatophores, or purely male products, applied to the outside of the shell of the female. While the female is 95 mm. long with claws 120 mm. long, the spermatophore mass is 9 mm. long and wide, with a maximum diagonal length of 10 mm., so that it takes up quite a portion of the sternal surface of the thorax, which is but 33 mm. wide.

This flat mass is somewhat irregular on the surface and its anterior half bends up at a wide angle with the posterior, since it is applied closely to the shell which is curved between the fourth and fifth legs. It is made up of a translucent yellow brown material through which a curved whitish content can be seen dimly on each side pass-

ing back from a terminal orifice, becoming bent posteriorly. The mass sticks so tightly to the shell that a knife point does not separate it. It cuts like hardened paste, cracking along the knife cut. It at once suggests a coagulated mass containing a tubular cavity more or less full of sperm on each side; that is, two more or less fused spermatophores stuck to the shell. The two do not have their anterior openings at the same level, as far as noted in several specimens, but one is in advance of the other, and posteriorly one side is not like the other. Moreover, the whole mass, though roughly of trefoil outline, quite lacks the exact bilateral symmetry which would be expected in any crustacean median organ, such as a real spermatheca.

On removing a piece of the spermatophore and teasing it it was found that the outermost indurated shell-like covering incloses a somewhat softer friable yellowish mass itself inclosing a white-yellow rod, or more or less coiled filament, quite different from the rest of the mass, being a granular aggregate of innumerable rounded agglutinated objects. Sufficiently magnified these are obviously sperm, rounded, with a dark staining central body and outer film of protoplasm that presents various forms. In some it is projected as pseudopodia-like processes. On the surface of the mass especially these sperms send out clear films, as if actively amœboid leucocytes. Comparing these with the cells in the testes of the male we find that these are smaller, the testes now being inactive, apparently, but the cells in the deferent ducts are just like those in the spermatophores.

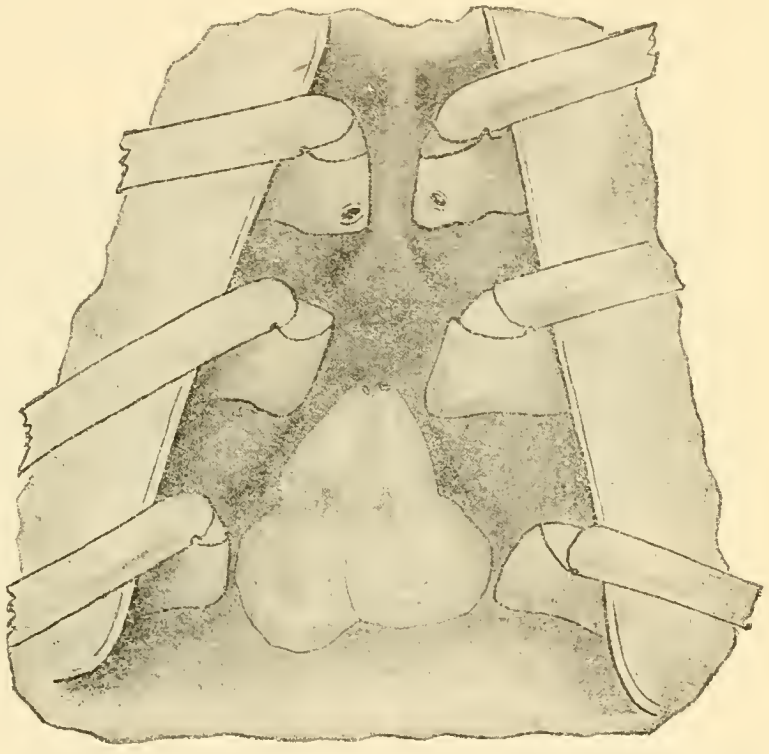

FIG. 11.—SURFACE VIEW OF UNDER SIDE OF THORAX OF A FEMALE POLYCHELES SCULPTUS, SHOWING BASES OF LEGS AND LARGE PAIR OF SPERMATOPHORES FUSED TOGETHER AND FASTENED TO THE SHELL BETWEEN THE LAST PAIRS OF LEGS.

In this female the eggs in sections of the small H-shaped ovary are apparently immature, which suggests that the sperm must remain sometime in the spermatophore before the eggs are laid. Other females show the eggs already fastened to the pleopods, including the small first pair.

That these masses on the females are really spermatophores was again indicated by the observation that in one female *Polycheles sculptus* from *Albatross* station 2677, from off Cape Fear, in 478 fathoms, there were two in place of the usual single pair of the spermatophores. One pair was as in fig. 11, the other was similar but not so well made, that is less completely fused and more evidently complex. It was applied to the regular one so as to lie over its posterior half and thence project back freely without contact with the body wall of the female.

It was quite evident that this accessory pair of spermatophores was but a pair of tubes filled with a mass of white substance, presumably sperm. Probably after one male had applied the normal pair of spermatophores another male added a second pair.

Sectioning pieces of a spermatophore shows that it is but a secreted mass containing sperm and no other cellular elements whatever.

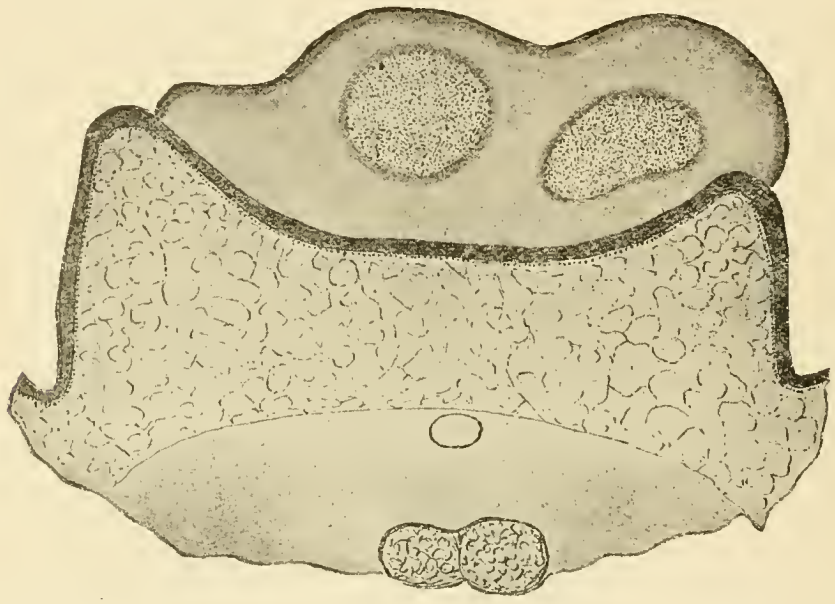

FIG. 12.—CROSS SECTION OF VENTRAL PART OF THORAX OF POLYCHELES SCULPTUS WITH NERVE CORD BELOW AND THE APPLIED SPERMATOPHORES ABOVE OUTSIDE THE SHELL WHICH IS INDICATED AS A DARK LAYER.

A cross section through the shell of the female represented in fig. 11, across the anterior part of the applied spermatophore mass, is represented in fig. 12. Below is the median nerve cord and blood vessel, connective tissue, and thick shell of the female. Above is the pair of spermatophores showing as a secreted mass containing a central rod of sperm, right and left. The secretion has become more dense where it is in contact with the water and the sperm, producing a sort of denser shell, but there is no special structure there, and moreover even this differentiation is absent where the secretion comes against the shell of the female to which it adheres so firmly. The asymmetry of the two combined spermatophores is seen in the section.

In sections farther back where the mass is wider, fig. 11 and fig. 13, the ventral nerve ganglion is much nearer the shell, since this region

of the female is not elevated as is the region toward the fourth legs, fig. 11. Here the spermatophoral mass seems more clearly a mere applied mass of secretion containing two sperm strands. In this posterior region the strands of sperm are bent, as dimly seen in fig. 11, and hence they appear elongated in cross section, fig. 13. The strand on the left of the figure shows that there the sperm does not completely fill out the tubular cavity in the secreted spermatophore, but that there is some other secreted material inserted here between the general walls of the spermatophore and the actual sperms. Probably there is a slight admixture of sperm and secretion such as occurs toward the end of the filling of the spermatheca in *Cambarus*.

In the main each spermatophore is a long bent rod of sperm inclosed in a thick envelope of some translucent secretion and stuck fast to the sternum of the female along with a like spermatophore.

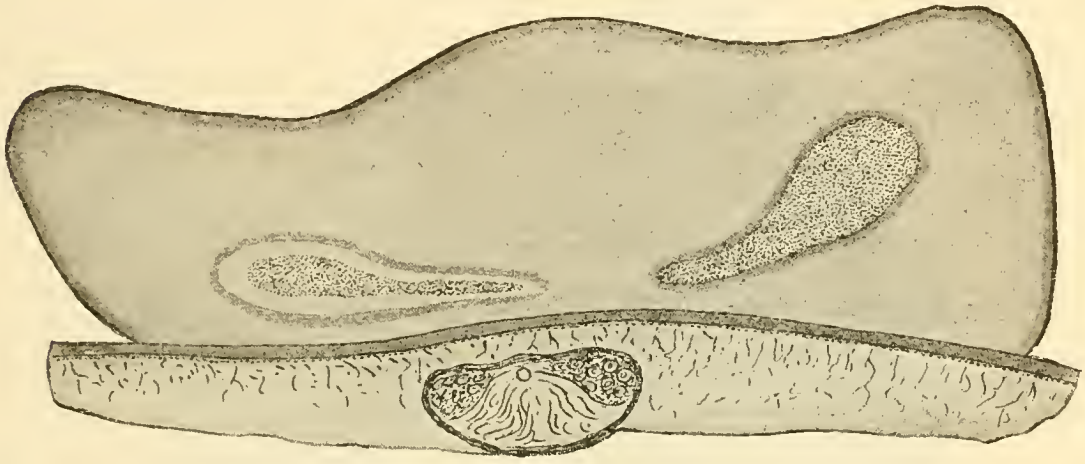

FIG. 13.—CROSS SECTION POSTERIOR TO THAT SHOWN IN FIG. 12.

That these two spermatophores arise from the deferent ducts of one male seems probable from the following observations on the male of this same species.

In a male from the last-mentioned locality the brown mass previously mentioned as proceeding from the orifice of the male duct, fig. 14, is found on cutting off the leg to run throughout the base of the leg as a large rounded cylinder up into the body of the male.

The part of this mass that projects into the water is seen in fig. 14 as the dark bent object above, while its continuation from the base of the leg into the body is represented as cut across below.[a] Following this up into the body we find the colored cylinder continues as a cast of the deferent duct for a distance of 25 to 30 mm. and with a width of 2 mm. to end abruptly at the relatively small and delicate lobulated

[a] The dark-colored protuberance is more than 2 mm. long, not the same exactly on the right as the left leg, of cylindrical form but flattened so that one diameter is 2 mm. and the other about 1.5 mm. It bends at the tip as if to coil, and is somewhat retort shaped. The white contents seen throughout the translucent colored part comes to the tip and is there closed off as if by the elasticity of the inclosing secretion.

testes. On each side the duct full of secretion and its central sperm core is differently bent. Apparently the sperm mass is long enough to supply spermatophores to two or three females.

The projecting mass shows plainly a central core, fig. 14, and this continues up through the leg. When the projecting mass is cut into sections it is found that it has the same structure as it has within the leg, as indicated in fig. 15. Here the rounded mass is a secretion filling the deferent duct completely. The protuberant mass is only the secretion emerging from the deferent duct in which it is made about the central core of sperm.

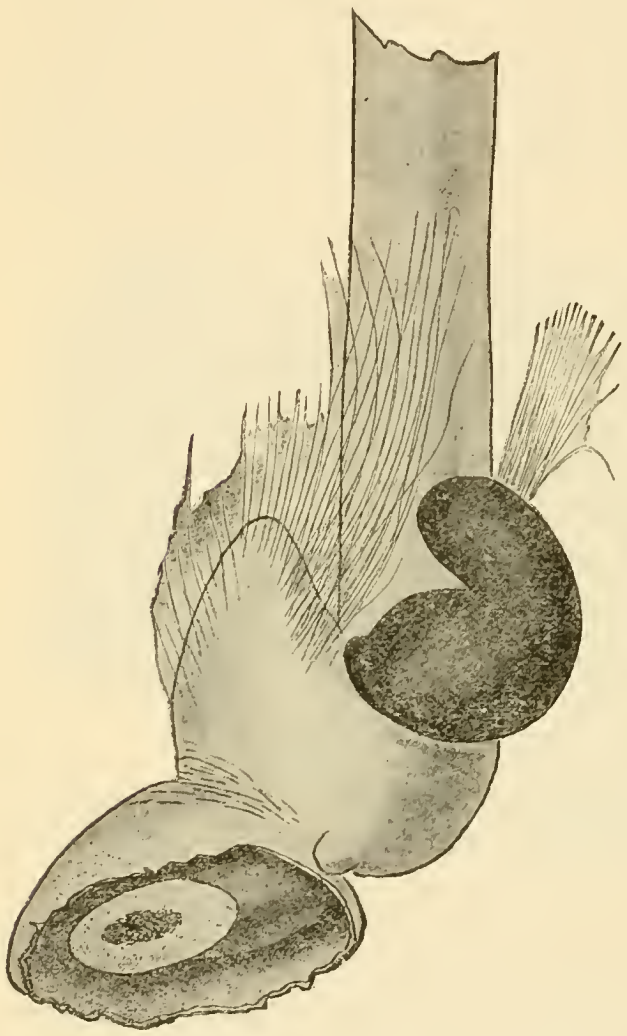

FIG. 14.—SURFACE VIEW OF BASE OF LAST THORACIC LEG OF MALE POLYCHELES SCULPTUS SHOWING BELOW THE DEFERENT DUCT AND CONTAINED SPERM CUT ACROSS AND ABOVE THE LARGE DARK SPERMATOPHORE EMERGING FROM THE ORIFICE.

In this section the shell of the basal segment of the leg is lined by epidermis and connective tissue surrounding the large muscles and the deferent duct. This duct has a thick muscular wall lined by epithelium and full of a clear secretion which in the preparations is shrunken so as to show conchoidal fractures. The central part of the contents of the duct is a rod of sperm exactly as in the spermatophore mass on the body of the female, but the sperm shows fewer protoplasmic processes.

The secretion inclosing the sperm seems not to have clotted more firmly about the sperm nor the walls of the duct than elsewhere, but otherwise the mass is like that of the spermatophore on the female.

That these projecting masses are the spermatophores fixed in process of emergence from the deferent ducts and about to be transferred to the female to form the united pair of spermatophores found upon the sternal surface of the female seems most evident. The occurrence of a minute mass of sperm in a minute string of secretion lying among the hairs on the base of the leg, fig. 14, near the orifice of the sperm duct suggests that the emerging mass may have portions of its

contents squeezed out of it as it is emerging and further strengthens the view that these masses are the spermatophores.

The only objection to the acceptance of this view is the statement of Geoffrey Smith in his paper above referred to.[a] He states:

The presence of this spermatheca is of considerable taxonomic importance, as it appears to be entirely absent in the other Schizopods, viz, Mysidacea and Euphausiacea, but to be present in certain of the more primitive Decapods. In the lobster and certain prawns a similar spermatheca is present, and in the peculiar Eryonidea (*Polycheles, Willemœsia*) the presence of a spermatheca in the same position was pointed out to me by Mr. Gray, of the Oxford University Museum. The investigation of this spermatheca in the female of *Polycheles* has revealed a structure identical with that of *Anaspides*. The spermatheca of *Polycheles* is a shield-shaped chitinous structure with a median opening leading into a tube which bifurcates exactly as in *Anaspides*. There can be no doubt that the structure in both cases is strictly homologous, and that we have in the spermatheca of Anaspidacea a Decapodan character, parallel to the presence of the otocyst on the first antennæ.

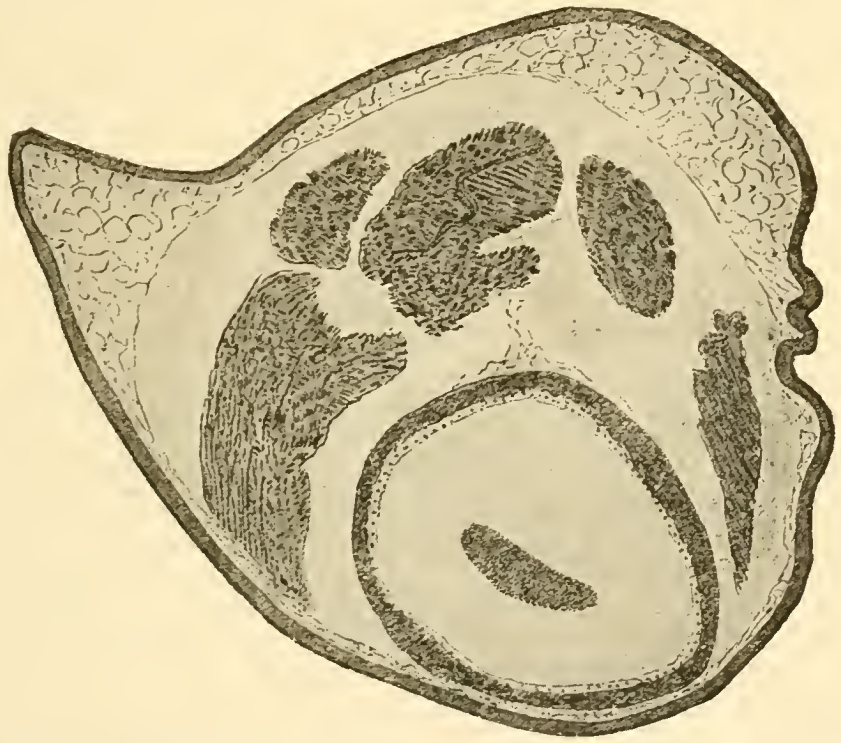

FIG. 15.—CROSS SECTION OF BASE OF LAST LEG OF MALE POLYCHELES SCULPTUS, NEAR THE EXTERNAL ORIFICE OF THE DEFERENT DUCT, SHOWING THE MUSCULAR WALL OF THE DUCT AS A DARK CIRCLE ENCLOSING THE CLEAR SPERMATOPHORE SECRETION AND A CENTRAL CORE OF SPERM.

As several authors have described the spermatheca of Anaspidacea as an actual cavity within the female shell within which a pair of spermatophores is found, we can not suppose this spermatheca comparable to what we have found in *Polycheles*. Hence to reconcile the present description of the spermatophores of *Polycheles* with the above statement of Smith that *Polycheles* has a spermatheca which is identical with that of Anaspidacea (that is, a female organ

[a] Quart. Journ. Micr. Sci., 1909, pp. 517–518.

and not a male production), we seem to have only two alternatives. Either the different species of *Polycheles* differ so much that the one investigated by Smith has a spermatheca while several others do not, but have only spermatophores, or else we must assume that the interpretation of what was seen in *Polycheles* as a spermatheca is an error. The former assumption seems to be very improbable. An error may readily be ascribed to the examination of poorly preserved material, such as deep dredgings often supply. The seeing of a cavity that forks exactly as in *Anaspides* might arise from great familiarity with the latter form and a hasty investigation of *Polycheles* as subordinate material.

In conclusion we may express the hope that spermatheca may yet be found in other groups of crustacea that will throw light upon the relationships of these organs in the few groups in which they are now known.