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# Comparative anatomy of ABO of estuarine gobies (*Monopterus cuchia)* of India

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**Abstract -** A wide variety of air breathing organs have been evolved in fishes along with different lineages. Most of these fishes remain in water and uses air as the source of oxygen at variable degrees. And with the evolution of air breathing organs the circulatory system of the fishes have been modified at different levels to accommodate blood to and from the newly developed air breathing surface. However in most of the air-breathing fishes, except snakeheads and lungfishes, seem to lack the ability of separating $O_2$-rich effluent blood of the air breathing organ during the passage of $O_2$ through the central cardiovascular system, although this has been inferred usually only from anatomical studies. The purpose of this paper is to review the current knowledge about the air breathing organs in selected species of air-breathing fishes (eel gobies, mudskippers, swamp eels, snakeheads and lungfishes).

**Keywords: -** ***Monopterus cuchia,*** **estuarine, hypopharynx**, **buccopharynx**

## INTRODUCTION

Most of the fishes obtain oxygen from the water by using their efficient organs like gills but sometimes the low availability limits their oxygen intake. To cope with the hypoxic oxygen these fishes move to the water surface for the intake of oxygen.

From many years the air breathing fishes have attracted the different biologist for illustrations and understanding the evolution of different air breathing organs and their transition from water to land.[1] Many of the air breathing fishes occur in freshwater, estuarine and marine habitats.[2-4] Estuarine and marine air-breathing fishes are group of highly amphibious species such as mudskippers and rockskippers).

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The mud eel species *Monopterus cuchia* belongs to the family Synbranchidae and Synbranchiformes.[5] It inhabitats in holes, crevices muddy banks of swamps, lakes etc and slow running rivers[6] and it is an obligatory air breathing fish. The present article is basically focused on the structure and morphology of air breathing organs in the species of mud eel.[7]

In the respiratory regions there are quite extensive non-respiratory "Lanes" which would, therefore, reduce the overall values for respiratory surface. In addition, however, the respiratory islets themselves are often folded and this, together with the marked curvature of individual papillae would increase the surface area relative to that obtained by simple projection. A detailed study of the structure of vascular papillae of the respiratory islets and morphometry of the air-breathing organs of *M. cuchia* was undertaken.

## MATERIALS AND METHODS

Fifteen species of *Monopterus cuchia*, having the body weight 100-300g and having the length of 550-700mm, were kept in an aquarium at $25^0$ in the Department of Zoology, Madhepura. Several specimens were anaesthetized in MS 222 (1g/500ml) and were fixed by using vascular perfusion. Compressed air was fed into the air sacs at a pressure of 20cm H2O and a cannula was inserted into the bulbus arteriosus and perfusion was initiated with oxygenated physiological saline (0.9% NaCl) containing 2500IU heparin/ litre.

The process of perfusion was gradually followed by addition of 2.5 % of glutaraldehyde solution in 0.03 molar potassium phosphate buffer. Now the samples of tissues were taken from the several air breathing organs such as air sac, gills, hypopharynx, buccopharynx. Tissue blocks were post-fixed in 1% osmium tetraoxide solution (pH7.4,350 millosm.), stained in a 0.05 molar uranyl acetate solution, dehydrated in a graded series of ethanols and finally embedded in epon for transmission electron microscopy (TEM). Respiratory organs of a few *M.cuchia* were fixed, following anaesthesia by installation of 2.5% potassium phosphate buffered glutaraldehyde solution (pH7.4,350 milliosm.) through the mouth. Afterwards for 3 hours the fish were kept submerged in the same glutaraldehyde solution. Afterwards tissue samples were taken from the same positions and processed for TEM and SEM as described above. For preservation of mucus lining of respiratory tracts the fish that were anesthetized were decapitated and the cranial portions of the head were sectioned in a sagittal plane. Tissue samples were then taken from the same positions and post fixed in OSO4 (see above) to which 0.7% RHT was added. Tissues samples were also taken and post fixed in 0.7% RHT. Gills and air sacs of these fishes were also fixed in 2.5% glutaraldehyde and post fixed in 1% OSO4 in phosphate buffer kept at pH 7.4.

## RESULT

While conducting the study on air breathing organs of *Monopterus cuchia,* the following important features were obtained:-

**Morphology**

The suprapharyngeal pouches are specialized air sacs that developed into dorso lateral extensions extensions of the pharyngeal cavity on each side. Sagittal section of the head shows the extensions of the buccal cavity, buccopharynx, hypopharynx and the air sac. The respiratory surface separated from the oesophagus that extends upto the gullet in hypopharynx. The various distributions of the vascularized respiratory islets on the inner mucosal linings of the pharynx, hypopharynx, and air sacs are also found. The posterior part of the air sac does not contain any respiratory outlets. Its surface is covered by non-vascular epithelium with many chromatophores.

When the air breathing organs was observed under SEM (scanning electron microscopy) the following were observed:-

**a) Buccopharynx:**

The buccopharynx when observed under SEM it contained the respiratory islets that were separated from each other by deep furrows. Each of the respiratory islets was also separated by slit like clefts into various parts. Many small and large islets and membranes lined by the membrane were seen in the gill clefts. These gills are found between the consecutive branchial arches.

The respiratory islets when seen under SEM were found to be separated from each other by deep furrows. The respiratory islets were also divided by slit-like clefts into several parts. The gill clefts appeared as narrow apertures lined by membrane with many large and small islets.

**b) Hypopharynx:**

The hypopharynx which leads into the oesophagus is also respiratory in function. Where the delicate tissue barrier is peeled off, the inner structure of the vascular papillae is exposed. The cell of the vascular papillae of the respiratory islet is honeycomb in structure.

**c) Gills:**

The gills are fingerlike structure that usually found in fused form with the branchial arch or holes that represents the interlamellar spaces. The second branchial arch bears a few finger shaped filaments. Microridged epithelial cell covers the surface of the filaments. No differentiations of secondary lamellae which are being represented by protubearances are found. Slit like structures are found near the base of the gill filament

representing interlamellar spaces and the surface of the filament is covered by epithelial cells.

**d) Air sac:**

The dorso-posterior regions of the air sac are non-respiratory in nature and are covered by microridged epithelial cells. Chemoreceptor is also seen in air sac that is bounded by microridged cells. Micro air pockets have been detected in air sac that penetrates deep into the air sac wall.

## DISCUSSION

The gills found in *M. cuchia* are very much atrophied bearing few figure like structure. Filaments and lamellae are fused together to form pores through which the passage of water occurs during the aquatic ventilation. Secondary lamellae represent a bud like structure that is internally lined by endothelial cells.[8] The air sac represents the posterodorsal extended pouches of pharynx. Between the old islets and buccopharynx new respiratory islets develops. The posterior one third of the sac that serves as reservoir for residual air is non vascular in nature. In fishes since the regular gill filaments and lamellae are lacking but due to islets present at inner surface of the buccopharynx, hypopharynx and gill arches helps in exchange of gases and also in aerial respiration.

In *M.cuchia* air breathing organs are quite remarkable that functions not only for exchange of gases in both air and water but also for passage of different food such as earthworm, insects, mollusks etc. behind the respiratory hypopharynx is found which is a small chamber and leads into the oesophagus. This fish has a highly vascularised respiratory islets and the respiratory membrane is entirely covered by mucous which anchored by epithelial surface.

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