Fine Structure of the Posterior Salivary Gland of *Eledone cirrosa* and *Octopus vulgaris*

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Summary. The posterior salivary gland of Octopods comprises a parenchyma of branching tubules in a connective tissue stroma. The tubules are lined by either of two distinct epithelia. Type A is composed predominantly of columnar cells containing large granules whose contents vary in appearance from cell to cell. Type B consists of three cell types: A circumferential layer of processes of *striated cells* containing radially orientated infoldings of the cellular membrane, between which are packed numerous mitochondria; *cistern cells* which contain an invaginated system of membrane loops, the interior of which is in communication with the lumen; and *lumen lining cells*. All these cells send processes to the basement membrane of the tubule, so that both epithelia are pseudostratified. The functional significance of this cytological specialisation is discussed.

Key-Words: Salivary gland — Octopods — Epithelium — Cell types — Fine structure.

Introduction

The posterior salivary glands (PSG) of Octopods are remarkable both for the variety of substances they have been shown to secrete, and for the diverse functions they have been ascribed. Lo Bianco (1908) described them as the source of the toxin with which the *Octopus* paralyses its arthropod prey. Ghiretti (1960) isolated the toxin and showed it to be proteinaceous. The PSG toxin is also active against mammals, and at least one Octopod species has been responsible for human fatalities (Sutherland and Lane, 1969). The gland has been shown to contain large quantities of various biogenic amines (Erspamer, 1954; Hartman, *et al.*, 1960; Juorio, 1970) some of which have been identified in the external secretion (Ghiretti, 1953a and b). Histochemical preparations have shown that at least some of these amines are stored in large concentrations in columnar cells within the gland (Matus, 1971). Proteolytic activity (Ghiretti, 1950) and hyaluronidase activity (Romanini, 1952) have also been demonstrated in the PSG secretion. In spite of this interest in the pharmacology of these glands, only a few brief studies of their microscopic anatomy have appeared (Livon, 1881; Joubin, 1887; Gennaro *et al.*, 1962; Arvey, 1960). The present study was undertaken to elucidate fine structural aspects of the PSG relating to histochemical results previously reported (Matus, 1971), and the cytological basis for the apparent functional diversity of the gland.

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Methods

Specimens of *Eledone cirrosa* from the Devonshire coast of England weighing 400 to 800 g, and *Octopus vulgaris* from the Bay of Naples weighing 150 to 300 g, were killed by severing tentacles and mantle, the posterior salivary glands dissected out and fixed immediately. For light microscopy, tissue was fixed by the block Cajal method for marine material (Stephens, 1971). Electron microscopic specimens were prepared by fixation for 3 hours in 2% osmium tetroxide in sea water, buffered at pH 7.4 with 0.01 M tris (hydroxymethyl) aminomethane hydrochloride (tris-HCl). After washing with pH 7.4 0.01 M tris-HCl buffer in seawater, tissue pieces were dehydrated in graded alcohols and embedded in Araldite. Silver/gold sections were stained on the grid with 0.4% lead citrate in 0.1 N sodium hydroxide. For light microscopy sections 1 to 2 μm thick were mounted on glass slides and stained with 1% toluidine blue in 0.1% borate buffer at pH 11.

Observation

The posterior salivary glands lie dorsally in the mantle cavity, immediately behind the cranium. Each gland is roughly almond shaped, usually pale yellow in colour, and in specimens from large animals (over 1 kg) can be seen with the naked eye to consist of a mass of tubules embedded in a translucent matrix. Each gland receives an afferent blood vessel at its anterior border, and gives rise to a duct from its medial surface. Innervation is by the salivary nerves whose fibres arise from large cell bodies in the posterior portion of the superior buccal lobe of the brain and run along the common salivary duct and each individual duct to each gland (Young, 1965).

The microscopic anatomy of the PSG was reconstructed from the appearance of sections of tissue fixed by the block Cajal method and examined in the light microscope (Fig. 1). The parenchyma consists of tubules which branch repeatedly and follow a meandering path through a connective tissue stroma. These tubules exhibit no particular orientation with respect to the gross anatomy of the gland, nor do they show morphological variation in different regions of the gland. They are lined by either of two distinct epithelia. The more common (*type A*) consists

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**Fig. 1.** Low power micrograph of posterior salivary gland to show irregular orientation of tubules and distribution of epithelia. Note wide lumen of tubules with *type B* epithelium. 

Cajal preparation. ×35

**Fig. 2.** *Type A* tubule epithelium showing columnar cells with basal nuclei and distal cytoplasm packed with granules. Cajal preparation. ×280

**Fig. 3.** *Type A* tubule epithelium showing variegation of granules. Note extent of non-granulated basal region of cells. Osmium tetroxide fixation, toluidine blue stain. ×175

**Fig. 4.** *Type B* tubule epithelium showing relatively wide lumen and argyrophilic innervation. ×115

**Fig. 5.** *Type B* tubule epithelium showing nerve fibres (sf) and relative positions of cell types by distribution of nuclei; lumen lining cell nucleus (ln) closest to lumen (ln), cistern cell nucleus (cn), and striated cell nucleus (sn). Cajal preparation, phase contrast. ×710

**Fig. 6.** *Type B* tubule epithelium showing communication of lumen with interior of membrane system of cistern cell (cc) and lumen lining cell (lc). Regaud’s fluid fixation, Leischmann stain. ×710

**Fig. 7.** *Type B* tubule epithelium showing processes of lumen lining cell and cistern cell and convoluted appearance of cistern cell membranes. Osmium tetroxide fixation, toluidine blue stain. ×800