



# Ultramicroscopic structure of the lens of *Anabas testudineus* and its significance

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## Abstract

The lens of *Anabus testudineus* is spherical. Scanning electron microscope reveals that the lens is composed of lenticular fiber cells which possess various functional apparatus. The structure of the lens suggests a semi – aquatic mode of vision. The structure also suggests that the unabsorbed portion of the light which enter the eye are scattered by the lens.

**Keywords :** Lens, *Anabas testudineus*.

## 1. Introduction

The photo-environment in fish live is probably more varied when compared with that of any vertebrates. Some of them are inhabitants of clear streams water and the surface of water bodies, where penetration of light is quite high. Some are bottom dwellers or inhabitants of turbid water bodies with poor illumination, while some change from an environment of very low light levels to that with a very high light intensity. Due to their exposure to very different light conditions fish adapt themselves to great extent, which give rise to diversity in structure and physiology of visual system. Like any other ocular tissue the refractive structures (cornea and lens) also shows chemical specialization as well as structural modifications in response to photo-adaptation (Lythgoe, 1972; Kennedy and Milkman, 1956; Somiya, 1976; Dey, 1992). Besides their normal role of refraction, the cornea and lens perform extensive and varied functions in the visual system of different organisms. They may act as an

interference filter in the eye, reduce reflection at the eye surface, help in the reflection of specific wavelengths from regions behind the receptive cells and play a role in selective light absorption (Bernhard *et al.*, 1965; Kennedy and Milkman, 1956; Somiya, 1976).

Unlike terrestrial vertebrates, the principal refractive structure in the fish eye is the lens, since little refraction takes place at the cornea whose refractive index is approximately equal to that of water. Hence in fish, specialization in the dioptric apparatus in response to photo-adaptation is expected more in the lens than in cornea. However structural specialization in response to optical phenomena other than refraction has been described in some fish cornea (Lythgoe, 1972).

Several studies on the specialization of the dioptric apparatus in response to photo-adaptation in fish exist in published literature. However very few investigations have been carried out in air breathing fish. The present work reports the occurrence of some spherical particles in the lens

of the *Anabas testudineus*, which may act in the scattering of light according to Rayleigh (1911). The structure of the lens also suggest semi-aquatic mode of vision.

## 2. Materials and methods

### Scanning electron microscopy

The lenses were excised from the eyes and were cut with a fine razor blade and secured horizontally to a brass stub (30 mm diameter × 20mm high) with the help of double adhesive tape. The samples were placed, with the cut surface facing the electron beam of the microscope. A thin electroconductive metal coating was applied to each specimen using gold as a target metal in an ion sputter coater, JFC 1100 (Joel). Observation were made with a scanning electron

microscope JSM-35CF (Joel) using the secondary electron emission mode at an accelerating voltage of 15kv and at a working distance of 15 mm. Fifteen individual fish representing both males and females were used for study.

## 3. Results

The lens of *A.testudineus* is spherical (Fig.1) in shape and off- white in colour. It is transparent and brittle in nature. Scanning Electron Microscopy (SEM) micrograph off the whole lens shows two distinct region outer cortex and inner deep medulla or nucleus. The lens is enclosed in a capsule. The outer epithelial layer is thin and distinct. No ringlets are found on the epithelium layer. Beneath the epithelial layer there are multiple layers of cortical fiber cells, which are the main histological structure.

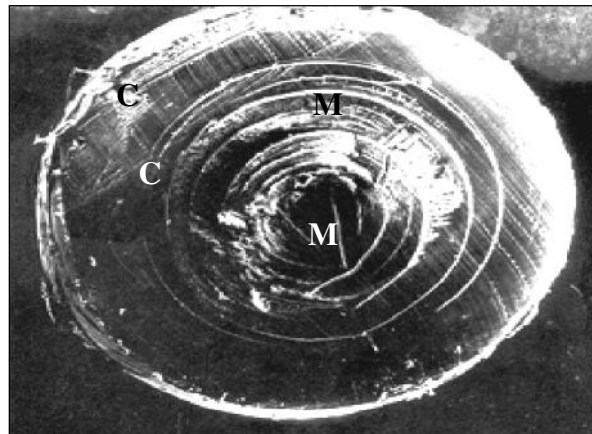


Figure - 1 : Showing the spherical shaped lens of *Anabas testudineus* with distinct cortex (C) and medulla (M)

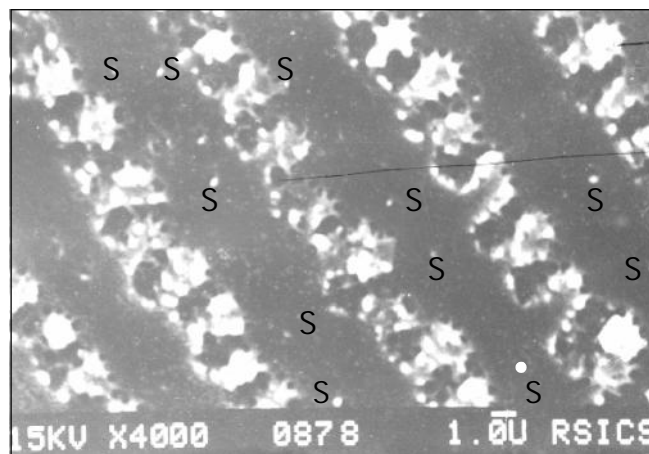


Figure - 2 : Magnified SEM micrograph of the lens of *Anabas testudineus* showing numerous spherical bodies (S)

#### 4. Discussion

The eye of fish, like those of more familiar animals, has evolved adaptations responsible for two main functions : (1) to collect light and (2) to form a focused image for analysis by the retina. The feature of fish visual system collection of light and formation of image by the lens is called optics and focusing the image on the retina is called accommodation.

Structurally, fish eyes are superficially quite similar to those of terrestrial vertebrates, although they typically have a short axial and are nearly hemispherical. The optics of animals living under water is different from those of animals living in air in one major respect that in underwater there is no air/cornea interface to provide extra dioptric strength to the eye (Matthiessen, 1880). In all underwater eyes, the refractive power of the cornea is neutralized and the lens needs to be much powerful. In addition lenses of fish must have a short focal length to minimize eye size (Sivak, 1983). Together, these constraints have been met through the evolution of spherical lens, which has a very high refractive power in most fish. *A. testudineus* have a spherical shape lens (Fig. 1) indicates very high refractive power of the lenses.

Since the lens is the only refractive element of fishes so it said to possess a spherical or nearly spherical crystalline lens of high refractive index (Feng *et al.*, 2005). The wavy nature of the lenticular fibers cells seen in the SEM micrograph of the lenses of *A. testudineus* indicates crystalline

nature of the lens. The refractive index is thought to drop continuously and parabolically from the center to the periphery so as to produce a lens with little or no spherical aberration (Matthiessen, 1880). How it maintains the spherical shape of the embryonic nucleus is unknown.

The lenticular fibers of the lens of all vertebrates filter and regulate the light entering the retina (Bernhard *et al.*, 1965; Fernald, 1990). After investigating the SEM micrograph of the lens of *A. testudineus* it is seen that it has a well-developed lenticular fiber. This indicates that light passes through the lens both in denser and rarer medium (Lythgoe, 1979) which suggests that *A. testudineus* possess a semi aquatic mode of vision.

Numerous spherical bodies of various sizes are observed in the micrograph of the lens of *A. testudineus*. The presence of spherical granules indicates that since reflection usually does not take place by the lens some portion of the light is scattered from the lens to regulate the quantity of light entering the retina. This suggests that spherical scatters takes place in the lens of this fishes.

From the above discussion it can be concluded that *A. testudineus* is an inhabitant of swampy turbid water so the spherical scatters in the lens may be an adaptive feature to regulate the quantity and quality of light entering the retina. More over the structure of the lens signifies that *A. testudineus* retain a semi aquatic mode of vision

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