Ultrastructural observations on paracnids. I: Coelogynopora axi Sopott (Turbellaria, Proseriata)

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Abstract

The 'Schlauchdrüsen' or paracnids of *Coelogynopora axi* Sopott, 1972 consist of two components: a muscle cell and a secretory cell.

The secretory cell is provided with a tube, which bears a border of microvilli. In the normal position the tube is situated in the interior of the secretory cell, and the microvilli stand at the inner side of the tube. After expulsion of the tube the microvilli are situated at its free surface.

The evagination takes place in response to chemical stimuli and is effected by the contraction of the myofibrils of the muscle cell.

The paracnids are supposed to be mechanisms of defense.

However, conformities with nematocysts and spirocysts of the cnidarians do not exist.

The paracnids in other species of the Coelogynoporidae, for example in *Invenusta paracnida* (Karling, 1966) and *Carenscoilia bidentata* Sopott, 1972 differ from those of *C. axi* in many details.

Introduction

Many turbellarians, for example species of the genus *Microstomum* and *Archimonocelis* have the ability to store cnids, which are derived from the food.

Within the family Coelogynoporidae conspicuous refractive glands are very common. These refractive glands have a certain similarity to cnids and are called paracnids (Karling 1966).

Among these paracnids there are some types, which show a clearly developed, eversible tube, for example, the glands of *Invenusta paracnida* (Karling, 1966), *Coelogynopora axi* Sopott, 1972 and *Coelogynopora gallica* Sopott-Ehlers, 1976. In the paracnids of other species, such as *Coelogynopora tenuis* Meixner, 1938 and *Carenscoilia bidentata* Sopott, 1972 these tubes are absent.

Lightmicroscopical observations lead to the conclusion that the glands of the Coelogynoporidae are autochthonous formations (cf. Karling 1966), but a more exact analysis of the fine structure of the different types of glands is impossible at the lower limits of light microscopy.

Materials and methods

The animals were extracted from sand samples taken from a beach at the eastern side of the island of Sylt (North Sea).

Before fixation for TEM the animals were kept in sea water diluted with distilled water (Sopott-Ehlers 1979). For further steps of TEM-preparation see Ehlers & Ehlers (1977.)

The methods for SEM-preparation are described in Ehlers (1977.)

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Results

The paracnids of *Coelogynopora axi* are situated in the peripheral parenchyme of the ventrolateral sides of the animals and have a diameter of about 10 μm. In live individuals they are round in the top view and heartshaped in profile. The tube measures 8 μm (Sopott-Ehlers 1972, p. 26f.).

As electronmicroscopy reveals, the paracnids of *Coelogynopora axi* consist of two cells: a muscle cell with myofibrils and a cell, which contains secretion.

The muscle cell surrounds the secretory cell in a cup-like manner, forming an envelope. Within the myofibrils no cell boundaries were observed, and apparently a single cell forms the muscle envelope of the secretory cell. Cell organelles, such as mitochondria, rough ER, and glycogen particles, can be found in peripheral sections of the proximal region of the muscle cell. A nucleus could not be clearly identified. A layer of basement lamina, which separates from the subepidermal basement lamina (Fig. 1B), runs between the muscle envelope and the surrounding tissue, as well as between muscle cell and secretory cell. The enveloping cell and the innermost layer of the basement lamina are linked to each other by hemidesmosomes (Fig. 1E). Branches of nerve cells run closely to the muscle envelope.

In the normal position, which means in the state of rest, the paracnids of *C. axi* are droplet-shaped (Fig. 1A). The cell containing secretion stretches distally to the body surface and has its opening – with microvilli – between epidermal cells. The cytoplasm surrounding this orifice (Fig. 1C) contains many microtubules. Epidermal cells and secretory cell are linked by zonulae adhaerentes and septate desmosomes. In the distal region the cell membrane is pleated several times in the longitudinal axis of the gland cell.

The epidermal cells of many turbellarians are characterized by the existence of a layer of tonofilaments, the cell web, (Bedini & Papi 1974). Such tonofilaments, are also contained in the distal part of the gland cell but more closely packed than in the cell web of the epidermal cells. This layer of tonofilaments continues into the interior of the gland cell (Fig. 1A, B) and builds up the eversible tube. The membrane, which bounds the layer of tonofilaments, forms a border of tightly arranged microvilli. In the proximal part of the cell the tube touches a plasm area, which is enclosed by a membrane and contains secretion granules (Fig. 1D). This area is linked to adjacent cell vacuoles by septate desmosome-like structures. The hemispherically shaped nucleus is located a short distance beneath this bowl containing secretion. Cell organelles- dictyosomes, rough ER, glycogen particles, free ribosomes and mitochondria (which have a conspicuous dark matrix) are found in the vicinity of the nucleus. Further away from the nucleus cell organelles occur in a marginal position. The largest part of cell volume contains vacuoles. Their contents have a fibrous to granulated texture, which may be coagulated fluid.

The process of eversion is an evagination. It results from contraction of the myofibrils of the muscle cell. During evagination the paracnid becomes lance-shaped (Fig. 2E). The nucleus of the secretory cell moves to the level of the epidermis. The tube is turned inside out, so that the microvilli are on the free surface (Fig. 2A-E). The tube extends beyond the epidermis like a chimney. The substances of the gland cell can be discharged through the distal opening of the tube.

Discussion

The evagination of the tube can be caused by addition of a few droplets of fixatives like picric acid or glutaraldehyde to the sea water. The stimulus is probably transmitted by the branches of the nerve cells in the vicinity of the enveloping cell to this cell. This causes to contraction of the myofibrils and evaginates the tube. Thus a reaction to chemical stimuli occurs. One can conclude from this, that the paracnids of *C. axi* have a function in protection against enemies; a function in prey capturing is also possible.

Many extrusomes in the protozoa (Hausmann 1970), as well as nematocysts and spirocysts in the cnidarians have a similar significance. Beyond this the spirocysts are supposed to have a function in substrate attachment (Mariscal *et al.* 1977). Substrate attachment is surely not a function of the paracnids, because the animals have well-developed adhesive organs. Beyond these functional aspects as mechanisms in protection or capturing prey, extrusomes, nematocysts and spirocysts are not com-

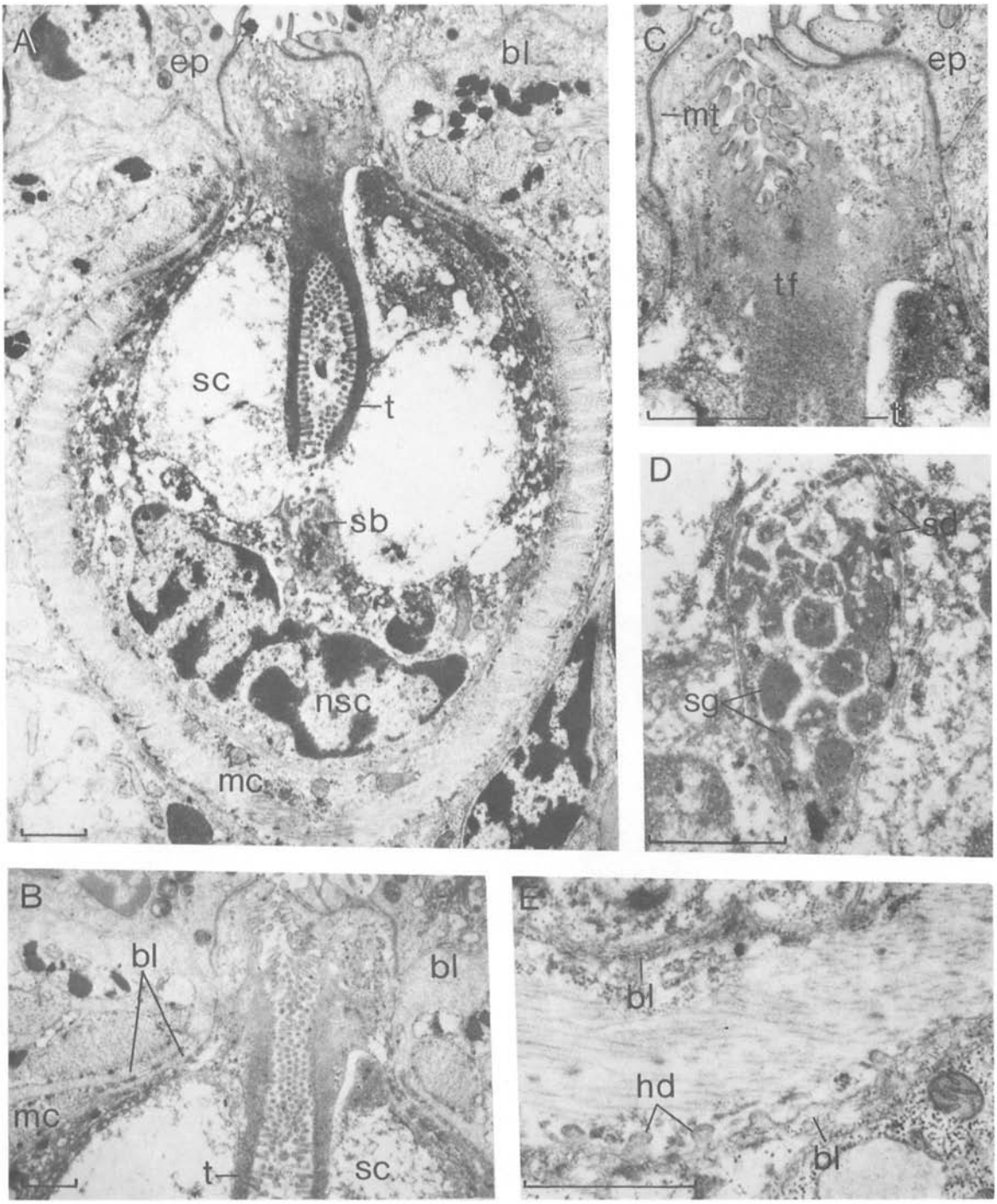

Fig. 1. Coelogynopora axi. A-E. TEM-micrographs. A. Paracnid in longitudinal section. B. Distal part of a paracnid. C. Microtubules in the vicinity of the orifice of the secretory cell. D. Bowl with secretion granules. E. The two layers of basement lamina. In the upper part the basement lamina between the secretory cell and the muscle cell; in the lower part the basement lamina between the muscle cell and the adjacent tissue. (Scale in all figures = 1 μm)

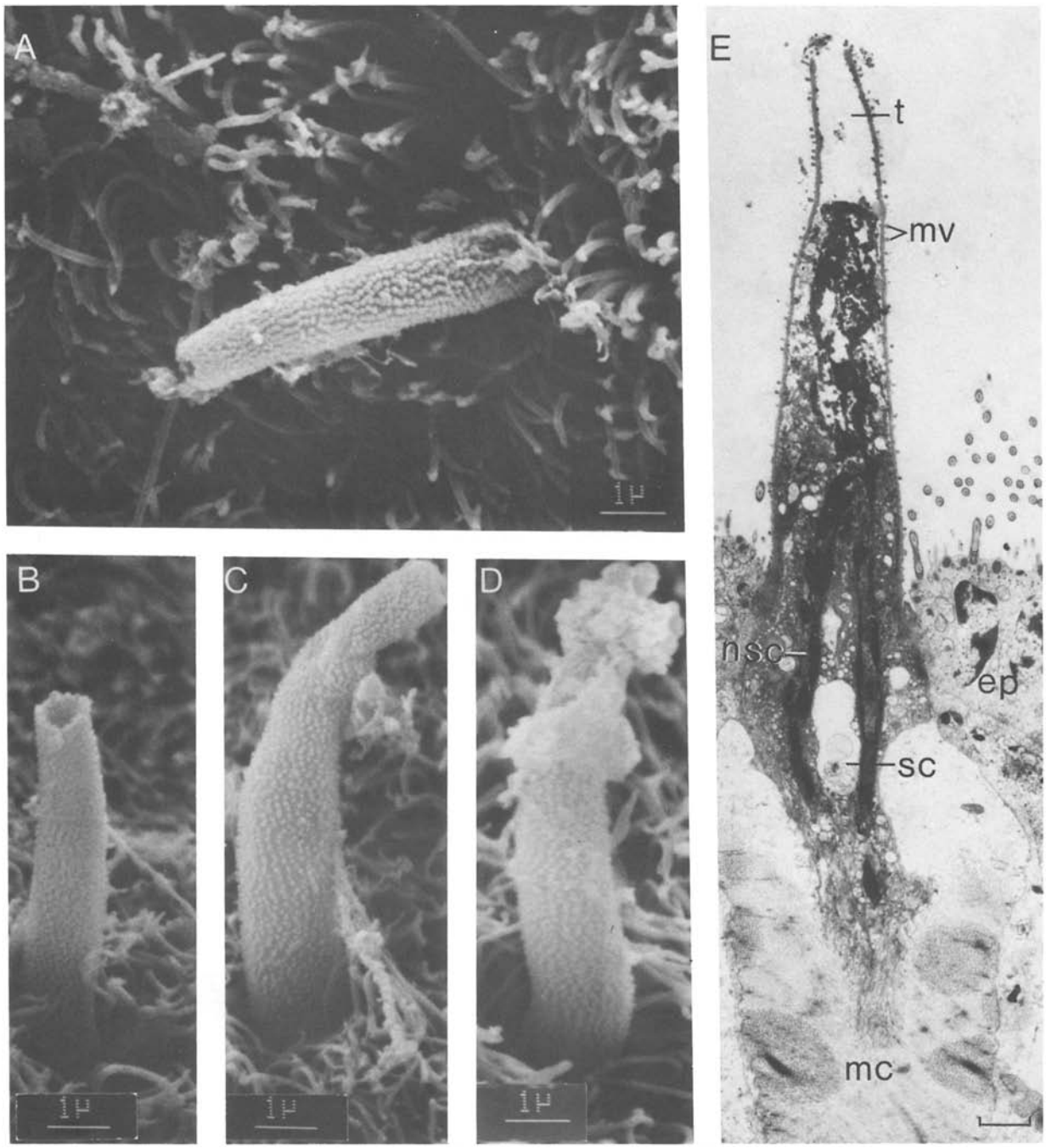

Fig. 2. Coelogynopora axi. A-D. SEM-micrographs. A and C. Completely evaginated tube. B. Partly evaginated tube. D. Completely evaginated tube with secretion. E. TEM-micrograph of an evaginated tube in longitudinal section.
(Scale in all figures = 1 μm)

parable with the paracnids of *C. axi*. Extrusomes develop from specialized regions of the cytoplasm, i.e., they are organelles. Nematocysts and spirocysts are differentiated within special cells, so they are also organelles (e.g. Mariscal 1974; Mariscal *et al.* 1976, 1977; Mariscal & McLean 1976; Ivester 1977; Satterlie & Case 1978). In contrast the paracnids of *C. axi* consist of two cells and consequently they are not organelles. Furthermore, no relations to the colloblasts of the ctenophora (Franc 1978) exist.

Karling's lightmicroscopical observations and the present electronmicroscopical finding make it very evident, that paracnids are genuine structures of the Coelogynoporidae. In addition, the ability of *C. axi* to regenerate the paracnids after injuries, e.g., damage of the tail, shows that paracnids are autochthonous formations.

Due to their similar lightmicroscopical structure, it is probable that the paracnids of *Coelogynopora gallica* correspond in their ultrastructure to those of *C. axi*. Therefore paracnids are probably not species-specific differentiations. In the species *Invenusta paracnida* and *Carenscoilia bidentata* two totally different fine-structured types of paracnids occur (Sopott-Ehlers in preparation).

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Abbreviations

bl – basement lamina
ep – epidermis
hd – hemidesmosomes
mc – muscle cell
mt – microtubules
mv – microvilli
nsc – nucleus of the secretory cell
sb – bowl containing secretion granules
sc – secretory cell
sd – septate desmosome-like structures
sg – secretion granules
t – tube
tf – tonofilaments

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