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A Study on The Effect of Hormones in Teleost Fish Melanophores

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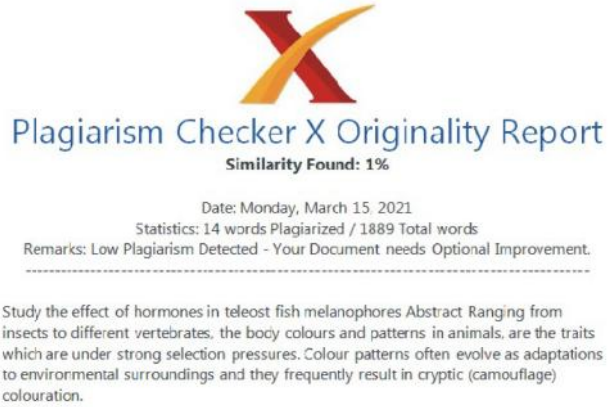
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Study the effect of hormones in teleost fish melanophores Abstract Ranging from insects to different vertebrates, the body colours and patterns in animals, are the traits which are under strong selection pressures. Colour patterns often evolve as adaptations to environmental surroundings and they frequently result in cryptic (camouflage) colouration.

Abstract

Ranging from insects to different vertebrates, the body colours and patterns in animals, are the traits which are under strong selection pressures. Colour patterns often evolve as adaptations to environmental surroundings and they frequently result in cryptic (camouflage) colouration. Conversely, under the pressure of sexual selection, they can instead lead to colourful displays i.e., the advertisement (alluring and warning) and also more diverse colouration patterns.

Many fish are capable of spectacular colour changes due to the motile activities of chromatophores controlled both by nerves and by hormones, synergistically. With the exception of some catfishes (family siluridae) melanophores with dark melanin in their melanosomes are innervated directly by adrenergic sympathetic pigment aggregating nerves.

In some teleosts (neopterygeans) it is the nerve fibres that reach the chromatophores and control the bidirectional movement of pigment granules in them. In addition hormones from hypothalamus (MCH) and from the Pars-Intermedia of the pituitary gland (MSH), can induce these pigmentary movements.

Key Words

Melanophores, Aggregation Dispersion, Agonist, Antagonist, Melatonin, MCH.

Introduction

In the 1940 s, the chromatic behaviour of the eel (that were claimed to have an adaptation time of 2 to 20 days with respect to their size of studied by different workers (cited in Fremberg, 1978) was supposed to be under hormonal

regulation of colour change dominated over the neural control and Waring (1940) even thought that in normal eels the nervous control was insignificant. In those times the so called two hormone theory was very popular which claimed the existence of a B (blackening) hormone and a W (whitening) hormone functioning antagonistically and both probably originating from the pituitary. This theory was then applied to the eel and also to amphibians and elasmobranchs (Parker, 1948) but this has later been ruled out in the two later groups. However, in some fishes it was claimed that they regulate their melanophores by dual hormonal control. Baker and Ball (1975) while working with *Poecilia latipinna* reported that the pituitary in this species permits denervated melanophores to show a more rapid and complete melanin concentration when fish are transferred from a black to a white background, favouring a role for a whitening hormone of pituitary origin. They stated that this pituitary factor that induces melanin concentration thus appears to have hormonal status & will here be refered to as the melanin concentrating hormone, MCH, while Kent (1959) and Rance and Baker (1979) reported in *Phoxinus* and trout respectively that the hormone within the pituitary is most concentrated in neurointermediate lobe, the findings Enami (1955) in the cat fish, *Parasilurus* however, were in favour of its greater concentration in the region of proximal pars distalis with its occurance also in the hypothalamus. Westerfied et al., (1980) studied gross physicochemical properties of MCH where they could suggest that it is a small positively charged polypeptide with no disulfide bonds and that it should not be confused with other melanin aggregating biogenic biologically active amines from fish brain such as dopamine, norepinephrine, epinephrine, and serotonin all of which do induce melanin aggregation in trout melanophores *in vitro* (Baker and Rance, 1979). Rance and Baker (1978) supporting the dual hormone concept suggested that the MCH is synthesized in the hypothalamus of teleosts and stored and released by the neurohypophysis. Kawauchi et al., (1983) isolated this novel peptide MCH from the pituitary of salmon (*Oncorhynchus keta*) possessing an antagonistic function to that of MSH (i.e.it aggregates the melanophores within the scale melanophores of *Tilapia*, trout, carp, black rockfish and greeling). They therefore, further substantiated the hypothesis of a dual hormonal control of colour change in fishes. In the eel, *Anguilla anguilla* Powell and Baker (1983) could show the release of MCH during adaptation to while background, to induce melanin concentration and to inhibit MSH release and that its release is hated in black -adapted fish.

In fish, the bidirectional translocations of melanosomes are fast and synchronized in melanophores and are regulated by hormones and direct innervation (Fujii, 1969; Bhargava and Hadley, 1973). The melanophores or other dendritic chromatophores do possess molecular motors that carry the cargo (the melanosomes in melanophores) along the cytoskeleton to disperse them throughout the cell or to aggregate them into the cell centre. The skin not only becomes pale but more transparent, when dark melanosomes are aggregated in the cell centre (centripetal movement) and increased body transparency can also contribute to background matching. Conversally, when melanosomes distribute themselves homogenously in the entire cytosol (centrifugal movement), in response to appropriate signals, the skin becomes dark. Fast long range and bidirectional melanosome movements are microtubule-dependant in both fish and frog melanophores (Rodinov *et al*. ,1998; Aspengren *et al*., 2006) but they are better synchronized in fish (Nilsson *et al*.,2002) and move at a faster speed (0.5 – 1.5µm/s) (Aspengren *et al*., 2009).

Parker (1948), divided animals into three groups depending on the degree to which direct innervation of chromatophores occur. Control entirely independent of neural activity (aneuronic) is found in certain forms in which the response is regulated solely by the activity of blood borne hormones. Thus elasmobranch fishes, amphibians and many reptiles among the ectotherms constitute this 1st group. The second group relates to the neopterygean teleosts where mononeuronic chromatophores are innervated by a single set of motor nerves, the excitation of which always results in aggregation of the pigment. The 3rd group of animals, according to him concerned with dineuronic chromatophores

that were supported to be innervated by separate pigment aggregating and dispersing fibres. However, the presence of dispersing fibres belonging to parasympathetic system with reference to double innervations theory' has been disproven (Fujji, 1993a; Fujii and Oshima, 1994). The co-ordinating systems for colour changes existing among the fish, thus show great diversity. In some fish, blood borne hormones are believed for the movement of pigment while in others, the pigment cells are solely regulated by nerves. Between these extrimities, there are many examples where both neural and hormonal control mechanisms are actually operational (Neil, 1940; Fujii, 1969; Abbott, 1973).

Materials and Methods

The fresh water Indian teleosts, the *Rasbora elanga* (comman name Bengala barb) of either sex were used as the experimental material. The native habitats of these fish is rivers, pools beels, streams and others. Inhibits rivers throughout Bangladesh (Rahman 1989 and 2005). Found in almost every district of Bangladesh. These are found in India, Bangladesh, Myanmar and Pakistan. Endangered in Bangladesh due to loss of habitats (IUCN-Bangladesh 2000). These fishes were originally described by Hamilton (1822). Body elongate and slender with very small mouth, Single pair of short rostral barbels and body colour is silvery. Lateral line is complete and descends gradually. Fishes are omnivorous. They can be found in large schools feeding at the surface on algae, small aquatic insects, protozoa, mud and sands (Shafi and Quddus 2001). Peoples do not like it because of its nasty habits such as feeding on sputum and living in nasty areas ,however some poor rural people take it as food. Fish were procured with the help of a local fisherman from Ram sagar reservoir situated in Datia (M.P.). The fishes were used of either sex with average weight and size. The fresh water teleost fish, the *Rasbora elanga*, with mean overall length of 5-6 cm. and a mean weight of 5 grams respectively were used in the present study. On the day of their arrival to the laboratory, fishes were treated with water containing $Kmno_4$ to prevent them from infection. They were stocked routinely in transparent glass aquaria (30x30x60 cm.) for a weak at temperature 18-30^{0}c under natural photoperiodic condition.

Results

Melatonin is also known chemically as N-acetyl 5-methoxytryptamine. It is the major secretory product of the pineal gland. Although detectable levels of melatonin have been reported in the plasma during day light, large increases in melatonin are observed during darkness (cf. Underwood 1985), creating a circadian cycle of the secretion of the hormone. Melatonin function in neuro endocrine transduction by converting endocrine signals (Axelood, 1974). Many biological effects of melatonin are produced through activation of melatonin receptors. Melatonin is produced by pinealocytes in the pineal gland, which acts as an endocrine hormone and is released into the blood. Production of melatonin by the pineal gland is under the influence of the supra chiasmatic nucleus (SCN) of the hypothalamus.Melatonin is also related to the mechanism by which some fishes, amphibians and reptiles change the colour of their skin and indeed it was in this connection the substance was first discovered. Production of melatonin by the pineal gland is inhibited light and enhanced by darkness. For this region melatonin has been called the hormone of darkness.

The freshly isolated scales were equilibrated in PS for 15 min so as to attain full dispersed state of the melanophores. The melatonin was applied to melanophores of all five fish showed weak aggregation with M.I.=3.08. When the perfusion fluid was changed to PS melanophores get redispersed fully at 15 min.

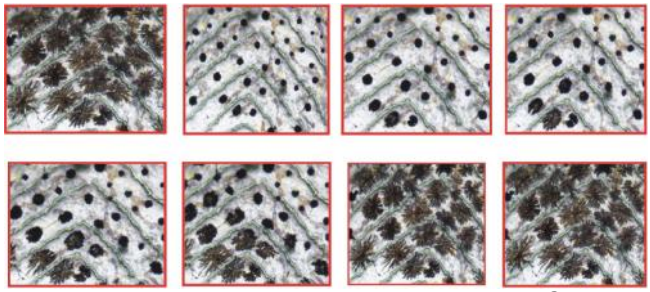

Fig: Typical serial photomicrographs showing the effect of MT (10^{-3} M)on a group of melanophores in an isolated scale preparation of the fish x100. (A)Equilibrated in PS(15 min), melanophores are completely dispersed in the cell, (B)5 min, after the application of MCH (10^{-6} M),melnophores are cmpleletly aggregated.(C) (D) (E) and (F) (G) (H) 10,30,50,70,90 and 110 min after the application of MT. Melanophores are dispersed.

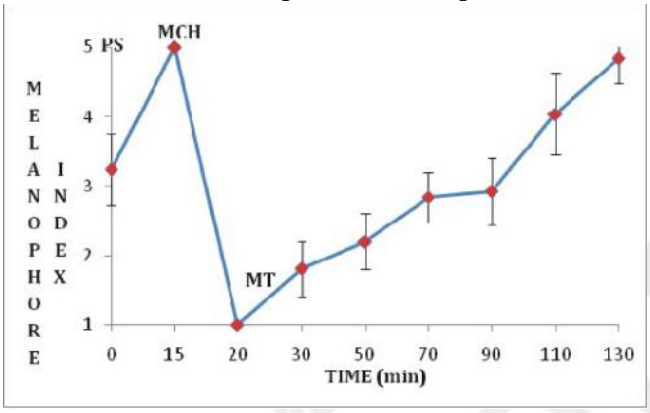

Fig: Pigment dispersing response of melanophores to Melatonin (10^{-3} M) as observed in MCH (10^{-6} M) treated melanophores of the fish. The results (data) are shown as means ± SD from five measurements on scales from five different animals.

Discussion

As early as 1924, Hogben and then in 1940, Neill could report relationship between the time and transitory colour change in animals with regard to their chromatic control mechanisms. Responses of melanophores to neural stimuli are very rapid and may be accomplished within minutes. Neill (1940) concluded that where the total time for complete colour change i.e. for the complete cycle [(a), time taken for the stimulus to act on a receptor (b), the time taken for distribution of a disturbance through the co-ordinating mechanism (c), the time taken for the effector to execute its response] is of the same order as the effector reaction time i.e.(c), then there is nothing to suggest that the co-ordinating mechanism is other than the nervous reflex. On the contrary, if however, the total time for colour change is markedly greater than the effector time, then some other co-ordinating mechanism must be involved eg. the reflex liberation of hormone and its gradual accumulation in the blood stream to a certain limiting value. Neill, on this basis could point out that where total time taken for colour change exceeds two hours hormonal co-ordination is indicated. On the otherhand a total change time of the order of 10 min. or less may be safely had consisted with predominantly nervous co-ordination, through the direct innervations of melanophores themselves within these limits, at least, the time relations of the chromatic behavior of any vertebrate animal can furnish a guide to the type of co-ordination involved, Neill further add to conclude his findings. Pigmentation is regulated by genetic environmental and neuro-endocrine factors. These control the amount, type and distribution of melanin and other pigments in the skin and eyes. Melanin has its role in photoprolection, camouflage and thermoregulation. It is an antioxidant and part of innate immune system.

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