

FECAMPIA ABYSSICOLA N. SP.
(TURBELLARIA: RHABDOCOELA)
AND FIVE COCOON TYPES
OF UNDESCRIBED SPECIES
OF FECAMPIIDAE FROM THE DEEP SEA

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ABSTRACT

A new species of parasitic turbellarians, *Fecampia abyssicola*, is described on the basis of specimens found in cocoons collected off West Africa at depths between 1500 and 4006 metres. Cocoons referable to the same species were also found in the Indian Ocean near Madagascar (4730 m depth) and in the Kermadec Trench in the West Pacific (4540 m depth).

Five different cocoon types belonging to as many unknown species of Fecampiidae are also figured

and described. Three belong to the *Kronborgia* type, i.e. long tubiform cocoons made by dioecious fecampids. One belong to the *Fecampia* type, i.e. a small club- or flaskshaped cocoon made by a hermaphroditic fecampid. The 5th type could not be referred to any group with certainty.

The finds are from the North-east Pacific, the Caribbean and the Antarctic seas at depth between 662 and 5045 metres.

INTRODUCTION

The Fecampiidae comprises the only turbellarian family in which all members are parasites that lack a mouth, and thus have to absorb food in the form of host tissue through the epidermis, an aspect that has been treated by Bresciani & Køie (1970). The larva may or may not possess eyes, mouth and a pharynx, but these organs are at any rate not present shortly after entrance into the host, which in practically all cases is a crustacean.

On reaching sexual maturity the worm leaves its host. The hermaphroditic *Fecampia* spp. and the female of the dioecious *Kronborgia* spp. then secrete a cocoon around themselves. Next, numerous egg capsules, each containing two eggs (zygotes) and a varying number of free yolk cells, are deposited in the cocoon (Caullery & Mesnil 1903, Christensen & Kannevorff 1964).

With few exceptions all finds of fecampid worms and cocoons are from the tidal or sublittoral zone, with most finds from depths less than 50 m. Exceptions are *Kronborgia caridicola* Kannevorff & Christensen found in shrimps taken in depths from 6 to 660 m and its supposed cocoon taken in depths from 200 to 1294 m (Kannevorff & Christensen 1966, unpubl. finds). Furthermore, two cocoon types (A & C) have been found at depths of 40-435 m and 200-500 m, respectively (Christensen & Kannevorff 1967).

However, materials handed over to me by various colleagues and institutions show that *K. caridicola* and the two unknown species producing the cocoon types A & C by no means are the only fecampids extending into the bathyal zone, and that at least five species are true deep-water species occurring from

about 1500 to over 5000 m, i.e. well into the deeper range of the abyssal zone.

Only cocoons were available, so none of the host species are known yet. Furthermore, only the material of one cocoon type contained sufficient material of the worm itself to allow me to describe it and name it. Apart from that, five cocoon types, belonging to species still unknown, are described.

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Thanks are also extended to Mr. Kai Olsen for making all the drawings and to Dr. Grete Møller Christensen for preparing the serial sections.

MATERIAL AND METHODS

The sources of the material treated and details on localities and depths are given in connection with the individual descriptions of the new species and the five cocoon types. By a cocoon is here understood a depository containing a multiple number of egg capsules (see Christensen 1976, p. 95 for a full discussion).

None of the cocoons had been fixed before storage in either alcohol or formalin. Hence, remains of worms and egg capsules were unfit for finer histological studies. Each cocoon was studied in transmittant light under a microscope. If found to contain egg capsules, and hence possibly also the

worm itself, the whole cocoon (*Fecampia* types) or part of it (*Kronborgia* types) were sectioned at 6-7 μ m and stained with Ehrlich's haematoxylin-eosin. Although results were meagre in most cases, valuable information was nevertheless obtained.

Because the cocoons of six unknown fecampid species were described earlier by Christensen & Kanneworff (1967) as types *A* to *F* incl., the five types described in this paper are listed as types *G* to *K* incl.

Type material has been deposited in the Zoological Museum, University of Copenhagen, Denmark.

DESCRIPTIVE PART

Fecampia abyssicola n. sp.

Text-fig. 1, Pls. 6-7

Material and distribution:

"Galathea" St. 65. Gulf of Guinea, 2°17' S, 8°10' E, 2770 m, 4 Dec. 1950. – Five cocoons (two with worms).

St. 233. Off E. Africa, 7°24' S, 48°24' E, 4730 m, 9 March 1951. – One cocoon.

St. 664. Kermadec Trench, 36°34' S, 178°57' W, 4540 m, 24 Feb. 1952. – One cocoon.

"Bartlett" St. 12. S. of the Azores, 37°15.9' N, 33°19.5' W, 1600 m, 14 Feb. 1975. – One cocoon.

"Discovery" St. 7991. Off W. Africa, 24°13' N, 17°07' W, 1500-1520 m, 23 July 1972. – Two cocoons (one with worm).

St. 9131/9. Off W. Africa, 20°18' N, 21°43' W, 4015-4006 m, 19 Nov. 1976. – Nine cocoons (three with worms).

St. 9131/10. Off W. Africa, 20°15' N, 21°35' W,

3952-3950 m, 19 Nov. 1976. – Seven cocoons (two with worms).

St. 9131/11. Off W. Africa, 20°09' N, 21°26' W, 3921 m, 20 Nov. 1976. – Nine cocoons (two with worms).

St. 9134/1. Off W. Africa, 21°55' N, 18°03' W, 1949-1942 m, 26 Nov. 1976. – One cocoon (with worm).

St. 9541/3. Off W. Africa, 20°09' N, 21°40' W, 3910-3912 m, 15 May 1977. – Three cocoons (two with worms).

As can be seen, there was a worm present in 13 of the 38 cocoons. As type species was chosen a worm present in a cocoon from "Discovery" St. 9131/11. Other cocoons contained crumpled capsule remains and in nearly all cases a small aggregate of organic debris. The following description, based on specimens in the spawning stage, will hopefully be augmented by future finds of worms in the parasitic phase.

Morphology

External features: The body is round, sausage-shaped and evenly ciliated. The size of the worm can only be estimated. Based on known cocoon:worm size relationships in other *Fecampia* spp., a length between 3.5 and 11 mm for mature worms is indicated, the actual size in each case being dependent on host size and number of worms present in it.

The colour is unknown. Eyes are absent, and a posteriorly situated gonopore is the only opening to the outside.

Epidermis: The epidermis cells are about 10 μm high, but demarcations between them can only be seen in tangential sections. The nuclei are large and slightly oval in shape. Rod-shaped rhabdites occur, sometimes abundantly, in the distal part of the cells, but seem to be absent in worms in the late spawning stage. The epidermis rests on a thin but distinct basement membrane.

Muscular system: Just beneath the basement membrane there are two feebly developed muscle sheets, i.e. one with fibres running in a circular and one with fibres running in a longitudinal direction. No other muscle strands could be seen.

Subepidermal cells: Because only spawning animals were available, nothing certain can be said about the cocoon glands and the primordial yolk cells, but they are no doubt radially arranged as in other fecampids. In the spawning stage most of the available space is occupied by yolk cells. Eosinophilic gland cells are present in front of the brain and appear to have outlets at the anterior end. Posteriorly, behind the yolk cells and partly surrounding the sexual duct system, there are at least two gland types present. One is eosinophilic, whereas the other remains largely uncoloured with the stains used.

Nervous system: The brain (Pl. 6A) is a transversal cord situated in the mesenchyme about 80-100 μm from the anterior end. From what appear to be ganglia, one on each side, lateral strands run to the subepidermal musculature sheets. No other strands were observed.

Reproductive system: In the spawning stage the whole worm is initially full of yolk cells between the brain and the posteriorly situated reproductive duct system and its associated glands. Only the paired gonads take up some space laterally within the posterior third of the diffuse vitellarium.

The gonads, which extend to the posterior end of the worm, are no doubt hermaphroditic, although no direct proof for this postulate is available. However,

the germ cells differ considerably within each gonad. In the inner part of the anterior half or less the cells are small (Pl. 6B), whereas they are larger elsewhere. In the posterior half there are only oocytes which become progressively more mature towards the posterior end, where they become compressed and thereby flattened. Except for minor variations, this distribution of germ cells is identical to that found in the three *Fecampia* species presently recognized (Caullery & Mesnil 1903, Christensen & Hurley 1977), and in these species it is well established that spermatocytes develop from small germ cells in the anterior half or more of the gonads.

In the spawning stage the gonads are irregularly twisted posteriorly, probably due to an extensive shrinking of the worm. Seen in cross sections the gonads do not differ much in diameter over most of their length. However, over a short distance of the posterior end the diameter decreases to that of one flattened oocyte, and this part acts as an oviduct.

The "oviduct" connects with a vitelline duct to form an ovovitelline duct leading to the uterus, which is situated centrally not far from the posterior end. From the uterus a short duct leads to the more or less centrally situated gonopore (Pl. 6C). Anteriorly the paired vitelline ducts are slightly dilated, each forming a funnel just behind the vitellarium.

Ripe spermatozoa were observed in the vitelline ducts which also act as spermaducts. As surmised by Caullery & Mesnil (1903) for the type species and verified for *F. balanicola* by Christensen & Hurley (1977), fertilization probably takes place where the ripe eggs are about to enter the vitelline duct (Pl. 6D), i.e. this part of the "oviduct" acts as a seminal receptacle. Spermatozoa were also seen, at times abundantly, among the yolk cells in line with and especially posterior to the anterior ends of the gonads. They were not present inside the gonads as observed in other *Fecampia*, a fact for which no satisfactory explanation can be given at present.

Two fertilized eggs and a dozen or more yolk cells are passed into the uterus at a time, and it is in this organ that the capsules are formed (Pl. 6E).

As the worm goes on producing its egg capsules it gradually shrinks in length and diameter, and this is accompanied by an extensive wrinkling of the epidermis in most places.

The cocoon

Plate 7A shows the cocoons from "Discovery" St. 9131/9. It indicates the size and shape variation that

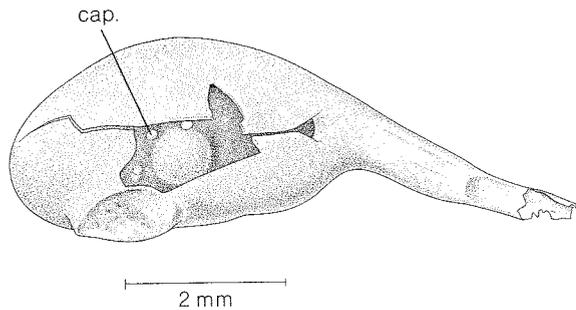


Fig. 1. Cocoon of *Fecampia abyssicola* n. sp. "Bartlett" St. 12. Ball-shaped body in center is the remainder of the worm. cap. = egg capsule.

normally occurs. Of the 38 cocoons available, 37 varied in length between 2.8 and 6.8 mm when disregarding the nozzle, but one from the "Galathea" St. 65 measured 8.6 mm. All the "Discovery" cocoons had more or less deep, irregular holes caused by the presence of foraminiferan shells or debris of the *Globigerina* ooze, on which the worms obviously had settled to secrete their cocoons (Pl. 7B). Not only the ventral side of the cocoon, but also the nozzle and the dorsal side may at times be affected. Pl. 7C shows a cocoon which still had foraminiferan shells embedded in its wall, and most of the "Discovery" cocoons probably "lost" their shell and/or shell debris during the dredging operations and subsequent handling of the material.

All the "Discovery" cocoons looked much as those figured and, except for the absence of embedded material, the same is true for the "Galathea" and the "Bartlett" cocoons. Characteristic is the relative long and sharply demarcated nozzle, whose tip in many cases had been mutilated. The body of the cocoon is wider relative to length than in other *Fecampia* species so far described. The wall thickness varies between 100 and 180 μm ; it is thinnest on the ventral side. Those attached to a hard substratum may in places have an even thinner ventral wall.

The multi-layered wall differs from other fecampid cocoon walls in being very hard with no elasticity at all. It could in theory be an artifact caused by the preservatives used, but this is unlikely.

All the "Galathea" cocoons were or had been attached to a hard substratum (wood, pumice, echinoid shell piece). However, the worms and egg capsules found in them did not in any way differ from those of the "Discovery" cocoons. The single "Bartlett" cocoon was 4.1 mm long, not counting the nozzle. The few capsules found in it (Fig. 1) also agree in size

with those of the "Discovery" cocoons. In my opinion, therefore, all these cocoons were made by members of one and the same species.

All but two of the cocoons came from deep water (1500-4015 m) within a limited area between the Azores and the Gulf of Guinea. One came from 4730 m depth north of Madagascar in the Indian Ocean and one from 4540 m depth east of New Zealand, and it cannot be surprising to find that an abyssal East Atlantic species also occurs in the Indo-West Pacific area (see e.g. Madsen 1961). The Madagascar cocoon did differ in one respect. Although about half full of egg capsules, no trace was found of the worm itself. The embryos were all in about the same stage of development, with none having reached the ciliated stage. It seems certain, therefore, that the worm had not finished spawning when the cocoon was collected. This indicates in turn that the worm was either induced to leave its cocoon or - more likely - dropped out through a hole made in the cocoon during the dredging operation.

Egg capsule and larva

The egg capsule is often slightly oval in shape and measures 125-140 μm in diameter. Recently spawned capsules and capsules with ciliated larvae may be seen in the same cocoon. This shows that the spawning phase must last for a significant number of days, possibly weeks. Some cocoons also contained free larvae. In one case a great number of larvae had been caught in the act of penetrating the seal-off matrix of the nozzle on their way out.

The larva is 155-165 μm long and 30-40 μm in diameter. Its epidermis is 4-5 μm thick and carries 10-12 μm long cilia (Pl. 6F). The anterior end is rounded whereas the posterior end is slightly pointed. Eyes are absent. Dense bodies similar to those found by Kjøie & Bresciani (1973) in the anterior epidermal cells of *Kronborgia amphipodicola* Christensen & Kannevorff are present. Superficially it appears as if a mouth and a pharynx are present, but this is dubious (see the systematic discussion). Near the anterior end there are some conspicuous eosinophilic glands with long necks leading to and penetrating the frontal epidermis. Absorbed yolk material can be seen in the posterior part of the larva and is still present when it leaves the capsule and the cocoon.

Systematic discussion

The species described here has been placed in the genus *Fecampia* because it is very similar to the type species *F. erythrocephala* Giard, as described in detail by Caullery & Mesnil (1903) along with *F. xanthocephala*, which only differs from the former in size range and colour. Hallez (1909) doubted that *Fecampia* has hermaphroditic gonads and is a self-fertilizer. However, the same conditions pertain to the Californian species, *F. balanicola*, described by Christensen & Hurley (1977), and hence there is no doubt that Caullery & Mesnil gave a correct interpretation of what they saw. It is on this background that I think that the small gonocytes situated more or less centrally in the anterior half of the gonads of *F. abyssicola* must be spermatocytes.

The gonads themselves are elongated and situated laterally in the posterior end, as in the European species. They seem to differ somewhat from those of *F. balanicola* in shape, relative length and position of the anterior ends. However, only specimens in the mature parasitic phase can really be used for such a comparison. The distribution of male elements also differs somewhat from both the European and the Californian species, and the general rule that only oocytes occur in the posterior part of each gonad is more striking in *F. abyssicola* than in other *Fecampia* species.

The larva differs from the larvae of *F. erythrocephala* and *F. xanthocephala* in having no eyes. Eyes were also surmised to exist in the larva of *F. balanicola* by Christensen & Hurley (1977), but a final answer must await examination of live material.

The dense bodies which Kjøie & Bresciani (1973) found surrounding the anterior end of the larva of *Kronborgia amphipodicola* occur also in the larva of *F. balanicola* (own unpubl. obs.) and *F. abyssicola* (Pl. 6F). They may well give the illusion that a mouth is present. The mouth figured by Caullery & Mesnil (1903, pl.fig. 38) also reminds one of dense bodies forming a ring, so European *Fecampia* larvae should also be reexamined. Concerning a pharynx, Kjøie & Bresciani (1973) state that what Caullery & Mesnil described as a pharynx could well be gland ducts. After reexamination of some sectioned material of *F. balanicola* I may add that this may also be the case for that species.

Biological aspects

As other *Fecampia* species, *F. abyssicola* no doubt parasitizes one or more species of benthic crusta-

ceans. Considering its vertical distribution (1500–4730 m), isopods and amphipods are the most likely organisms amongst which to search for the host or hosts.

All species of *Fecampia* start to secrete their cocoon soon after emergence from the host (Caullery & Mesnil 1903, Christensen & Hurley 1977), the maximum period of "free life" recorded being 4 hours (Southward 1951) in a laboratory glass jar. The worm is able to swim by peristaltic movements and prefers to settle and secrete its cocoon on stones and other hard substrates. Hence it is to be expected that *F. abyssicola* also will prefer to do that. However, whereas shallow-water *Fecampia* species easily can find a hard substratum within the time available, this may often be more difficult for a species associated with a deep-sea ooze bottom, where pieces of hard substrates may be few and far between. Nevertheless, just before this paper went to press, Dr. Jan van der Land (pers. comm.) informed me that the cocoon commonly occurs on stones of all sizes from deep waters off the coast of West Africa.

Whether the worm leaves its cocoon after spawning, which is the case for *Kronborgia* species (Christensen & Kannevorff 1965, Christensen 1976), was discussed briefly for *F. balanicola* by Christensen & Hurley (1977) who felt that it was not likely for *Fecampia* to behave differently. They pointed out, however, that this was not in agreement with the view held by Caullery & Mesnil (1903) for the European species. All available evidence indicates that *F. abyssicola* remains in its cocoon after spawning. A serially sectioned cocoon thus contained a worm which was only about one mm long and in such a state of deterioration that it would have been moribund. There were few traces of the gonads remaining, and the worm had evidently released all of its egg cells. Furthermore, practically all cocoons with remains of empty capsules contained a more or less ball-shaped aggregation of organic material (Fig. 1) which hardly could be anything but the remainder of the worm itself.

On this background it is probably significant that the material of *F. balanicola* examined by Christensen & Hurley (1977) did not include any cocoon without a worm inside, although none of these worms appeared to have ceased to spawn when collected. Evidently all *Fecampia* species deposit their egg capsules in consecutive layers around themselves, starting against the wall over the whole length of the cocoon. Hence, at the end of spawning the worm lies with capsules all around it, as well as in front of and

behind it. *Kronborgia* spp., on the other hand, deposit their capsules behind them, starting at the posterior end of the tubiform cocoon and ending by depositing capsules in the anterior end. This difference in spawning behaviour, necessitated by the two different cocoon types, may well be the clue as to why a *Fecampia* succumbs in its cocoon, whereas *Kronborgia* creeps out before dying.

Cocoon type G

Pl. 8A-B

Material:

"Pillsbury" St. 1178. Northern Caribbean Sea, 19°14' N, 73°14' W, 1760 m, 21 July 1969. – One cocoon with egg capsules. Attached to a piece of bark.

This cocoon was mentioned and figured by Wolff (1979, p. 119, pl. 1D). It is refigured here (Pl. 8A). The "body" is more or less oval in shape (1.3 × 1.1 mm) when viewed from the dorsal side, and it is the smallest fecampid cocoon known so far. The incomplete nozzle is 0.7 mm long. The cocoon is brownish and not white as in all other fecampid cocoons hitherto described, and it does not appear red in stained serial sections as do other cocoons. Furthermore, the wall is only 17-18 μm thick, consists of a single layer, and is so translucent that deposited egg capsules can be clearly seen through the dorsal wall. The flat ventral wall, with which the cocoon was attached to the substratum, is even thinner, being only 6-7 μm thick (Pl. 8B).

The cocoon was difficult to remove and section, and a good number of capsules were lost due to a rupture in the ventral wall. Wolff (1979) estimated the number of capsules to be about 200, but examination of the serial sections revealed that the number must be closer to 400. The capsule, which measures 70-75 μm in diameter, contains two embryos, i.e. the normal number in fecampid egg capsules. None of the embryos seen in the serial sections had reached the ciliated stage.

There was no trace of the worm itself. It could have been lost through the rupture during handling, but this is pure conjecture.

Although the cocoon, by its outside shape and its single opening through a nozzle, reminds one of a *Fecampia* cocoon, it differs so much in wall structure and staining characteristics that I find it premature to discuss the possible systematic position of the unknown species that produces it.

Cocoon type H

Pl. 8C-D

Material:

"Pillsbury" St. 976. Near Lesser Antilles, 17°35' N, 61°21' W, 3852 m, 30 June 1970. – One cocoon (with worm). Attached to a *Thalassia* rhizome.

This cocoon was also mentioned and figured by Wolff (1979, p. 119, pl. 1C and 1980, p. 205, fig. 2a). It is white, oval in shape (4.5 × 3.2 mm) when viewed from the dorsal side, and has a curved nozzle about 2.3 mm long (Pl. 8C). The multi-layered cocoon wall is 58-62 μm thick, with the ventral wall thinner in most places. As other fecampid cocoons, except type G described in this paper, it appears red in stained serial sections.

The fact that the nozzle turns off as if it was a continuation of an outer winding of a coiled tube gives the cocoon an apparent similarity to the cocoon of *Kronborgia spiralis* (Baylis) (see Baylis 1949, Christensen 1976). However, sectioning of the cocoon revealed that there was no internal spiral traits. It is under all circumstances not certain that the cocoon is typical for the unknown turbellarian producing it. Aberrant cocoons are commonly made by some fecampid worms (Baylis 1949, Christensen & Hurley 1977), and the cocoon discussed here could, e.g., well be a distorted *Fecampia* type cocoon.

The whole cavity of the cocoon was taken up by the worm that made it (Pl. 8D). The worm was oriented with the anterior end poking into the nozzle. It is not possible to give a description of the animal good enough to assign a name to it, but the following information may be useful in recognizing future finds of it.

The epidermis is 15-17 μm thick and have 10-12 μm long cilia. Beneath a basement membrane there are the usual two layers of feebly developed muscle sheets. The brain was not observed because the nozzle, with the anterior end of the worm, was lost before the cocoon was sectioned.

Nearly empty cocoon gland cells could be seen radially arranged in some sections. Mostly, however, only their nuclei could still be recognized, and in some sections no traces were left. Obviously, as also substantiated by the absence of spawned egg capsules, the animal was about to finish, or had just finished, the secretion of its cocoon when it was collected.

Paired gonads are present laterally in the posterior end of the worm (Pl. 8D). What were definitely oocytes could be seen appending to and near the

gonad surface, but many germ cells in the inner central parts were immature and could not be sexed. Short ducts are present close to the posterior end, but no details could be worked out. This part of the worm is also full of feebly staining gland cells which probably have functions in connection with capsule formation and/or spawning. Spermatids or spermatozoa were not seen anywhere.

There is no doubt that the animal belongs to the Fecampiidae, and I believe that its gonads will turn out to be hermaphroditic. If that proves correct the worm will eventually be placed in *Fecampia* or a new genus closely related to it.

Cocoon type I

Fig. 2

Material:

"Eltanin" St. 428. Antarctic (Weddell) Sea, 62°41'-62°39' S, 57°00'-57°46' W, 662-1120 m, 5 Jan. 1963.
- 22 complete or almost complete cocoons, 29 pieces longer than 5 cm.

This cocoon (Fig. 2) evidently belongs to a fecampid worm of the *Kronborgia* type. It is coiled in a peculiar manner with each winding connecting with adjoining windings at several points. When handling the cocoons the connections come apart easily, but numerous "scars" found in the cocoon walls of "unrolled" cocoons and cocoon pieces show that the figured pattern is not fortuitous.

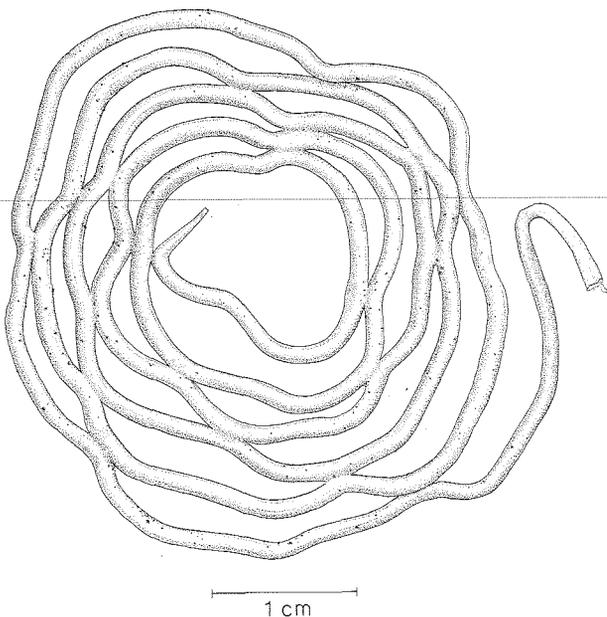


Fig. 2. Cocoon type I. "Eltanin" St. 428.

The cocoon reminds one of types *A* and *E* described by Christensen & Kannevorff (1967), but it differs, among other things, from both these types in having the anterior end in the center of the coil and the characteristic bent posterior end on the outside. However, type *K* described in this paper also has the anterior end centrally placed.

The anterior end, through which the larvae leaves the cocoon, tapers to about one third of the cocoon diameter within a short distance. Conversely, the posterior end terminates with an increase in diameter, a feature also known in other tubiform fecampid cocoons.

The longest cocoon was an almost complete specimen measuring about 75 cm in length and having a maximum diameter of 1320 μm . A good number of cocoons or cocoon remains were as thick or nearly as thick. Only one piece was significantly thicker, having a diameter of 1480 μm , which indicates that the maximum length of type *I* will not exceed the mentioned 75 cm very much. Few had a maximum diameter of less than 1000 μm , although the thinnest measured only 740 μm . Evidently the size of the cocoon differs considerably, just as it does in other fecampids in general and those of the *Kronborgia* type in particular.

The smooth, whitish surface of the cocoon may have tiny sand grains slightly embedded in it, but nothing reveals where it has been made, except that it could not have been in contact with a hard substratum.

The multi-layered cocoon wall is 50-65 μm thick, but is often covered on the outside by an unstainable amorphous substance similar to that found in type *A* (Christensen & Kannevorff 1967).

Most of the cocoons and cocoon remains contained egg capsules or capsule remains. The capsules are slightly oval in shape and measure 175-190 μm in diameter. Intact capsules contained two embryos, and all stages of development were present in the material, including ciliated larvae ready to hatch. One cocoon was in fact largely full of hatched larvae. The larva has the usual fecampid shape with a rounded anterior end and a tapering posterior end. No eyes or mouth could be observed. The cilia are much longer, relative to the thickness of the epidermis, than in adult animals.

A few cocoon pieces, each suspected to contain part of the worm, were sectioned, but the results were poor. All that could be recognized was a ciliated epithelium containing rhabdites and an interior full of yolk material.

The worm no doubt leaves the cocoon after spawning. No trace of it was found in a number of cocoons filled with egg capsules from end to end.

Cocoon type J

Fig. 3

Material:

"Eltanin" St. 1660. Antarctic Sea, 61°31'-61°22' S, 108°00'-108°24' W, 5042-5045 m, 23 Apr. 1966. - One incomplete cocoon (with egg capsules).

The single cocoon found of this type lacks a part of unknown length in both ends (Fig. 3). The diameter is 660 μ m and the multi-layered wall is only 22-24 μ m thick. The colour and sheen resemble that of other tubiform fecampid cocoons. The bendings shown in the figure must be considered fortuitous.

The whole cocoon was full of slightly oval egg capsules with a diameter of 120-140 μ m. A microscopical examination of capsules from both ends of the cocoon showed that they had been deposited recently when the cocoon was collected.

In both size and general look the cocoon shows a remarkable resemblance to the tropical shallow-water cocoon type *D* (Christensen & Kannevorff 1967, fig. 6), but apart from being from a very different locality the capsules found in type *D* measure only 80 μ m.

As in the case of type *I* nothing reveals under which circumstances the cocoon was produced. It represents the deepest find of any fecampid cocoon so far described.

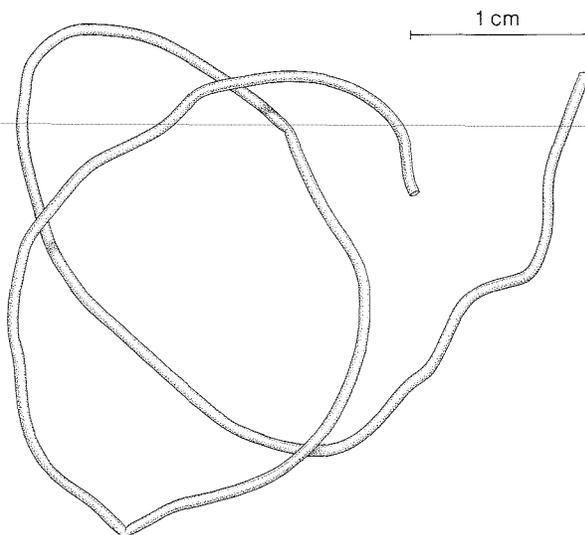


Fig. 3. Cocoon type J. "Eltanin" St. 1660.

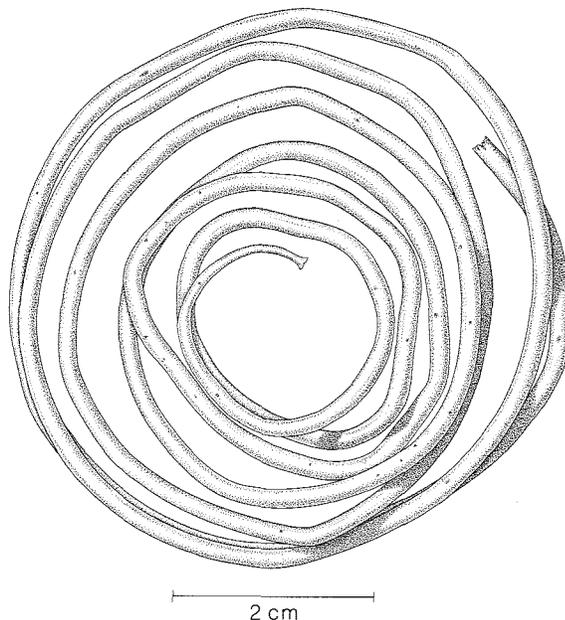


Fig. 4. Cocoon type K. Biol. St. Nanaimo, No. 63-207.

Cocoon type K

Fig. 4

Material:

"Commando" U.S. Bur. Comm. Fish. U.S.N.M. Acc. 248201. N. E. Pacific, 45°43' N, 125°13' W, 1920 m, 28 May 1964. - Two cocoons (both broken in pieces).

Biological Station Nanaimo, No. 63-207. N. E. Pacific, 50°32' N, 129°01.5' W, 1380 m, 10 Sep. 1964. - One cocoon (broken in pieces).

No. 63-213. N. E. Pacific, 50°59.5' N, 130°06' W, 2195 m, 11 Sep. 1964. - One cocoon.

This cocoon type (Fig. 4) was mentioned by Kannevorff & Christensen (1966) because of its similarity to the cocoon of *Kronborgia caridicola*. We were in error, however, with respect to the direction of coiling, which is sinistral and not dextral as in *K. caridicola*. The coiling is also much flatter.

The anterior end tapers smoothly and ends in a trumpet-shaped opening. The posterior end, which was lacking in the figured specimen but present in the others, is somewhat thickened and heavily encrusted with mud particles. This part, therefore, anchors the cocoon in the bottom, just as it does in *K. caridicola*.

The incomplete specimen in Fig. 4 is about 88 cm long, and "reconstructions" of two of the other cocoons gave a length of 106 and 110 cm, respectively. This makes type *K* the longest fecampid cocoon on record. The maximum diameter of the

cocoons varies between 1.8 and 2.6 mm. The multi-layered wall is 120-140 μm thick.

None of the cocoons contained worm remains, but

egg capsules were present in three of them. They measure 145-155 μm in diameter, and two ciliated larvae were present in all of them.

CONCLUDING REMARKS

From the foregoing account of a new species and five cocoons belonging to unknown species, it can be concluded that fecampids cannot be too rare parasites of deep-sea animals. Furthermore, in view of what we know about other fecampids of the *Fecampia* and *Kronborgia* types, it is almost certain that the host in all cases will turn out to be one or more species of Crustacea Malacostraca.

It is to be expected that a good number of new

species will be found once the nature of these animals and their characteristic cocoons become known to a wider circle of marine biologists than those presently informed. I hope that this paper can be of help in this respect.

A paper, to be published elsewhere, on the geographic and vertical distribution of the Fecampidae is under preparation. That is why that subject is not discussed further in the present paper.

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