A STUDY OF THE INBESTATIONS

OCCURRING IN PARECHINUS ANGULOSUS.

A THESIS FOR THE DEGREE OF M.Sc.

by

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C O N T E N T S.

ILLUSTRATIONS.

Fig.1. Cryptochilidium (a) n.sp.

*Fig 2. Cryptochilidium (b) n.sp.

Fig 3: Form X.

*Fig 4. Cohnilembus caeci.

Fig 5. Anophrys elongata.

Fig 6. Range of variability in size, shape of body outline and nuclei of Cryptochilidium (a) n.sp.

Fig 7. Range of variability in size, shape of body outline and nuclei of Form X.

Fig.8. Range of variability in size, shape of body outline and nuclei of Anophrys elongata.

Fig. 9. Ventral view of Syndesmus sp.

Fig 10. Dorsal view of Syndesmus sp. showing gut.

Fig.11. Diagram of reproductive organs of Syndesmus sp.

*Cryptochilidium (b) and Cohnilembus caeci do not vary sufficiently to justify special drawings.

I N T R O D U C T I O N.

Data on the ciliate infestation of the alimentary tract of echinoids has been steadily growing. Work has been done on sea urchins from Bermuda, Tortugas, the east and west coasts of Japan, the coast of North Carolina, the coast of California, the Mediterranean Sea and the North Sea.

The present paper deals with the sea urchin Parechinus Angulosus the only species of sea-urchin to be found along the southernmost parts of the coast of South Africa. Five species of ciliate have been found of which three appear to be new species. All of these species belong to the order Holotrichida.

Apart from the ciliates a red Rhabdocoele worm of the genus Syndesmus has been found. It lies in the perivisceral cavity attached to the outside of the intestine, and appears to be a new species.

Many of the ciliates found in sea urchins are closely related to free-living species, and are fairly cosmopolitan in distribution. A careful consideration of taxonomic status and of geographical distribution should therefore result in considerable information regafding the origin of the endozoic habit.

MATERIAL AND METHODS.

Most of the work for this study was done on Pangulosus from the East and West coasts of the Cape Peninsula. However, a few specimens were also obtained from Victoria Bay and East London.

CILIATES: The routine method for examining sea urchins and obtaining material was as follows:-

Freshly collected sea urchins were rinsed in fresh water to clear the outside of any chance contamination. A hole was made in the test with scissors and the perivisceral fluid drained out. The cut was continued around and the oral surface carefully removed. If much fluid was present in the bulging sacs of the intestine, it was pipetted out with a sterile pipette through a small puncture. This gave abundant material for investigation. If however the intestine was packed with faecal matter it was placed in a watchglass opened up and diluted with a little sterile salt water. The difficulty of getting rid of the faeces was thus overcome.

The study of living material was difficult owing to the rapid movement of the ciliates. For detailed study of the cytoplasmic structures the ciliates were left in an uncovered watchglass for several hours. Just before death the various structures were most clear. Addition of very dilute

copper sulphate retarded the activity considerably without immediately killing the ciliates.

Neutral Red, diluted with seawater, as a vital stain was found most useful, especially for showing up the contents of the food vacuoles.

Osmic Acid was found to be by far the best fixative for showing up cytoplasmic structures. Smears were exposed to the fumes of osO4 for varying periods of time. For immediate study ten minutes sufficed but for permanent preparation prolonged osmification was found to be the most satisfactory. In the latter case they were mounted straight away in glycerine jelly or first stained with toluidine blue. This stain showed up the cilia clearly and also the nucleus by staining it a light blue. Even better results were obtained by following the technique of Schewiakoff (Hoare 1927) After fixation in osmic acid, one or two drops of weak(2%-4%) solution of soda are added. The slide is left uncovered till most of the water has evaporated. This brings ectoplasm cilia etc. out in special relief. Iodine fumes were also found a useful fixative for cytoplasmic structures.

Bouin's Fluid, Sublimate Formol and Schaudinn(s fixative all caused shrinkage of the cytoplasm. Haedenhaem's iron haematoxylin and Feulgen's nuclear stain were used for staining.

SYNDESMUS.....

SYNDESMUS n.sp. Bouin's Fluid or Sublimate Formol were both good fixatives for Syndesmus. The worm was placed on a slide and flattened under a coverslip. The fixative was then allowed to run in under the coverslip. Delafield's haematoxylin was used for staining with either eosin or fast green as a counterstain.

CILIATES ASSOCIATED WITH PARECHINUS ANGULOSUS.

Specimens of Parechinus were obtained from Sea Point (West Coast) and False Bay, Victoria Bay and East London (East Coast). In all specimens taken from the East Coast the same type and degree of infestation was present. But, in comparing East Coast specimens and West Coast specimens, differences were immediately apparent. West Coast specimens showed two additional ciliates namely, Cryptochilidium (b) n,sp. and Cohnilembus caeci. Cohnilembus was never found in sea urchins from the East Coast but Cryptochilidium (b) appeared very occasionally. Common to both coasts were Cryptochilidium (a), Anophrys elongata and Form X. These differences show a definite temperature gradient since the East Coast is bathed by the warm Indian Ocean and the West Coast by the colder Atlantic Ocean.

The degree of infestation can be represented by the following table:-

TABLE....

TABLE TO SHOW DEGREE OF CILIATE INFESTATION OF PARECHINUS ANGULOSUS FROM SEA POINT AND ST. JAMES.

P. Angulosus	Cryptochilidium (a)	Cryptochilidium (b)	Form X.	Anophrys Elongata	Cohnilembus caeci.
SEA POINT	***	*	**	**	*
ST. JAMES	****	-	**	****	-

**** exceedingly abundant.

*** abundant.

** constantly present but not abundant.

* constantly present but scarce.

- absent.

Various parts of the alimentary tract were examined and it was found that the ciliates were located in a fairly regular manner. Ciliates were never found in the oesophagus but were mainly congregated in the bulging sacs of the upper intestinal loop. Anophrys and Cohnilembus were nearly always absent from the rectum. Cryptochilidium (a) and (b) were the two dominant forms to be found in the rectum. These two together with Form X could be found anywhere along the intestinal tract. Segregation often occurs in the upper intestinal tract and one sac may contain only Anophrys

Elongata.....

Elongata or only Cryptochilidium (a).

No sea urchins were found completely devoid of ciliate infestation - even the very young ones were quite heavily infested.

In describing the organisms the ventral surface is referred to as the one most frequently in contact with the substratum.

DESCRIPTION OF SPECIES.

Order: Holotricha.

Suborder: Hymenostomata.

Family: Frontoniidae.

Genus: Cryptochilidium Schouteden 1906.

Species: Cryptochilidium (a) n.sp. Figs. 1 & 6.

Diagnosis:

Average length 135 u. Average width 45 u. The body is very much flattened and leaflike. The anterior end is rounded and the posterior end slightly pointed. The body is oval in shape and there is a crest at the anterior end. The cytostome is situated in the anterior third of the body and opens laterally into a small vestibule. The macronucleus is placed alongside this vestibule. It (the macronucleus) is irregular in shape and may be spherical but more usually fig-shaped. The micronucleus is single and situated a short distance above the macronucleus.

DESCRIPTION:

Average lenght 135 u (180 - 108u). Average width 45u (36 -54 u). The body is greatly flattened being broadest about the region of the macronucleus and tapering slightly toward the hind end. Sometimes the posterior end is produced into a caudal projection. In sideview, the part

above.....

above the cytostome seems to form a distinct proboscis region. There is a crestlike structure at the anterior end extending from the top of the oral margin to a little way down on the aboral margin. It seems to be a projection of the smooth pellicle of the dorsal surface.

CILIA: There are about 24 striations on the dorsal surface and about 22 on the ventral surface. Along these striations the cilia are inserted. They run in close parallel rows being especially close together at the anterior end where they resemble a number of fine closely set membranes. The striations on the ventral surface originate at the base of the crest whilst those on the dorsal surface originate at the top of the crest. There is a very long terminal bristle inserted to one side of the caudal projection and sometimes two or three small bristles also arising from the caudal projection.

CYTOSTOME: The cytostome opens about a quarter of the distance of the whole length of the body, from the anterior end. It opens into a small vestibule lying close to the border of the macronucleus. From the vestibule a narrow gullet runs into the posterior endoplasm accompanied by a long pharyngeal fibre. A row of closely set cilia are inserted along the roof of the vestibule and a row of much smaller cilia are continued down one side of the gullet. There appear to be one or two small non-mobile membranes situated

in.....

in the vestibule. A set of longer cilia overhang the cytostome.

FOOD VACUOLES: Food vacuoles have never been seen in formation although attempts were made with carmin particles. The food vacuoles are situated in the posterior end and stretch up as far as the posterior border of the macronucleus. They are fairly large and seem to consist of two different types. Some are dark and probably consist of newly assimilated food. Others are very light and are probably older vacuoles. The vacuoles are filled with algae, small diatoms and bacteria.

TRICHOCYSTS: Trichocysts line the posterior end and extend up to the oral region. They do not seem to be the type that discharge since various irritants have been placed in the culture fluid without any result.

CYTOPLASM: Ectoplasm and endoplasm are not clearly differentiated. There are a number of granules distributed through the endoplasm especially abundant in the posterior region and around the macronucleus. Their nature has not been determined.

NUCLEI: The macronucleus is quite large and lies in the anterior half of the body. It varies in shape being sometimes spherical, sometimes slightly kidney-shaped but more often fig-shaped. It shows a gran ular structure when stained

stained but in unstained specimens shows through as a clear transparent ~~parent~~ body. The micronucleus is situated about 6 u above it.

Division of the macronucleus is very common. It has been seen in from two to seven pieces regular in outline and arranged in an orderly fashion. On none of these occasions has the micronucleus showed any signs of division.

CONTRACTILE VACUOLE: The contractile vacuole is usually single and situated just below the macronucleus. When the animal is dying, however, quite a number of vacuoles form below the macronucleus, and either coalesce to discharge to the exterior, or run into a small posterior vacuole.

REPRODUCTION: Fission has been seen quite frequently. It is always transverse and takes place in a normal manner. Conjugation has occasionally been observed. Two individuals of smaller size than usual come together with fusion of their anterior regions. The macronucleus on one occasion was seen to be divided into two in both conjugating individuals and on another occasion into four. The behaviour of the micronucleus has not been observed.

HOSTS: All specimens of P. Angulosus examined were found to contain this ciliate in large numbers.

LOCATION: Can be found throughout the intestine and is often

the only species to be found in one of the sacs.

TAXONOMY: No previous description of this ciliate can be found nor is it mentioned by Kahl. Thus it is concluded that it must be a new species. It resembles Cryptochilidium Echini (Maupas) in many points but differs in the anterior position of its cytostome and macronucleus. The position of the cytostome and macronucleus which are always closely associated seems to be an important point in determining the different species of Cryptochilidium.

ORDER:

Order: Holotricha.

Suborder: Hymenostomata.

Family: Frontoniidae.

Genus; Cryptochilidium Schouteden 1906.

Species: Cryptochilidium (b) n.sp. Fig 2.

DIAGNOSIS: Average Length 115 u. Average width 47 u. The shape is oval, rounded at the anterior end and also at the posterior end, which is occasionally slightly pointed. The body is flattened but less so than Cryptochilidium (a). The Cytostome is situated in an inlet about a third of the total length from the anterior end. There is a crest at the anterior end extending from the top of the oral side to a little way down on the aboral side. The macronucleus is spherical, micronucleus single situated fairly close to it. Cilia in close parallel rows.

DESCRIPTION: Average length 115 u.(125 u - 100 u). Average width 47 u. The body is flattened and broadest about the region of the macronucleus. It is oval in shape with a pronounced curve in at the mouth. The posterior end is rounded but can become slightly pointed. There is a crest at the anterior end exactly similar to that of Cryptochilidium (a). It starts at the top of the oral side and is continued a little way down on the aboral side, and appears to

be.....

be a prolongation of the pellicle on the dorsal side.

CILIA: There are about 20-23 striations on either side. The cilia thus run in close parallel rows, curving slightly towards the oral side. The ciliary rows on the ventral surface originate from the base of the crest whilst those on the dorsal surface originate from the tip of the crest. There is a long terminal bristle inserted to one side of the posterior end.

CYTOSTOME: The cytostome opens on the lateral side about one-third of the total length from the anterior end. It opens into a shallow vestibule shaped like a lateral V thus 7. Cilia are inserted along both sides of this vestibule and there is possibly a small membrane inside it. There is no pronounced gullet to the endoplasm but sometimes a faint pharyngeal fibre can be made out.

FOOD VACUOLES: These fill the posterior region of the body up to the macronucleus. They are filled with small algae diatoms and bacteria.

CONTRACTILE VACUOLE: There is a single contractile vacuole situated between the macronucleus and the posterior end. It opens to the exterior through the side of the body on the same side as the mouth.

TRICHOCYSTS:....

TRICHOCYSTS: Trichocysts line the posterior two-thirds of the body. They have never been seen to discharge.

CYTOPLASM: Numerous granules fill the cytoplasm but their nature has not been determined.

NUCLEI: The macronucleus is spherical and the micronucleus situated fairly close to it. The macronucleus can be seen to be in various stages of division in different specimens. The division is orderly and regular and never more than seven places have been observed.

REPRODUCTION: Transverse fission has been observed and takes place in a normal manner. Conjugation has not been seen.

HOSTS: This ciliate is usually found only in P. Angulosus from Sea Point. However, it has occasionally been seen in the sea urchins from St. James.

LOCALITY: Can be found throughout the intestine though seldom very abundant.

TAXONOMY: This ciliate chiefly differs from Cryptochilidium (a) in the shape of the body, the details of the cytostome and the shape of the macronucleus - otherwise it is absolutely identical. It may possibly not be a new species at all but merely a variation - this is doubtful, however, in view of the consistency of its features. It is very constant in

size and shape.

FORM X. Figs. 3 & 7.

DIAGNOSIS: Average length 74 u. Average width 29 u. Almond shaped - pointed at both ends but more so at the posterior end. The cytostome is very small and located near the anterior end at the sid e. A fringe of longer cilia overhang the cytostome. The macronucleus is spherical and lies in the midregion of the body. The micronucleus is single and lies beside it. The contractile vacuole lies below the macronucleus and there are frequently present two or three subsidiary vacuoles.

DESCRIPTION: Average length 74 u. (87 - 60 u.) Average width 29 u. Flattened pointed at both ends but only slightly at the anterior end. One side more convex than the other. The ciliate varies in size but the shape remains fairly constant.

CILIA: The cilia are closely set, there being about [illegible] - 16-20 striations on each side. At the anterior end which is narrower than the rest the cilia are extremely closely set. There is a fairly pronounced caudal projection to which are attached a small number of bristles and one fairly long one inserted to one side of the projection.

CYTOSTOME: This is very obscure in living animals. In fixed specimens it can be made out as a shallow depression on the lateral side about a third of the total lenghh from the

anterior.....

HOST: This ciliate is found in P. angulosus from St. James and Sea Point. Usually it is not particularly abundant but on one or two occasions P. angulosus was heavily infested with it.

LOCALITY: It is found in greater numbers in the second or lower coil of the intestine.

REMARKS: The ciliate is a rapid swimmer and difficult to examine since it disintegrates almost immediately after death.

TAXONOMY: Because the details of the cytostome were so obscure it was difficult to state positively that this ciliate belonged to any particular genus. Moreover, so much confusion exists at present over the status of genera of this type of ciliate that it is difficult to assign a new ciliate to any particular one of them. Form X seems most closely related to the genus Cryptochilidium. This genus is in turn fairly closely related to ciliates of the genus Uronema and the name Cryptochilidium has now been set aside for ciliates of this type occuring in sea urchins.

Order.....

Order: Holotricha.

Suborder: Hymenostomata.

Family: Lembidae.

Genus: Anophrys Cohn 1866.

Species: Anophrys elongata. Biggar and Wenrich. Figs. 5 & 8.

DIAGNOSIS: Average length 131 u. Average width 32 u. The shape varies according to how swollen the animal is with starch granules. A normal individual is linear in shape and a little over three times as long as it is broad. It is pointed at the anterior end and rounded at the posterior and. The anterior third forms a thin mobile proboscis with the cytostome located at its base. A long row of cilia run downward from the anterior tip into the cytostome. The endoplasm is densely packed with starch granules. A spherical macronucleus is located about the midline with a single micronucleus lying close to it.

DESCRIPTION: Average length 131 u. (140 u - 120 u). Average width 32 u. The shape is linear, rounded at the posterior end and pointed at the anterior end. The whole body is extremely labile, the proboscis espedially so. The body is frequently enormously swollen with closely packed granules mf starchy in nature. (This was determined by fixation with iodine vapour). When swollen like this the proboscis part is

very.....

very much smaller than usual consisting of merely a point at the anterior end. Normally, however, the proboscis i.e. the part above the cytostome is about one-third of the body length and extremely flexible. When the ciliate is pushing its way through intestinal mucosa the whole body shows an extreme flexibility.

CILIA: Striations can only be clearly made out at the anterior end since the refringent granules obscure them elsewhere. There are from 6 - 8 striations on each side. The cilia are evenly distributed but are slightly longer on the oral surface. There is a long thin caudal cilium extending from the middle of the posterior end.

A short distance before the anterior tip on the oral side a row of very long cilia run along one side of the proboscis and into the mouth. There are longest just before they dip into the mouth where they become much shorter. These cilia point downwards towards the mouth and those in the mouth point horizontally out. They seem to be used for driving food into the mouth.

CYTOSTOME: The cytostome leads into a very small vestibule which is ringed with cilia. From there it is continued by a short passage into the endoplasm.

FOOD VACUOLES: Food vacuoles occur at the hind end. They are very small and filled with bacteria.

CONTRACTILE VACUOLE:.....

CONTRACTILE VACUOLE: The contractile vacuole is rounded and lies in the posterior end. It contracts at fairly long intervals. There are no accessory vacuoles/

CYTOPLASM: Ectoplasm and endoplasm are not clearly marked off. Large granules of a starchy nature pack the endoplasm from the base of the proboscis to close to the posterior end. They do not cover the nucleus which shows through as a tranparent sphere in the living animals. The proboscis too, is usually quite transparent.

NUCLEI: The macronucleus is spherical and lies about the mid-region of the body. Frequently it has a little niche for the micronucleus which lies embedded in it or close beside it.

REPRODUCTION: Transverse fission occurs quite frequently and in a normal manner. On one occasion a conjegating pair were observed. They were much smaller than usual and were fused in their anterior regions. Both showed division of the macronucleus.

HOSTS: A. elongata is particularly abundant in the sea urchins from St. James. It is also found in large numbers in the Sea Point sea urchins.

LOCATION: It is chiefly found in the upper loop of the intestine sometimes wholly filling one of the pouched to the exclusion of all other species.

TAXONOMY:...

TAXONOMY: This ciliate is identical with the A.elongata of Biggar and Wenrich. It is much larger than that of Powers but otherwise it is identical with his. The genus Anophrys was first formed by Cohn 1866 for Anophrys sarcophaga and since then four or five different species of Anophrys have been found in sea urchins.

Order; Holotricha.

Suborder: Hymenostomata.

Family: Lembidae(Kahl 1931) Cohnilembidae nom n Kahl 1933.

Genus: Cohnilembus nom. n. Kahl 1933 for Lembus Cohn 1865.

Species: Cohnilembus caeci (Powers 1935). Fig. 4.

DIAGNOSIS: Average Length 65 u; Average width 14 u. Cigar-shaped, body elongated broadest at the posterior end and gradually narrowing anteriorly. The anterior proboscis region is slightly bent to one side and is very mobile. The posterior end is bulging and rounded. The peristome starts at the anterior tip and curves round to the other surface opening into a rounded vestibule. From here a narrow gullet, accompanied by pharyngeal fibre, curves over the macronucleus into the posterior endoplasm. Attached to the right upper border of the peristome are two undulating membranes. Another small membrane is present in the vestibule. All this is very obscure in the living animal and all that can be seen are the borders of the membranes. There is a posterior contractile vacuole, a medium spherical macronucleus with the micronucleus close beside it and occasionally embedded in it.

DESCRIPTION: Average length 65 u (72 u - 55 u). Average width 14 u. The shape varies only insofar as it is sometimes much

shorter.....

shorter in the long axis and consequently much broader. Conversely it is occasionally much lengthened and very much thinner. The body is linear, with a bulging rounded posterior end and a narrow proboscis-like anterior region. This anterior region bends to the right; thus the front end is at an angle to the rest of the ciliate. In swimming the anterior end points downwards and waves from side to side while the whole animal continually rotates.

CILIA: These are evenly distributed in 8 - 10 longitudinal rows. A long terminal cilium is inserted into the middle of the rounded posterior end.

CYTOSTOME: This can best be observed in weakened specimens, since it cannot be clearly made out in active or dead creatures. The peristome starts at the anterior tip of one side and curves round to the other side where it opens into a small rounded vestibule just above the macronucleus. Two undulating membranes are attached to the right upper border of the peristome, and continued into the vestibule, one on either side. The individual cilia in these membranes cannot be made out. Another small membrane is present in the vestibule. From the vestibule a narrow gullet accompanied by a pharyngeal fibre leads across the macronucleus into the posterior endoplasm.

FOOD VACUOLES:.....

FOOD VACUOLES: There are from 3 - 7 large rounded food vacuoles lying in the posterior region. They are filled with bacteria which can best be demonstrated by the use of neutral red.

CONTRACTILE VACUOLE: A small contractile vacuole lies in the posterior region of the body. There are no accessory vacuoles but the single one has been seen to empty from time to time.

ENDOPLASM: Endoplasm and ectoplasm cannot be structurally distinguished. The endoplasm is clear and tranparent and in the anterior end above the cytostome are a large number of lipoid granules. Their nature was determined by prolonged osmification. These granules can sometimes be seen further down in the body.

NUCLEI: The macronucleus is large and spherical and occupies a median position in the body. The micronucleus sometimes lies embedded in it but morefrequently lies at the side.

REPRODUCTION: Neither fission nor conjugation have been observed.

HOSTS: This ciliate has only been found in sea urchins from Sea Point, never in sea urchins from the East Coast. It is seldom very abundant but always present.

LOCATION: Found especially in the lower coils of the instestine but not in the rectum.

TAXONOMY:

TAXONOMY: After reading the excellent analysis of Lembus by Hoare (1927), no difficulty was found in placing this ciliate. It corresponds in all details with the genus Cohnilembus and with Powers (1935) description of Cohnilembus caeci from the littoral echinoids of the Tortugas. However, the great variability in size described by Powers was not encountered in C. caeci from P.angulosus.

Phylum: Platyhelminthes.

Order: Rhabdocoelida

Suborder: Lecithophora

Section: Dalyelliodia.

Family: Anoplodidae.

Genus: Syndesmus. n.sp. Figs. 9,10 & 11.

In about 65% of the Parechinus angulosus examined from Sea Point, there were found from 1 - 12 red flatworms belonging to the genus, Syndesmus. They lay in the perivisceral cavity attached to the outside of the alimentary canal. These worms were never found in Parechinus angulosus from the East Coast.

The genus Syndesmus was first described by Silliman (C.R. Ac.Sci XCIII 1881). He found them on a large green nematode, a parasite of Echinus esculentos. In 1886, Ph. Francois found them in Strongylocentrotus lividus and Echinus acutus at Banyuls. His description rather differed from that of Silliman and he suggested the species name echinorum. In 1896, Russo published a description (Monit. Zool. Ital VII) but his paper is altogether inaccessible. Shipley, 1901, gives a description of Syndesmus echinorum found in Echinus esculentus from the English Channel. The only other mention of such a worm is from Powers 1935 who found it in Centrechinus antillarum from Tortugas. He gave a fough diagram of the worm but did not describe it.

The present worm from Parechinus definitely belongs to the....

the genus Syndesmus but differs in many points from Sechinorum of Shipley and the Syndesmus of Powers.

EXTERNAL APPEARANCE: The worm is about 1½ mm to 4 mm in length when flattened under a coverslip. The red colour varies from a very pale shade to an almost maroon colour. Vertically the worm is hollowed out in the centre and this centre part is much paler than the rest. Thus the red colour seems chiefly confined to the large parenchyma calls. It has been suggested that the colour is due to ingestion of the red colouring matter in the blood of the sea urchin.

The worm is ciliated, the front end is rounded and the posterior end terminates in a short papilla through which passes the common genital aperture.

ALIMENTARY CANAL: The mouth opens on the ventral side a short distance from the anterior end. It leads straight into a spherical suckerlike pharynx. The gut lying very close to the dorsal surface is straight but has numerous sac-like pouches. It ends blindly about three-quarter way down the body.

EXCRETORY SYSTEM: There are two lateral branched excretory canals, one on either side of the body.

NERVOUS SYSTEM: The nerve ganglion lies directly above the mouth and has nerves arising from each angle.

REPRODUCTIVE SYSTEM: The worm is hermaphrodite and the

reprod-...

reproductive organs lie towards the ventral surface.

THE FEMALE SYSTEM: The female system consists of paired vitellaria, paired ovaries and paired shell glands. The vitellaria lie between the ovary and testes, occupying the midregion of the body. They are large branched structures stretching out to the lateral margins of the body. Each branch ends in a slightly swollen tip which stains more darkly than the rest of the gland.

The ovaries are also paired and bfanched, but much smaller than the vitellaria. Large rounded ova can easily be distinguished filling the ovary. The ovaries and vitellaria open into a common chamber lying between them in the midline of the body. From the chamber runs the oviduct, which swells almost immediately into an oval receptaculum seminis. It then runs straight down to the region of the genital atrium where it widens into a muscular vagina.

In the midline of the body is a transparent tube, the uterus. At its top end it contains a large golden egg enclosed in a capsule. This capsule is prolonged into a much coiled thread like a tangled skein, and its very fine end is continued down to the opening of the uterus, into the genital atrium. In a few worms one or two smaller eggs have been observed in the uterus in addition to the large one. On one occasion, the egg was shot out of the body together with the long thread which possibly serves for attachment.

The shell glands are paired, scattered, unicellular structures lining the lateral sides along the posterior region of the body. Fine ducts connect the shell glands with the shell reservoirs which lie on either side of the uterus.

The vagina is a muscular protrusible organ. It is covered with fine hairs and bristles which probably aid in copulation. Lying between the vagina and the penis is a rounded structure filled with yellowish coloured ~~grandes~~ granules. This may possibly be a bursa copulatrix or a prostate gland. It always gets protruded with the penis and the vagina.

MALE SYSTEM: This consists of paired testes lying above the vitellaria and just below the pharynx. They are fairly compact organs. A pair of vasa efferentia run from each testis and open into a vesicula seminalis from which runs the single vas deferens. The vas deferens loops up on one side of the mouth and is very much coiled in the region of the testes but straightens out as it runs between the vitellaria. About three-quarter way down the body it opens into the ductus ejaculatorius. This is a thin hollow needle-like structure which runs into the muscular penis. When not protruded the penis has its distal part turned in, something like the inturned finger of a glove. It is also covered by hairs and bristles and when protruded turns inside out and can be extended to about five to six times its normal length.

TAXONOMY:....

TAXONOMY: The reasons for placing this worm in a different species to Syndesmus are as follows. Syndesmus echinorum has a straight rod-shaped gut with no pouches whereas Syndesmus n.sp. has numerous pouches to its gut. Shipley makesa point of stating that Syndesmus echinorum has only a single row of ova in each branch of the ovary whereas Syndesmus n. sp. has many. No bursa copulatrix, receptaculum seminis, shell reservoir or complicated penis and vagina were described for echinorum. Altogether the morphology of the posterior region differs considerably in the two worms. There may be points that were overlooked by Shipley, but until this can be confirmed there appears to be no justification for placing the worm from Parechinus in the same species as that from Echinus esculentus.

Power's drawing of Syndesmus from Centrechinus is very vague but also differs in the morphology of the posterior region. Therefore, it seems safer, for the time being, to regard Syndesmus from Parechinus as a new species.

D I S C U S S I O N.

The close relationship of many of the ciliates endoparasitic in the alimentary tract of sea urchins to free-living species is an interesting guide to the origin of their endozoic habit. The infestation seems very widely spread and offers much scope for a comparative study.

All 5 species of ciliates infesting Parechinus have been found to be unable to live outside the host for any length of time. If placed in a dish of sterile saltwater and the dish is covered to make it as airtight as possible (since the ciliates must live in fairly anaerobic conditions in the intestine) then the ciliates may live for from 12 to 15 hours. They last longer (about 20 hours) if kept in the fluid from the intestine under the same conditions. Cryptochilidium (a) and Cryptochilidium (b) are the most sensitive to changes in conditions. Cohnilembus caeci is the least sensitive. After death of the host the ciliates may live for about 24 hours but not longer.

None of the ciliates infesting Parechinus have been found to be truly parasitic in the sense that they are pathogenic to their host. No intestinal mucosa has ever been seen in the food vacuoles. However, ciliates are often closely attached to the intestinal mucosa and continually swim in and out of it. They appear to be harmless commensals feeding on diatoms, algae and bacteria all of which are abundant in the intestinal

contents. They are only parasitic in the sense that they cannot live outside the host for any lengh of time and are extremely well adapted to existence among faecal matter. Ordinary free-living marine ciliates have never been encountered in the intestine.

As regards degree of infestation Cryptochilidium (a) is the dominant form both from East and West Coasts. Since it is also the most susceptible to any changes in environment, it seems probable that it is the oldest member of the association. The absence of Cryptochilidium (b) and Cohnilembus caeci from the East Coast may possibly be accounted for by the difference in temperature between these two coasts. The East Coast is bathed by the warm Agulhas current and this temperature is probably unfavourable to Cohnilembus caeci and Cryptochilidium (b). However, C.caeci has been described by Powers from the Tortugas where the currents are very warm.

Powers has suggested that the centre of infestation is to be found in the sea urchins from the Lesser Antilles and that this infestation has been carried northward along with its host through the agency of the gulf stream. It seems possible that the Southern equatorial current is responsible for the southward spread of the infestation but more information is required regarding the ciliate infestation of sea urchins in the Pacific before this can be confirmed.

As regards taxonomy, the ciliates from Parechinus fall into two main groups. The first group comprising Cryptochilidium (a), Cryptochilidium (b), and Form X are all members

members of the family Frontoniidae. The second group consisting of Anophrys elongata and Cohnilembus caeci are members of the family Lembidae. It is interesting to note that all the ciliates infesting P.Angulosus are of the Hymenostomatous order.

Anophrys elongata has been found by Mrs.Biggar (1932) in Bermuda sea urchins and by Powers 1935 in sea urchins at Tortugas. Cohnilembus caeci was described by Powers (1935) and he points out its close relationship to Anophrys echini of Di Mauro (1904).

The genus Cryptochilidium (Schoutenden 1906) is very cosmopolitan in its distribution. Different species of Cryptochilidium are found associated with Sea urchins from all parts of the world. Yagio (1934) has described three species of Cryptochilidium from the intestine of Anthodidaris crassispina a Japanese sea urchin, - unfortunately, his paper is unobtainable Biggar and Wenrich have described C. bermudensis and C. echinometris from Bermuda sea urchins. In addition to these two, Powers 1933 has described C.echini (Maupas 1883) from Beaufort N.C. and the Bay of Naples and C.gracile from the Bay of Fundy. In addition to these seven species, may be added Cryptochilidium (a) and (b) and possibly Form X, from P. angulosus. All these species form a series ~~of~~ in which the cytostome remains constant at the level of the macronucleus but the extent of the region anterior to the macronucleus differs. This cosmopolitan distribution of Cryptochilidium taken in conjunction with its extreme sensitivity to a change

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in conditions seems to confirm the fact that it is the oldest member of the infestation.

The transmission of the infection has not yet been ascertained but even the youngest sea urchins, measuring only an inch in diameter are heavily infested.

A study of the infestations in Durban sea urchins would probably yield interesting results since many of the Durban species are the same as those found at Tortugas and Bermuda.

SUMMARY.

1. Five species of ciliates are described infesting the alimentary tract of Parechinus angulosus from the coast of South Africa as far as East London.

2. The new species are:-

Cryptochilidium (a)
Cryptochilidium (b)
Form X.

The other two are:-

Anophrys elongata.
Cohnilembus caeci.

3. Three of these ciliates, Cryptochilidium (a), Anophrys elongata and Form X are common to both East and West Coasts of South Africa.

4. The remaining two species, Cryptochilidium (b) and Cohnilembus are confined to Sea Point (West Coast).

5. The ciliates are not parasites but commensals i.e. they are not pathogenic to the host.

6. The ciliates cannot live for very long outside the host.

7. In addition to the ciliates, a new species of Syndesmus, a red Rhabdocoele worm was found in the perivisceral cavity of about 65% of P.angulosus from Sea Point.

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