Secretory Cells in the Gills of an Indian Fresh-water Spiny Eel, *Mastacembelus armatus* (LACÉP.)

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Introduction

The study on the gills in the Teleostei has been a subject of considerable inquiry and discussion by a number of investigators. KEYS and WILLMER (1932) described the occurrence of chloride secreting cells in the gills of fishes, particularly the common eel. They stated that these cells occur in some fresh-water teleosts and the presence of such cells apparently complicated their physiological interpretation. VIALLI (1935) made a comparative observation on the gills of salt, and fresh-water eels and remarked that chloride cells are present in salt water forms while such cells are lacking in others. He considered the ecological, physiological and anatomo-comparative importance of the forms examined by him. BEVELANDER (1935, '36) made an extensive study on the branchial epithelium of fishes. Later LIU (1942) successfully acclimatized a strictly fresh-water teleost, *Macropodus opercularis*, to a saline medium nearly as concentrated as sea water; and maintained that the change in the mechanism of osmotic regulation in such a specimen is reflected in the enormous development of chloride secreting cells in the gills. BIJTEL (1947, '49) described the structure and mechanism of movement of the gill filaments in Teleostei; and MOTT (1951) the blood vascular system of the eel.

This investigation on the branchial epithelium of the fresh-water eel, *Mastacembelus armatus* has been undertaken to amplify the observations recorded previously.

Material and methods

Live eels were collected from their natural environments. Specimens for the gross study of the gills were fixed in 10% formalin, and material for microscopic work was fixed in Bouin's fluid. A number of transverse and longitudinal sections of the gill filaments were cut at 6 μ. Sections were stained with Delafield's haematoxylin and eosin which gave uniformly good results. Mallory's triple connective tissue stain and mucicarmine for mucous tissue were also employed.

Morphology and histology of gill filaments

Morphology: The eel possesses four branchial arches on either side and each arch bears, on its outer side, a double row, the two hemibranchiae, of gill filaments (gill-plates of the first order). Every filament in turn, bears on each side a row of lamellae (gill-plates of the second order, respiratory leaflets or secondary folds) which provide the surface for both respiratory and osmotic exchange.

According to OPPEL (1905) each filament on the branchial bar is supported on the inner side, approximately two-thirds of the length, by a small rod of cartilage (the gill ray). BIJTEL (1949) states that each filament is supported by a bar-like piece of skeleton (the gill rod) which consists of the chondroid type of tissue. The thin lamellae are ridges which stand nearly perpendicular on both sides of the filaments and are without any supporting apparatus.

Histology: Sections of the gill filaments of *Mastacembelus armatus* show the relation of the filaments and their lamellae, the investing respiratory epithelium with intra-epithelial glands, the supporting tissue, the vascular supply and the gill ray.

The lamella (leaflet) is invested with an upper and lower respiratory epithelium; each composed of a single layer of flattened cells. The only epithelial glands observed were the unicellular mucous glands in different states of physiological activity (Fig. 1). The chloride secreting cells recorded by KEYS and WILLMER (1932) in certain fresh-water teleosts were nowhere observed in the branchial epithelium of *Mastacembelus armatus*. The observations, thus, agree with those of BEVELANDER (1936) who remarked that the intra-epithelial branchial glands are the mucous glands. The epithelium rests on a thin basement membrane and below it are the supporting and vascular tissues. The supporting cells (the pilaster cells of BIETRIX, 1895) are tall, narrow and somewhat columnar; each cell having a centrally situated nucleus. The blood channel system lies between the upper and the lower respiratory epithelium and is enclosed between the two membranes that are kept apart by the supporting cells.

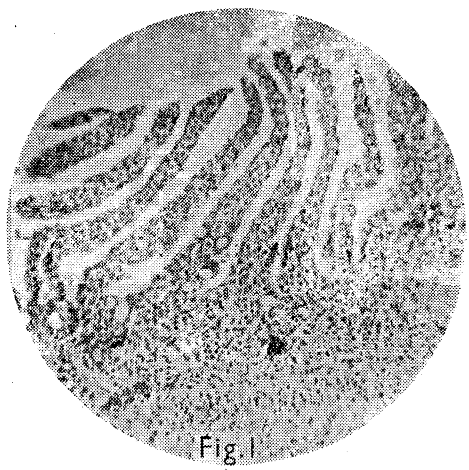

Fig. 1. Microphotograph of leaflets showing the mucous cells (Delafield's haematoxylin and eosin).

Discussion

SMITH (1930, '31, '32) has shown that the osmotic regulation of body fluids in both the teleost and elasmobranch fishes is effected to a large extent by the extrarenal excretion of salt (NaCl and KCl) under conditions that may involve considerable osmotic work. MARSHALL and SMITH (1930) pointed out that in vertebrates, the role of osmotic regulation is taken up in fishes by the gills and in mammalia by the loop of Henle of the kidney. KEYS and WILLMER (1932) described special type of chloride secreting cells in the branchial epithelium of marine eels but did not extend this observation to the fresh-water eels. They found no trace of such chloride secreting cells in the branchial epithelium of young salmon from fresh water environment as are present in the gills of salmon that pass from sea to fresh water. They remarked that these cells are secretory and are definitely not mucous cells and are less abundant in fresh-water teleosts than in the marine forms. Without a thorough study of the histology of the gills of fishes from various habitats, they maintained, however, their conviction on the occurrence of chloride secreting cells in the gills of eels, at least, and probably also in the gills of other marine teleosts. According to them the presence of mucous cells between the leaflets of the gills seems to be confined to fresh-water species which appear to have been lost in the true sea-water forms.

Studies on the branchial epithelium of *Mastacembelus armatus* show that only mucous glands occur in; the chloride secreting cells being absent. These observations are consistent with the views of BEVELANDER (1935, '36) who remarked that there is no indication of any specialization in the branchial epithelium in fishes indicating their special role of extrarenal excretion. The only specialized cells are the intrabranchial glands, the mucous cells. BEVELANDER concluded that the respiratory epithelium admirably effects the important physiological process of the exchange of materials between the blood of the gills and the surrounding medium. Observations in *Mastacembelus armatus* also agree with those of VIALLI (1935) who reported the absence of chloride cells in the eels trapped from soft water. COPELAND (1948) on basis of adaptation experiments and cytological examination of cells maintains that there is a "type" cell-columnar——possibly also mucus secreting ——which is responsible for chloride secretion. BEVELANDER, in a personal communication, states "In re-reading COPELAND's paper, I still think the cells he describes are mucous cells. He may have a point I failed to recognize——that was not known——that mucus (polysaccharides) may well be concerned with ion transfer."

LIU (1942) has shown that in acclimatized saline-adapted strictly fresh-water paradise fish, *Macropodus opercularis* the chloride secreting cells are enormously developed, but in the control specimen these cells are actually inconspicuous. He attributed the presence of large number of cells as an adaptation to salt water but made no comment on the function of these cells in the gills of fresh-water fishes. This contrast stresses the significance of such cells in osmoregulation against a hypertonic medium but the presence or absence of such cells in the fresh-water fishes still seeks informative and authentic explanation.

Summary

(i) The morphology and histology of the gill filaments of *Mastacembelus armatus* are described.

(ii) Chloride secreting cells are absent in the branchial epithelium.

(iii) The intra-epithelial branchial glands are the mucous cells.

(iv) COPELAND, KEYS and WILLMER and others have described certain cells in respiratory (branchial) epithelium of fishes which appear in fishes adapted to different osmotic environments.

The fact, however, that BEVELANDER, the author and others, have described only mucous cells in this environment, and the very great possibility that mucus is concerned with ionic transfer suggests that chloride and other ionic transfer effected by the branchial epithelium is mediated by mucous cells.

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