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Observation on Chromatic/pigmentarybehaviour (colour changes) of a fresh water fish – *Ophiocephalus gachua* (Ham.)

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Abstract

Several types of chromatophores occurring in *Ophiocephalus gachua* are represented on the head & back. The scale is circular shape. Discard centre , 8-20 primary processes of moderate thickness having upto 6 branches, tips rounded or pointed with 2-3 secondry branches and process length/disc diameter ratio as 1:2. The entire melanophore population is mostly of a black colour but some appearing gray , probably those that generated a new , can also be seen frequently. The yellow pigment cells , the xanthophores are also dendrite cells and they are distributed over the same areas as the melanophores.

The presence of large members of Leucophore and melanophores also serves to mask the xanthophores were appearently always in the condition that may well be turned as the expended or the dispersed one the whiteness and iridescence of light strips may partly be due to their presence in great numbers over other areas on the body. Although to determine wheather they are motile or non motile was beyond the , however irridophores reflect white light rays by tyndall scattering.

Physiological color change is the result of dynamic pigment movement of multiple chormatophore and their interaction with each other within the dermal chromatophore unit. Regulated by hormones, neurotransmitters, and even environmental cues such as light and temperature, chromatophores undergo rapid pigment reorganization to produce a wide arry of chromatic changes. Depending on the stimulus, different chromatophore type respond with either dispersion to maximize their relative contribution to the overall colour produced, or aggregation to minimize their effect in the animal kingdom, there are few phenomena as fascinating as the ability to quickly change color and pattern, an ability that can be used to hide from a predator or communicate with a conspecific. Rapid color change on the scale of seconds to hours, termed physiological color change, is typically accomplished via mobilization of pigment or nanostructures within specialized cells called chromatophores. Although physiological color change has been observed in insects, arachnids, crustaccans and cephalopods, the structures and mechanisms of invertebrate color change are markedly different than those of vertebrates.

For the preparation of this manuseript, relevant literature[1-41] has been consulted.

Regardless of sex the fresh specimens of *Ophiocephalus gachua* (Ham.) were collected localy from fish market morar, of body length 9-12cm the fish were stock in glass aquaria to acclimatise them for laboratory conditions. The care was taken to replace tank water from time to time. The animals were fed on dry prawns at alterrate days.

Recording of melanophore responses. The physiological saline solution or ringes solution. Composition Nacl- 128mmKcl- 2.6mmCacl2- 1.8mm

For recording of melanophore responses projection microscope was utilized for recording the observations employing high power magnification. Drugs was applied on the melanophores as external solution by changing the physiological solution to various experimental fluids. Experiment using isolated scales (in vitro study):

The experiments were carried out exclusively on the scale melanophores of *Ophiocephalus gachua* of body length 9-12 cm. MI method was used to measeure melanophore responses and DOI method[30] for obserbation of colour change of the fish in different background condition's. MI index 1- punctate or aggregate, 2 punctostellate 3 stellate 4stello reticulate and 5reticulate or expended or dispersed stage.

On a black background the most promiment feature was the melanophores was found in fully expanded (reticulate condition- MI – 5) some melonophore observed in MI 4 or 3.5 also. The normal reactions of the melonophores in general are contraction or aggregation (MI 1 to 2) and expansion on a black background : in the dark there is a general tendency to expand. So on a the black background the fish become dark in colour while on a white background the fish become pale in colour due to aggregated condition of the melonophores.

When a scale is isolated it accompanies a severance of the chromatic nerve fibres; and a slow but gradual dispersion of melanosome within its melanophores become appearent. Whether this serverance of nerve fibers lead to a temporary aggregation of melanosomes before entering in to the dispersion phase due to the leakage of some transmitter from unique, as they become stellate (melanosomes dispersed in to the dendrite process of the cells) in the absence of stimuli and this dispersed state is reered in the literature as the resting (unstimulated) state of melanophores.

With the result presented here, the neural chromatic control mechanisms in the Teleost *Ophiocephalus gachua* appears to include the sympathetic pigment transmission at neuromelanophore junction is of adrenergic type.

1. Melanophores maintain the state dispersion, the resting state when they are under no stimulation being maintained in isotonic physiological saline the likely explanation for this behaviour as proposed by kumazawar *et al.*, 1984 is that in unstimulated periods, there is a spontaneous release of melanin dispersing principle (ATP) from the chromatic nerve terminals.
2. K+ ions caused melanosomes aggregation in this innerverted melanophores but they failed to do so in denervated melanophores

obtaind from a reserfinshed fish resprine is known to depleted adrenergic transmitter and thus the chromatic fibers are characterized as sympathetic pigment aggreged by fibres belonging to the adrenergic system.

3. Adrenaline, a directly acting adrenomimetic drug and norepinephrine, approved transmitter at neuromelanophore junction were very effective in inducing pigment aggregation in the melanophores.
4. While beta- adrenergic blocking agent (propranolol) failed to inhibt the aggregation caused by adrenaline and norepinephrine, alpha agent exhibited a marked inhibtary effect on the pigment aggregating action of the amines.
5. Epinephrine primarily an indirectly asking adrenomimetic agent mimics adrenaline to produce pigment aggregation in the melanophores. Like catecholamines (Adrenaline & norepinephrine) its aggregating is also produce through alpha adrenergic receptors on the melanophore membrane.
6. It was concluded that the sympathetic neuromelanophore transmission in the fish *Ophiocephalus gachua* is of adrenergic type, where melanosome aggregation receptors are characterized as α- adreno receptors. They may belong to α2 subtype but further studies are required to make such an statement. This kind of neural regulation is catagorized, as an orthodox one and is reported in majority of teleost in contrast to that where cholinergic innervations have been shown to that execute a melanosome aggregating response such as the one reported for only 3-4 species belonging to family siluridae viz- *Parasilurus asotus, and Kryptapetus bicirrhic*.

Chromatophores are colourful cells that can be classified loosely by their overall colour but are more accurately designated by ther colour-promatophores mechanisms os the types of pigments/structures that they contain. Pigmentary chromatophores impart colour by selectively absorbing particular wavelength of light, whereas structural chromatophores produse colour by reflecting and scattering particular waveclangths of light with cellular nanostructures. Among the pigmentary chromatophores that impart colour via absorption of specific wavelengths of light, there are three predominant chromatophore types found in colour-changing vertebrates: the black-broun melanophores (which containmelainin), red erythrophores, and yellow xanthophores (both of which can contain either carotenaids, pteridnes, or some Additionally, there are two structural chromatophores types that imbue organism with color via reflectance of light: the colorless iridophores and the white lights-reflecting leucophores (both containing purines). All integumentary vertebrate chromatophore types originate from the embryonic neural creast, a migratory, multipotent cell population. As chromatophores mature, they typically form functional associates with each other, termed “dermal chromatophores units’’, just below the epidermis.

Consider the fundamental unit of physiological colour change in vertabreates, the dermal chromatophore unit incorporates melanophore, erythrophores, xanthophores, and iridophores into an isolated cellular system. This functional unit is capable of producing a wide range of colors by absorbing or reflecting specific wavelength of lights. From surface of the integument to the base of the drmis the chromatophores unit consists of the dendritic processes processes of the melanophores, a

single layer of xantho- or erythophores, a layer of iridophores, and the main cell body of the body of the melanophores. It should be noted that, as conserved as this functional unit might be, the relative amounts of each chromatophore type and their relative arrangements vary from species to species and can even vary from one area to another on the same animal.

While the dermal chromatophore unit can be considered to function as a single with respect to color generation, the actual color reflected is the result of teh four individual types of chromatophores serving different roles byundergoing dynamic, cooridinated pigment reorganisation. In general, red-yellow erythrophores (or xanthophores) absorb the shorter wavelength of lights incident upon the dermal chromatophore unit, and the remaining wavelength are either reflected back by the silvery iridophores or absorbed by the brown black melanophores. it is the relative state of pigment dispersion and aggregation in each chromatophore, as well as their relative densities, that determines how much each contributes to the observed color of skin.

The melanophore/melanocyte in the skin and other body region (excluding the epidermal epithelium of the eyes) originate from the neural crest and migrate to their definitive location where melanin is synthesized. This localization of the pigment cell in response to both intrinsic and extrinsic development cues (guided by numerous mechanism of gene) to form a species specific patterns in vertibrates is amply demonstrate. In the past, numerous factors concerning the melanophores has been suggested to explain the integumentry melanophore pattern in fishes.

Melanophores may be masked partially by other chromatophores. The species specific melanophores patterns could also involve differential nervous stimulation, and a differential neuro effector system with a synergestic prolonged hormonal control. The melanophore patterns based, at least partly, on local variations in the melanophore size, type, pigment content, density and number of layer and in some cases these data supplemented by regional differences in their. Physiological responses have also been described microscopically for[1,22,30,31].

The interpretation of the data obtained pertaining to various melanophore characterstics clearly reveal that □-

- A high density of melanophore
- A less inter spacing between the melanophores.
- A high percentage of melanophores of type
- The distribution of melanophores both in the distal as well as proximal part of the scale and
- An overall high melanin content covering the entire skin in dispersed condition.
- Above are the obvious factors responsible for the overall darker upper half (dorsal side of the fish in sharp contrast to the lighter lower half ventral side) that impart a metallic shining lusture to the fish.

In this light ventral surface, melanophore density was so low that little chromatic change was appearent. When the fish was adapted to either black or white . Illuminated background. The melanophore found in other layer in the skin contributing to the general shade of the fish was beyond the scope of present dissertation.

Hereditary and environmental factors which influence any level in the structural and

functional organization of the chromatophores appear and modify the performance of the entire system. The pigment cell population (melanophores) of fishes have two distinct attributes.They are capable of aggregating or dispersing their melanin granules in response to appropriate stimuli.

They synthesize disintegrate the melanosomes when the fishes are placed for a prolonged period. Ranging from many days to many seeks on an illuminated black or white background, the colur change so caused are characterized by absolute gains and lossess in the amount of pigment within the cells accompanied usually by an increase or decrease in actual number of melanophores and such changes in colouration are known as chromogenic (quantitative = morphological) colour change.

The known agents mediate chromomolar colour change in teleosts are nerves & hormones and these same agents, therefore, would appear to be involved in the chromogenic colour change but a great diversity exists over the controls on fish melanophores. It may be-

- Entirely nervous with little participation of hormone eg., fundulus heteroclitus
- Entirely hormonal (No direct neural involvement) eg., Anguilla
- Involving both nerves & hormones in varying proportions either functioning individually or synergistically eg., phoxinus photinum. The observation of present study are in aggreement with the same[4,21].

References :

1. Ahmad, R.W., (1970) *J. Zool, 160:* 371-375.
2. Bagnara, J.T. and W.R. Ferris (1971) Biology of the normal and abnormal melanocyte, PP. 57-76. University of Tokyo Press, Tokyo
3. Beckere, C.H.R., (1965) *Zwiss. Zool. 17(2):* 37-103.
4. Dixit (shukla) A. (1980) *Proc. Golden jubilee session nat. Acad. Sci. India Allahabad;* pp. 60.
5. Dixit (shukla) A. (1981) *Proc. IInd all india symp. On experimental* zoology pp.62.
6. Dixit (shukla) A. *et al.,* (1982) *Proc. 32 session nat. Acad. Sci. India* Bhavnagar (31st oct-2nd nov).
7. Dixit (shukla) A and A.K Jain (1984) *XXXI Ann. Conf. Appi. Calicutta.*
8. Dixit (shukla) A and A.K Jain (1994) *Nat. Symp. On aquaculture for 2000 AD* Madurai, 27-28 Oct.
9. Dixit (shukla) A. (1995) *Proc. Nat. Sess. Fish bio. Shanti niketan 24:* 25 Jan.
10. Dixit (shukla) A., P.K Dubey and A.K Jain (1981) *Environment india 4:* 10-12.
11. Dixit (shukla) A. *et al*., (1982) *J. Jiwaji University 10:* (90-92).
12. Dixit (shukla) A. (1995) *Ind. J. APPL. Pure bio. 10*(1): 15-17.
13. Dixt (shukla) A. (1995) *J. Aqua. Bio. Fish 2* (1-2): 47-50.
14. Dixt (shukla) A (1995). *Ind. J. Appl. Pure bio. 10(2):* 159-162.
15. Dixit (shukla) A. (1996) *Ind. J. Appl. Pure bio. II*(I) : 19-21.
16. Dixit (shukla) A. (2000) *Ind. J. Appl. Pure bio. 15*(1): 9-11.
17. Dixit (shukla) A. (2000) *Ind. J. Appl. Pure bio. 15*(2): 147-149.
18. Dixit (shukla) A. (2000) *Ind. J. Appl. Pure bio. 15*(2): 81-82.

19. Dixit (shukla) A. (2000) *Ind. J. Appl. Pure bio. 15*(2): 135-138.
20. Dixit (shukla) A. (2002) 21st Conf. Of india council of chemistry, Jabalpur 24-26th Oct.
21. Dixit (shukla) A. (2015). *J. Sci. College Gwalior.*
22. Dubey, P.K. and A.K. Jain (1982) studies on the chromatic behaviour of a fresh-water teleost, catla catla (Ham.)-I morphological types of melanophores and their differential numerical distribution.
23. Dwivedi, D.K. (1971) studies on the rate of colour change mechanism of dark bond due to background responses and the colour pattern in the normal conditions of the teleost – *Rasbora daniconius* (Ham.) *Proc. Ind. Sci. Cong.* 59th session, part III 607 abstract only.
24. Fries, E.F.B., (1931) *J. Expt. Zool. 60*(3): 84-26.
25. Fox, D.L. the pigments of fishes
26. Fujii, R. (1969) *Chromatophores and pigment in fish physiology. 3(6)* new York- London.
27. Fujii R. (1971) The physiology of fish melanophore pp 31 41.
28. Goodrich, H.B., (1935). *Ann. Rep. Torttuges lab; Wash.* 81-82.
29. Hadley, M. E. and W. C. Quedes (1957) Adv. Bio. Skin. *8:* 337-359.
30. Healey, E.G. (1965) J. *Physiol. (london) 17* : 13-14.
31. Hewer, H.R. (1925) Studies in colour changes of fish. Pp 123-140.
32. Jain, A.K. (1971) *Proc. Ind. Sci. Cong. 59th session, part III 606* (abstract only.)
33. Jain, A.K. (1975) *Acta physiol. Pol.* 2637-359.
34. Jain A.K. (1977). Studies on the colour change mechanism in a fresh water fish university of saugar, Ph.D thesis.
35. Jain A.K and H.N. Bhargava (1977) studies on the colour change mechanism in a fresh water teleost nandus nandus (Ham.) II. Hormonal control. Neuroendocrinology (in press).
36. Ligon, R.A. and K.L. McCartiney (2015) Regulation of physiological color change in vertebrates 1-29.
37. Odiorne, J.M. (1937) *J. Exp. Zool. 7*(6): 441-465.
38. Odiorne, J.M. (1948), morphological colour change in vertibrates. In. M. G ordon (Ed) biology of melanomas. Spec. Publ. N.Y acad. Sci. 4 288-308.
39. Parker, G.H. (1948) animal colour change and their neurohumours. Cambrige university press, London – new York.
40. Sumner, F.B. (1939), *Amer. Nat. 73(1939):* 219-234.
41. Teyssier, J., S.V. Saenko, van der Marel D. and M.C. Milinkovicth (2015) *Nat. commun. 6:* 63-68.