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Studies on the chromogenic (morphological) colour change in the fresh water fish *Ophiocephalus gachua* (Ham.)

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Abstract

An attempt has been made to know the nature of *contract* mechanism of the chromogenic response in fresh water fish *Ophiocephalus gachua* (Ham.). The melanophore population was analysed from observation on prolonged period (30 days) background adaptation of the fish. In this chromogenic response, it is regarded as truely physiological, this is a change both in number of melanophores as well as in the amount of chrome (melamosomes) per cell. The response is resultant of one to incident illumination and one to reflection from the background.

On the black background the fish shows a gradual incresase in its melanophores population. The white background stimulus brings about a rapid aggregation of melanosomes in the melanophores and on prolonging the condition the fish suffers gradual loss in its melanophore population. When the white history fish is subjected to a prolonged black background stimulus, maintaining the melanophores in their dispersed condition on the contrary, when the former is subjected (black history fish) to prolonged white background stimulus gradual loss and melanosome aggregation is observed.

It is seen that the chromogenic changes in melanophores in a normal background, adapted fish are comparatively unmarked sympathetic pigment aggregate fibres irrversibating the melanophore and a melanophore aggregating hormone (MAH) of pituitary origin working appear to play a role in controlling the chromogenic response in the fish *Ophiocephalus gachua* (Ham.).

Pigment cell enables fish to change their colouration. The fish colour change is of two types – physiological and morphological which result from change in morphology and density of chromatophores. Long term adaptation of fish to a certain background can be general by due to morphocolour change & has been studied from 1914. Finally morphocolour changes are discussed as physiological phenomena involved in the balance between differentiation and apoptosis of chromatophores. Physiological colour change is important for back ground matching, thermoregulation as well as signalling and in vertebrates it is mediated by synchronous intracellular transparent or pigmented organelles in chromatophores[33]. Works of a number of researchers[1-44] engaged in such type of studies have been consulted for the preparation of this manuscript.

The fish used for this research was purchased locally from fish market of Morar and Ladhedi. Regardless of the sex, fish used were of about 7-13cm in length. Fish were placed in normal background for 10 days then transeferred to white, black and normal background condition. Observation were recorded with the method proposed by Hogben and Slome (1931), five stages used for observation include punctuate, punctostellate, stellate stelloreticulate and reticulated described and used previously by Dixit (shukla) A.[4-19] The standard used for measuring the state of melanophores MI method quantitive observation of melanophore recorded (visual estimation). For the study, Fish were kept on white, black and normal back ground conditions (illuminate) by a bulb above 1 feet from the surface of aquarium water level for 30 days.

Then fish of white history were transferred to black and fish of black history to white background conditions for 15 days.

Observations were made specially by counting of melanophores from site A (Band above lateral line) and site C (intervening area above lateral line) colour of fish observed (pale or dark) by DOI method or white and black background respectively.

The fish *O. gachua* is sensitive in its colour change mechanism as background responses. Rate of colour change is more rapid at initial stages and followed with somewhat prolonged final stage of the process.

The quick responses to background in *O. gachua* suggest that the fish is mainly under nervous control for its colour change mechanism, atleast in the initial stages. It may, also be observed that the rate of colour change mechanism is faster in first 5 min in the white back ground (paling) as compared to that of darkening in black background.

This resembles to the result found in *Rasbora daniconius*[23], *Gasterosterus* (Hogben and Landgrabe, 1940) the result of paling experiment on this fish is quite different from the reports from others *eg. Scyllium canicula* (Waring, 1951) etc.

The quick colour change (paling) may seem to point out the presence of paling centre in the brain which as a result of stimulation from the background that affects the rate aggregation of melnophores (medulary paling centre).

The hormonal control is also implemented in the colour change mechanism may seem to become apparent in the later stages. This condition resembles *Rasbora.daniconius*[23] and *Macrones chryserus* and *Saccobranches fossilis* (Alexdender and Jhon, 1969).

The control of colour change mechanism is also supported by the effect of adrenaline on the melanophores in an isolated scale, A process used earlier by Spaeth (1916) on *Fundulus* and on Trout by Gianferrai (1922) on *Phoxinus* by Smith (1931) and on *Ameiurus* by Baeq (1933) and on *Rasbora daniconius* by Dwivedi[23] and by Jain[34] on *Nandus*.

In the present study counting of

melanophore in (P.E.M) scale indicates that decrease in number of melanophores was siginificant in white background (about 54.5%) in comparison to total gain (36.9%) in the melanophore count from black background fish, within same period of background conditions while on the normal back ground condition melanophore gain was observed (16.02).

On the reversal of fish of white history to black and fish of black history to white background (15 days) indicates that there is quick change in colour of the fish due to increase (27.03) in melanin content as well as number of melanophores whereas later resulted in loss of (58.02) melanophore number and melanin content within them (visual estimation).

On black adapted fish the melanophore were mostly observed in dispersed or stellore-ticulate stage whereas in white adapted fish melanophore mostly stellate or stelloreticulate and in aggregated stage also observed. Under normal background conditions melanophores were observed in puncto stellate and stellate stage few were observed in reticulate with dense xandhophores and leucophores (ventral region). Rapid colour change indicates that fish colour change mechanism (physiological) is under nervous control. Whereas latter slow gradual colour change of fish (morphological) confirms presence of hormonal control which is of aggregating type.

On a normal background, the fish neither receive a perfect black background stimulus nor a true white background stimulus; A normal background stimulus helps the fish in maintaining the melanophore semidispersed (M1 3-3.5) by slightly reducing the amount of aggregating neurohumoral transmitter at the nerve ending and the concentration of melanophore aggregating hormone in the blood. These two conditions seem to favour a slight increase of melanophore population during long term adaptation to the normal background as compared to a higher increase of melanophore population on a black back ground.

These results of the present study seem to indicate that there exists a mono-neuronic nervous control (melanin pigment aggregating nerve fibres) and a single hormonal control (MAH, Melanophore aggregating hormone) in the chromatic system of the fresh water fish *Ophiocephalus gachua* (Ham.) From this observation it can be concluded that:

I. The effect of back ground adaptation to melanophore loss is greater on an illuminated white background than the gain on the illuminated black background.
II. The ratio of loss of melanophore on white background then the increase in melanophore on a black background is approximately 1.5:1 for the same period of time.
III. The average increase in melanophore population is greater on a black background then average increase in number of melanophores on a normal background ratio approximately 2:1 for the same period of time.

The study indicates the participation of nervous as well as hormonal control of morphological colour change mechanism. The previous history (25 days adaptaion on white or black backgrounds) has an important effect on the chromogenic colour change in the fish on a normal background the shade of site A and site C range from 3.5 to 4.0 and 2.0 to 2.5 grades respectively of DOI and the general dark brownish shade of fish is due to partially dispersed melanophores (MI 2.5-3) and abundance of xanthophores[4].

Most of the teleost fishes show colour changes in response to background becomimg pale, due to melanin aggregation on a white back ground and, dark as a result of melanin dispersion on a black ground. These adaptive changes in response to background can be explained in terms of a single pituitary hormone, MSH/(MCH) produced in the pars intermedia.

There is considerable incidence in some teleosts for the production of melanin concentratin hormone by the pituitary.

In teleosts, variation can be observed *in vivo* and *in vitro*, that pituitary gland extract causes rapid melanin aggregation in some fishes, although in other it is a cause of melanin dispersion also. (Pickford & Atz, 1957, Kent, 1960) *eg*, in amphibians Pickford (1957), found MSH(MDH) and in fundulus MCH(MAH).

Hogan and Winten have done much to elucidate the problem of colour change in amphibians. In fish, however the classical work of Puchet followed by Vonfrisch has demonstrated that the nervous system was the chief factor in control of colour mechanism. This is more over confirmed by demonstration (of ballowritz) of nerve endings on the melanophores.

The colour changes in fish are so varied, the attention of workers turned to the possibility of some actions of the internal secreting gland/ ductless glands/ endocrine glands, by their work on isolated fish scale. The results show that not only cadrenaline, but extract of posterior & pituitary both cause aggregation of the melanophores.

The action to the pituitary extract in the opposite to that produces in amphibia where pituitary extract of posterior of pituitary results in dispersion of melanophores.

Adaptations, of teleost fishes in gross colouration of the body to illuminated background are of three distant types viz,

- Change in shade
- Change in colour
- Change in colour pattern

Induced by variation in those factors of background the most common type of adaptation in shade of the body, which become dark, light, background respectively. Changes in colour, too much background have been also worked out for a number of species. Rapid colour changes due to background response suggest that the background adaptations are under nervous control.

Adaptation to patterned background is nothing other then formation of lateral strips by alternate light and dark areas in the skin respectively through pigment dispersion.

The present study is an attempt to find out control system of chromogenic (morphological) colour change mechanism in *O. gachua*.

Difference in the stages of melanophores is clearly observed. The melanophores, xanthophores leuco observed the melanophores are most important in the normal colour changes of the fish. The melanophores are distributed over the head dorsal band and intervening area (site A & C).

The dorsal melanophore of the fish *O. gachua* melanophore are small and observed fairly close together. Melanophores have a rounded appearance. The centre of melanophore is filled with dense pigment grounded (melanin) than the periphery. They are formed mostly in stello reticulatephore.

The visual estimation of colour change of the fish was observed by DOI method[32].

For accurate microscopic observation, of the melanophore various stages were recognised. They were found to be punctate, punctostellate, stellate, stelloreticulate, & reticulate.

The xanthophores were also observed with melanophores but they disappeared after few minutes as the xanthophore is soluble in water (and other solvents also)[33].

The leucophore was apparently always in constant condition, was found abundant on ventro lateral & ventral region of the fish.

Incident light- reflecting light during the study effect of background were accurately observed. The normal reaction of the melanophores in general are aggregation on white back ground and dispersion on black back ground. In the dark, there is general tendency to disperse but in total darkness they may be observed in aggregated condition resulting paling of the fish.

The background changes on melanophores are very rapid and considerable individual variation exist but usually the time of reaction is about six minutes, This observation is of course, made by the naked eyes & followed DOI method proposed by Healey (1967). Changes are in the White background pale and in the Black background fish may be observed dark in color.

On a white back ground these melanophores are mostly found in the aggregated condition. On black back ground however, results vary from aggregation to dispersion. This range of melanophore condition may be seen on one and same specimen and is not due to individual variability of reaction. The only method that seems feaseable for starting their reaction is to say that the white back ground acts as a strong stimulus for aggregation of the fish.

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