

A New Turbellarian parasitic in the Sea-star,  
*Coscinasterias calamaria* (Gray)

By

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(WITH 6 TEXT FIGURES AND 2 PLATES)

ABSTRACT

A description of a new Turbellarian found encysted in the connective tissue of the tube-feet of the Sea-star, *Coscinasterias calamaria* (Gray) is given. The Turbellarian is devoid of a mouth, pharynx, intestine and certain other organs. It appears to be an aberrant rhabdoceol and is named *Acholades asteris* gen. et sp. nov. A new family, Acholadidae, is erected for its reception.

INTRODUCTION

Although a number of Turbellarians have been recorded as endoparasites of Holothuroidea and Echinoidea, only one seems to have been discovered in a member of the Asteroidea. It was found in several species of *Pteraster* occurring in the Gulf of Kola, Northern Russia, and was described under the name of *Pterastericola fedotovi* by Beklemicheff (1916, p. 34).

The species described in the present paper is an endoparasite of the large eleven-rayed sea-star, *Coscinasterias calamaria* (Gray), which is common in D'Entrecasteaux Channel and at other localities on the East Coast of Tasmania. The parasite becomes encysted in the connective tissue of the tube-feet of the sea-star. As so often happens in cases of parasitism the infecting organism exhibits marked degeneration and loss of structures which are normally present. Thus, mouth, pharynx intestine and certain other organs are lacking. However, there are sufficient characters to justify regarding the parasite as an aberrant rhabdoceol. It is named *Acholades asteris* gen. et sp. nov. A new family is established for its reception.

## DESCRIPTION

Order: **NEOPHORA**Sub-order: **Neorhabdocoela**Family: **Acholadidae**, nov.

*Definition of Family:* Neorhabdocoela with body epithelium completely ciliated. Without mouth, pharynx and intestine. Vitellaria strongly developed and separate from germaria, which are paired and lobed. Testes fully developed only in young stages. Without male copulatory organ and ejaculatory duct. Genital aperture and main nerve centre posterior.

Genus: *Acholades* nov.

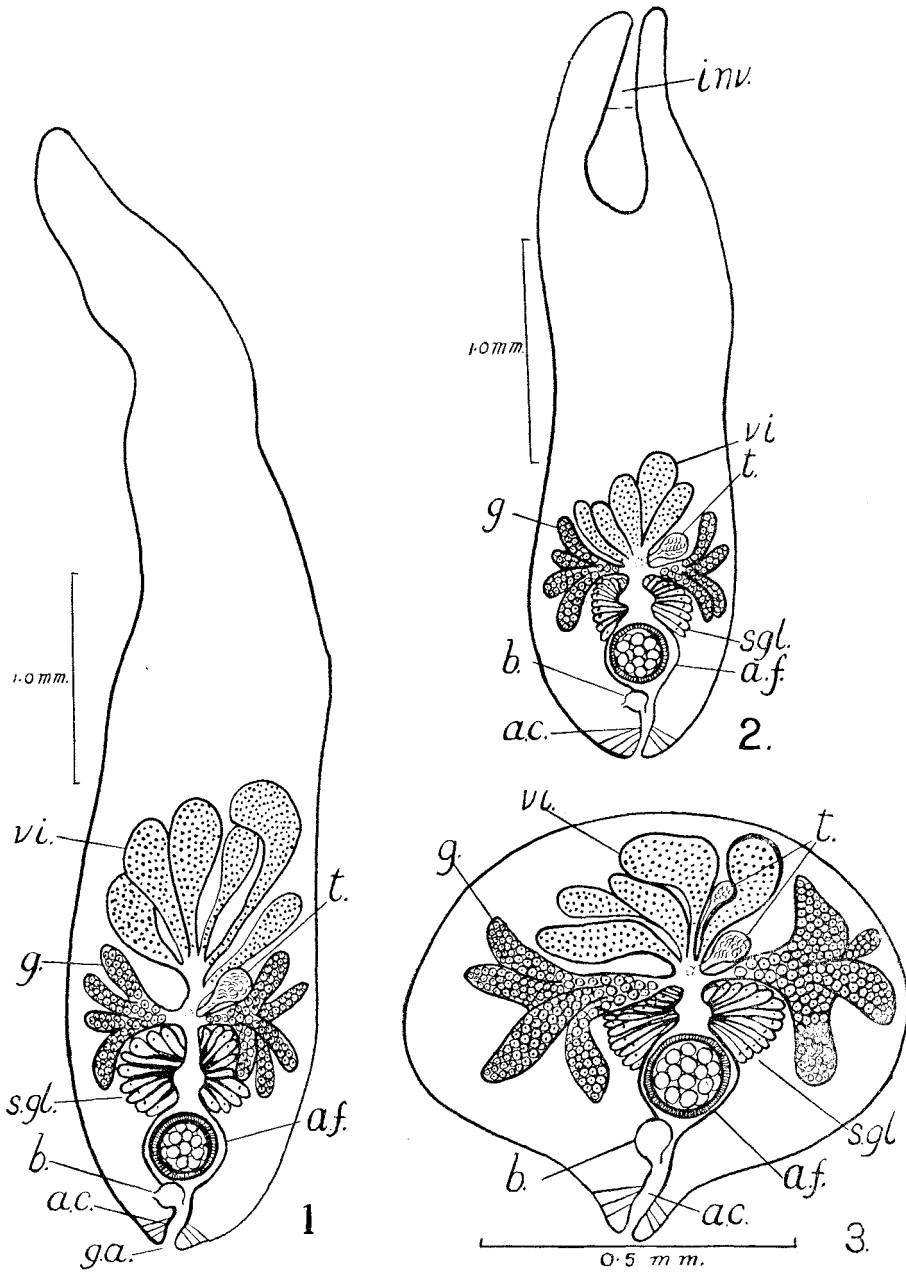
Definition of genus: As for family

Type of genus: *Acholades asteris* sp. nov.*Acholades asteris* sp. nov.

(TEXT FIGURES 1-6. PLATES I AND II)

*External features and cysts:* The cysts formed by the Turbellarian occur in the connective tissue between the ectoderm and the muscle layer of the tube-foot. No separate cyst wall is laid down, the parasite being merely surrounded by the connective tissue, which does not exhibit any marked alteration. Usually only one cyst is present but occasionally two or three occur in one and the same tube-foot. In most cases they are found near the base and have the form of conspicuous yellowish pear-shaped or spindle-shaped structures, which project outwards and downwards from the side of the tube-foot. Not so conspicuous, however, are small ovoid cysts, which are embedded in the connective tissue of the sucker-disk and which produce only a slight bulging of the margin of the disk (Plate I, figs. 1-4). The spindle-shaped cysts measure up to about 5.0 mm. in length and 1.37 mm. in diameter at the widest part. They usually open to the exterior at the distal or lower end. The small ovoid cysts in the sucker-disk, however, are wider than long. They measure 0.52-0.69 mm. in length and 0.75-0.98 mm. in width. They open to the exterior on the under-surface of the disk. In no case does any communication exist between the cavity of the cyst and the cavity of the tube-foot.

In the long spindle-shaped cysts the animal rests with the end bearing the genital aperture downwards and near the opening of the cyst. The shape of the Turbellarian more or less conforms to the shape of the cyst. However, the narrow end, which is regarded as anterior and which normally occupies the upper or basal end of the cyst, may be bent round so that it lies between the side of the animal and the cyst wall (Plate I, fig. 1) or it may be invaginated (Plate I, fig. 2). The length of a fully extended Turbellarian removed from a cyst may reach 5.0 mm. and its width at the widest part of its body 1.2 mm. Most specimens are yellowish in colour and the brownish yellow vitelline glands show faintly through the body wall as a dark mass.

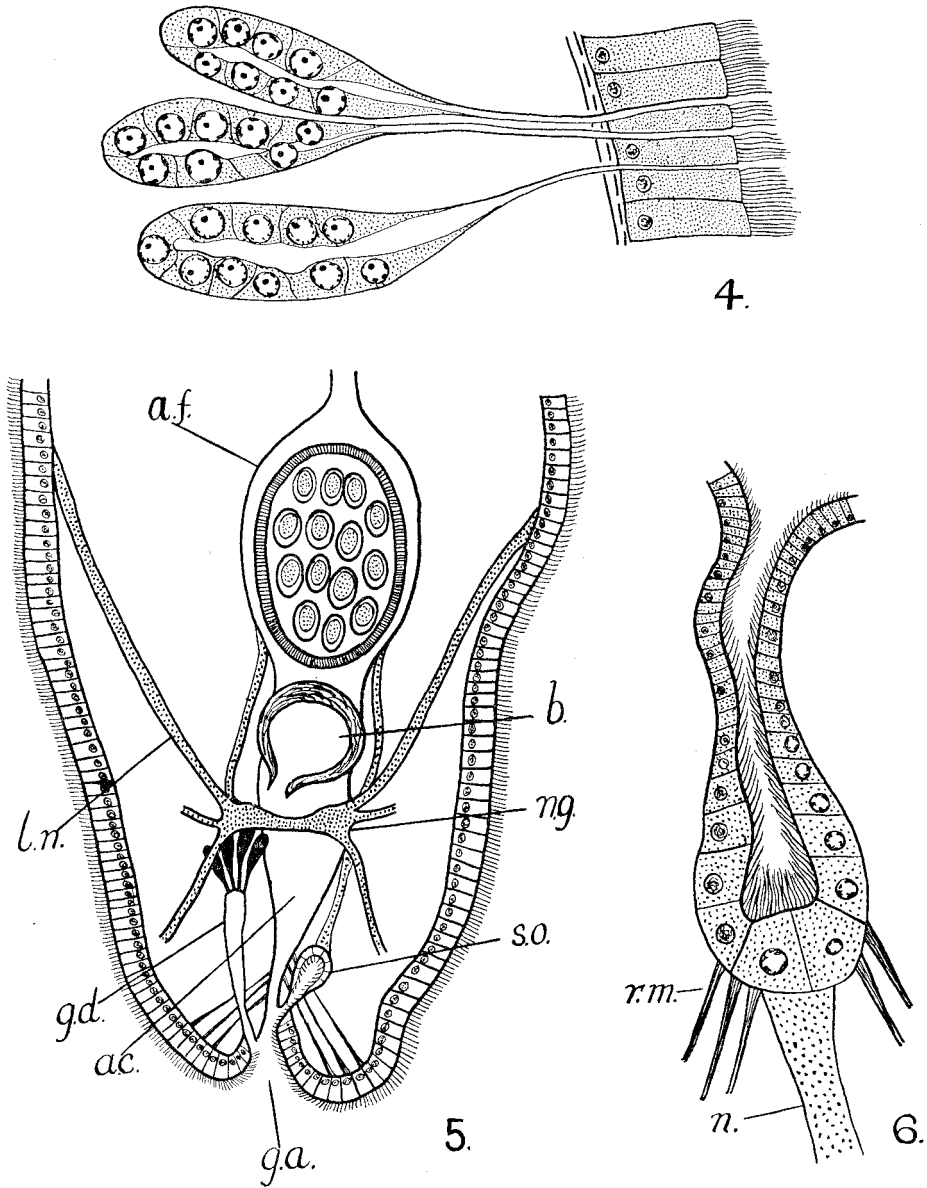


*Acholades asteris* sp. nov.

FIG. 1.—Usual form of specimen removed from cyst at side of tube-foot.

FIG. 2.—Specimen with invaginated anterior end.

FIG. 3.—Small specimen from sucker-disk of tube-foot.



*Acholades asteris* sp. nov.

FIG. 4.—A group of three glands opening on surface near genital aperture.

FIG. 5.—Ventral view of organs at posterior end of body in a fully extended specimen.

FIG. 6.—Longitudinal section of sensory organ.

In the small cysts found in the sucker-disk the animal is broadly oval in shape with the posterior end somewhat pointed and curved downward (text-fig. 3). Its length measures 0.50-0.65 mm. and its width 0.70-0.95 mm.

The surface of the body is completely clothed with cilia. There is no mouth. The genital aperture is situated at what is assumed to be the posterior end.

*Body epithelium:* The ciliated cells forming the body epithelium are columnar and measure 23-31  $\mu$  in height. Their nuclei are about 6  $\mu$  in diameter. Here and there between the bases of the columnar cells are large rounded interstitial cells about 10  $\mu$  in diameter and with nuclei of the same size as those of the columnar cells. A basement membrane appears to be absent and no gland cells or rhabdites are present. The epithelium is easily detached from the underlying muscular layer. When encysted specimens are fixed in Bouin's fluid they often contract leaving portions of the ciliated epithelium adhering to the connective tissue forming the wall of the cyst. This is clearly seen in Plate I, figs. 1 and 4.

*Body musculature:* Below the ciliated epithelium is a layer of circular muscles and below the circular muscles is a layer of longitudinal fibres. At the posterior end of the body the musculature is very strongly developed. The circular muscles round the genital aperture form a strong sphincter, which closes the opening, whilst the longitudinal muscles form a system of radial fibres which dilate the opening. There are no dorso-ventral muscles passing through the parenchyma.

*Digestive system:* There is no mouth, pharynx or intestine. However, the animal is able to invaginate its anterior end into the medullary parenchyma for a distance equal to about 1/4 of the length of the body (text-fig. 2; Plate I, fig. 2 and Plate II, figs. 5 and 6). The cavity of the invagination is usually filled with finely granular protoplasmic material and disintegrating cells, which are probably derived from the connective tissue of the tube-foot in which the parasite is encysted. The inner end of the invagination undergoes absorption and in some specimens large portions of the epithelium and musculature of the introvert can be seen in the medullary parenchyma, after the inner end of the invagination has been regenerated and evaginated. The mechanism by means of which invagination of the narrow anterior end is brought about presents a problem, since no retractor muscles are present.

Invagination was observed only in the larger forms encysted near the base of a tube-foot and not always in those cases. It was never observed in the smaller specimens encysted in the sucker-disk. Hence, it is not at all certain as to whether the process is a method of feeding, or whether it represents a condition imposed upon the parasite by a sudden contraction of the tube-foot of the host and the consequential contraction of the cyst in which the parasite is contained. Many specimens exhibit the condition and show different degrees of invagination and evagination (Plate II, figs. 5 and 6).

The medullary parenchyma contains numerous vacuoles enclosing food particles. Large portions of the parenchyma form a syncytium.

*Nervous system and sense organs:* A mass of nervous tissue resembling the brain of other Turbellarians is situated posteriorly below the atrium and near the ventral surface (text-fig. 5). It measures about  $118 \mu$  wide in the largest specimens and consists almost entirely of nerve fibres and very few nuclei. From it are given off three pairs of large nerves. One pair passes outwards and forwards to the body wall; a second pair passes posteriorly, one on each side of the atrium and the third pair passes upwards to the antrum femininum. A number of smaller nerves go to the body wall and adjacent organs.

The position of this nerve mass makes it difficult to define the correct orientation of the animal. In other Turbellarians the main nerve centre or brain is situated anteriorly and it might be claimed that the situation of the main nerve centre in the present species is also at the anterior end. Against this view, however, is the position of the genital aperture, which is situated posteriorly in the forms showing the closest relationship to the Turbellarian under consideration.

A sense organ in the form of a pear-shaped ciliated pit is situated posteriorly and opens into the atrium near the genital aperture (text-figs. 5 and 6). It measures  $58-63 \mu$  in length and  $37-42 \mu$  in the diameter of its widest part. Attached to its inner end are a number of retractor muscles and it is supplied with a nerve from the main nerve centre.

*Reproductive system:* The genital aperture opens into the genital atrium, which in the largest specimens measures about  $432 \mu$  long and  $79 \mu$  in diameter near the middle of its length. Its outer wall is provided with circular and longitudinal muscles. A number of strong dilator, retractor and protractor muscles extend out radially from its sides to the body wall. The lumen of the atrium is lined with club-shaped cells except immediately within the genital aperture, where it is lined with ciliated cells.

Situated above and slightly in front of the nerve centre is a spherical sac with strong fibrous muscular walls. It measures  $79-123 \mu$  in diameter and lies below or slightly to one side of the atrium into which it opens ventrally. It is regarded as a vestigial bursa. In addition to opening into the atrium it also opens into the parenchyma. Its lumen is often empty but in some cases contains spermatozoa, and in other cases degenerate cells. In some specimens indefinite channels in the parenchyma appear to open into it.

A group of very large club-shaped glands is situated immediately above and behind the nerve centre. In the largest specimens the glands measure  $105 \mu$  long and  $18-32 \mu$  in the diameter of the widest part. The glands open separately into the end of a common duct, which passes upward and opens into the atrium near the genital aperture (text-fig. 5).

In the posterior end of the animal are numerous smaller glands composed of elongate clusters of cells having very conspicuous nuclei about  $5 \mu$  in diameter. The ducts of these glands pass out between the cells of the body epithelium surrounding the genital aperture (text-fig. 4).

Well developed testes are found only in small specimens of the parasite, such as those encysted in the sucker-disk of the tube-foot. Usually two testes are present. They are pyriform or ovoid in shape

and measure 68-110  $\mu$  long and 52-55  $\mu$  wide. One is situated dorsally on the left side between the vitellaria and the germaria. The other is situated antero-ventrally between two of the vitelline lobes. Each testis gives rise to a short duct. The two ducts converge and enter the gonoduct (ductus communis) dorsally immediately above the entrances of the left and right germaria.

In large specimens, 3-5 mm. long, the testes have degenerated and have been replaced by masses of spermatozoa or disintegrating cells. Spermatozoa also often occur in small masses in the parenchyma in front of the vitellaria, below the shell-glands and at the sides of the antrum femininum.

The male reproductive system has no seminal vesicle, no ejaculatory duct and no copulatory organ.

The germaria are paired and situated one on each side immediately behind the vitellaria. Each is divided into four or five lobes, some of which extend anteriorly at the sides of the vitellaria and some posteriorly at the sides of the shell glands. The two germaria open into the gonoduct laterally immediately behind the vitellaria.

The vitellaria consist of a number of large yellowish brown pyriform or clavate lobes in the posterior half of the body. In well extended specimens they occur in the posterior 2/5. The lobes form a group in the medullary parenchyma and in non-contracted animals have their wide ends directed forwards (text-fig. 1). In most cases the lobes are single but may be divided in 2, 3 or 4 secondary lobes. They measure up to 1.18 mm. in length and 0.18 mm. in diameter at the widest part. Posteriorly the narrow ends converge and open close together into the anterior end of the gonoduct.

The gonoduct which corresponds with the ductus communis of other species extends from the vitellaria to the antrum femininum. It measures up to 419  $\mu$  in length and 53  $\mu$  in diameter. Its outer wall is provided with very weak circular muscles and strong longitudinal fibres. The circular muscles are more strongly developed at the junctions with the vitellaria and with the antrum femininum, in which places they probably act as sphincters.

The so-called shell glands lie immediately behind the entrances of the germaria into the gonoduct. They form a compact mass of pyriform cells completely surrounding the gonoduct. In transverse section the glandular mass measures 288-524  $\mu$  in diameter and occupies a large part of the centre of the field. The secretion in the narrow necks of the pyriform cells stains very darkly with haematoxylin. The cells do not open separately into the gonoduct. They are grouped together in clusters. Each cluster opens into a small diverticulum from the wall of the gonoduct.

Posteriorly the gonoduct opens into the antrum femininum. This is a large cavity in which the eggs collect and in which they become surrounded by an egg-capsule. In the non-extended condition of the parasite the antrum femininum is almost spherical. In the small forms encysted in the sucker-disk it measures 209-236  $\mu$  in diameter but in the larger specimens encysted in the side wall of the tube-foot it measures

353-458  $\mu$  in diameter. Posteriorly it opens into the genital atrium. Its outer wall is provided with circular, longitudinal and oblique muscles. It is lined by an epithelium of flat cells, which merge into club-shaped cells anteriorly and posteriorly. Strong protractor and dilator muscles extend radially from its posterior end to the body wall. The cavity appears to function both as an antrum femininum and as a uterus.

Only a single egg-capsule is present at one time. In non-extended specimens it is spherical measuring 173-288  $\mu$  in diameter and having a wall 13-15  $\mu$  in thickness. In fully extended specimens the capsule becomes ovoid in shape. The yellowish material forming the wall of the capsule appears to be derived from the yolk, since it resembles in colour and appearance material associated with the yolk granules of the vitellaria. It does not in any way resemble the secretion of the so-called shell glands. If an egg-capsule is removed from a living animal and placed in sea-water in a Petri dish, it sinks to the bottom and soon adheres firmly to the dish. At the same time its colour becomes dark-brown.

It is estimated that 70 eggs or more may be contained in the capsule of a specimen about 5 mm. long. Each egg measures about 44  $\mu$  long and 39  $\mu$  in width and is enclosed in a delicate membrane. In some capsules the eggs exhibit early cleavage stages and blastomeres are scattered irregularly through the yolk of the egg. In addition to containing eggs the capsules also contain yolk granules and vitelline cells.

*Habitat:* *Acholades asteris* encysts in the connective tissue of the tube-feet of the sea-star, *Coscinasterias calamaria* (Gray).

*Locality:* All the Turbellarians, about 50 in number, examined during the preparation of the present paper, were taken from specimens of the host collected in D'Entrecasteaux Channel. Most of the sea-stars were dredged up from depths of about 6 fathoms during the months of May to August, 1951 and 1952, and March and April, 1953.

Infection of the host is often very heavy and it is not unusual to find 20 or more of the Turbellarians encysted in the tube-feet of one ambulacral groove. There is a tendency for the tube-feet near the apex of the groove to be more frequently parasitized than those at the base of the groove. Among 267 specimens of *Coscinasterias calamaria* taken in D'Entrecasteaux Channel 216 were observed to be infected.

The parasite also occurs in the same host at Spring Bay on the East Coast of Tasmania. Among 99 specimens of the sea-star collected at this locality in July, 1954, seventeen were infected.

*Affinities:* Although *Acholades asteris* lacks a mouth, pharynx and intestine, it possesses other features in which it shows rhabdocoel affinities. For example, the well-developed vitellaria, paired germaria, extensive shell-glands, posterior position of the genital aperture and the large antrum femininum containing the egg-capsule are features found also in the rhabdocoel family Umagillidae.

The absence of a mouth and pharynx has already been reported in the two genera *Fecampia* Giard (1886, p. 499) and *Glanduloderma* Jägersten (1941, p. 1). The former is parasitic in certain Isopods and crabs, the latter in Myzostomids. Both these genera have been placed



by Jägersten in the family Fecampiidae. However, *Acholades* differs from them in lacking epidermal rhabdites, a layer of sub-epidermal gland cells and an intestine. It also differs in having compact instead of diffuse vitellaria and in its main nerve centre being situated at the same end of the body as the genital aperture.

In the structure of its reproductive system and in lacking a mouth, pharynx and intestine, *Acholades asteris* differs widely from *Pterastericola fedotovi* Beklemicheff, the only other Turbellarian recorded as an endoparasite of a sea-star.

For these reasons it has been found necessary to erect the new family Acholadidae.

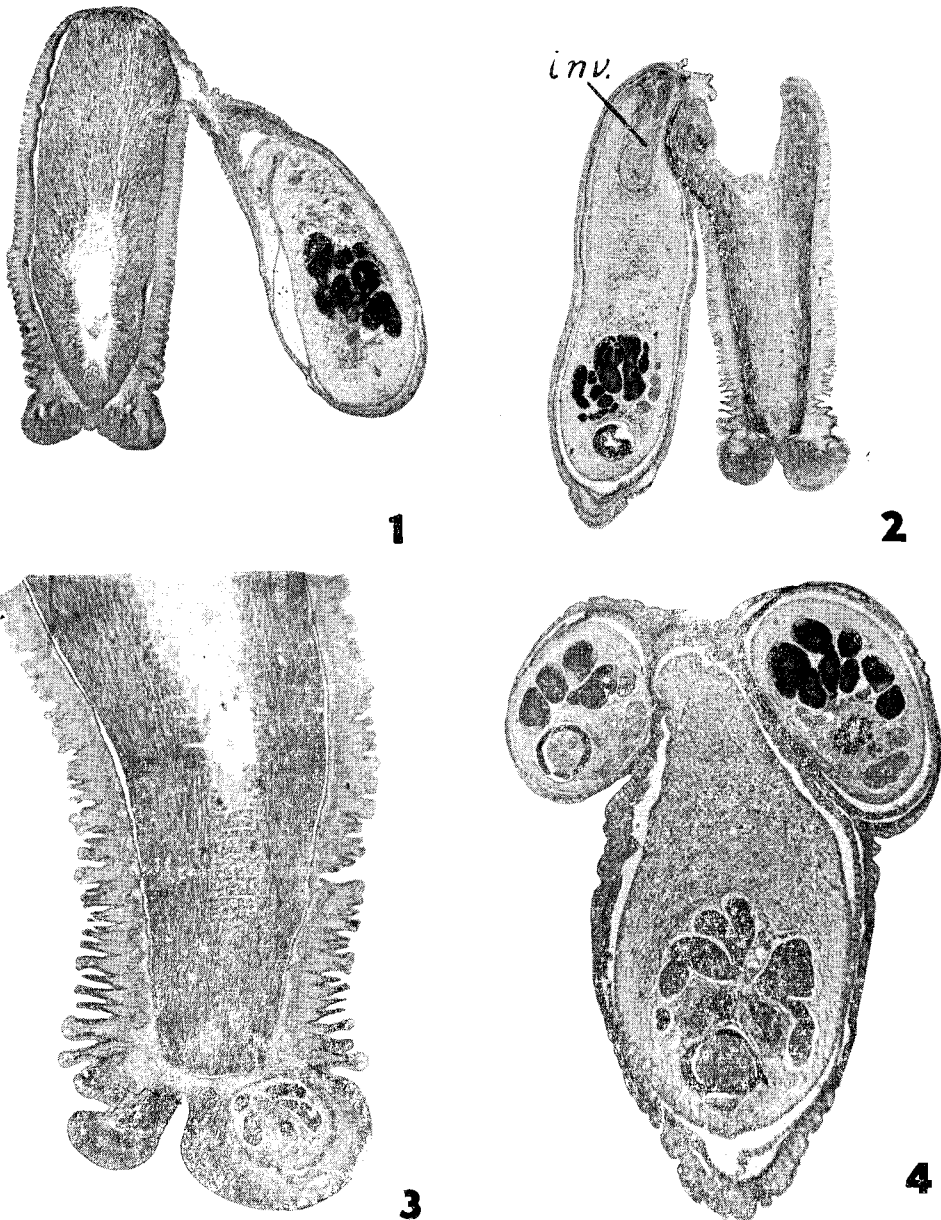
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## REFERENCES TO TEXT FIGURES AND PLATES

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|--------------------------------------|-------------------------------|
| <i>a.c.</i> —Atrium genitale commune | <i>l.n.</i> —Lateral nerve    |
| <i>a.f.</i> —Antrum femininum        | <i>n.</i> —Nerve              |
| <i>b.</i> —Bursa                     | <i>n.g.</i> —Nerve centre     |
| <i>g.</i> —Germaria                  | <i>r.m.</i> —Retractor muscle |
| <i>g.a.</i> —Genital aperture        | <i>s.gl.</i> —Shell-gland     |
| <i>g.d.</i> —Gland duct              | <i>t.</i> —Testis             |
| <i>inv.</i> —Invagination            | <i>vi.</i> —Vitellaria        |





*Acholades asteris* sp. nov.

- FIG. 1.—Longitudinal section through tube-foot of *Coscinasterias Calamaria* with encysted parasite at side. The anterior end of parasite is reflexed in the cyst.
- FIG. 2.—Longitudinal section through tube-foot and encysted parasite. The anterior end of parasite is invaginated.
- FIG. 3.—Longitudinal section through tube-foot showing small specimen of the parasite encysted in the sucker-disk.
- FIG. 4.—Longitudinal or oblique sections through three encysted specimens of the parasite in the wall of one tube-foot.

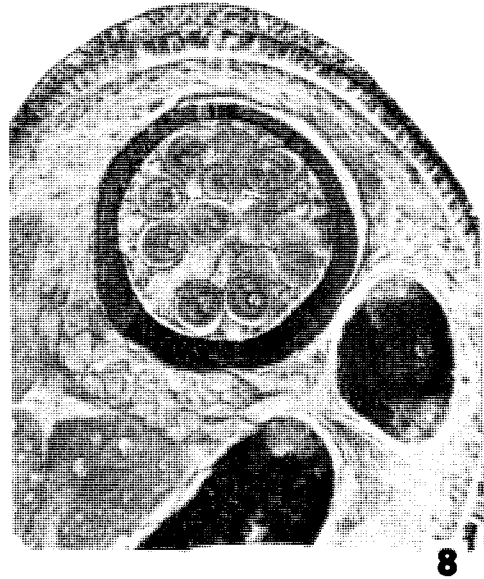
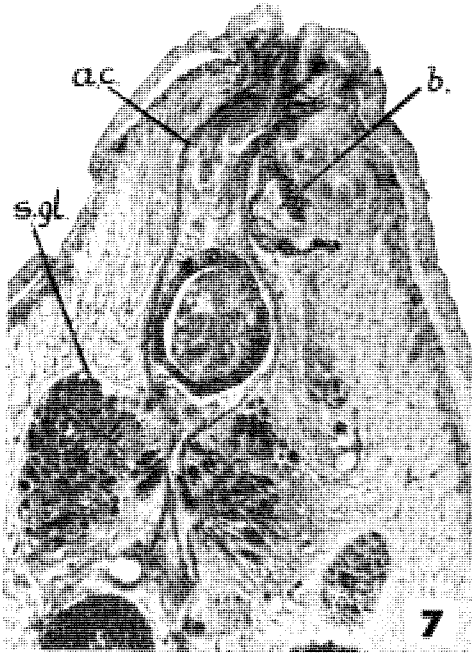
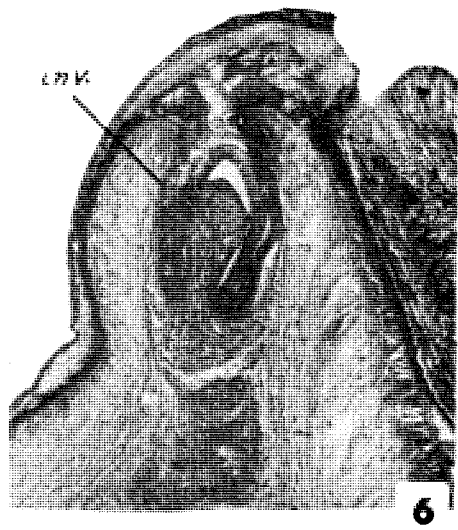
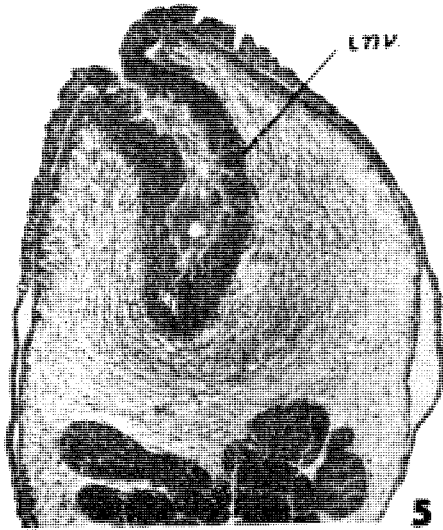


FIG. 5.—Longitudinal section through anterior end of a specimen of the parasite removed from a cyst. The anterior end is deeply invaginated and almost reaches the vitellaria.

FIG. 6.—Longitudinal section through anterior end of an encysted specimen of the parasite. The anterior end has been invaginated, partly absorbed and regenerated. The section shows the regenerated end being evaginated leaving remnants in the medullary parenchyma.

FIG. 7.—Part of a sagittal section through posterior end of the parasite showing genital atrium and the antrum femininum containing an egg-capsule.

FIG. 8.—Oblique section through posterior part of parasite showing the large thick-walled egg-capsule containing eggs which are undergoing cleavage.