**ABSTRACT**

In behavioral studies on animals, the colour-change physiology has its own importance. The well-defined and functional chromatophoral systems responsible for magnificent colour changes of certain species are restricted mostly among the higher animals including the cephalopods, crustaceans and the poikilothermic vertebrates. Among fishes, teleosts are the most extensively studied group with regard to pigmentary mechanisms. The extent of information in Indian species is comparatively negligible and limited to only five species including the fish under present study i.e., *Hancus hancus* (Eis). Therefore, the studies concerning colour-change mechanisms in animals have attracted the attention of naturalists since the time of Aristotle who described the changing tints of devil fishes and chameleons with remarkable accuracy. However, the most noteworthy advances in this curious and exciting behavioral discipline include the pioneer attempts of von Frisch (1910-1920), Hogben (1922-1940), Parker (1930-1948) and Waring (1936-1963) during the current century.

Within the past three decades a rapidly-growing interest in the mechanism of pigmentary adaptation has become evident from the monographs of Parker (1948), Sjönerman (1963) and Waring (1963) which provide detailed information on the subject.

The chromatic control mechanisms in teleosts are variable depending upon the species. Thus in some species the background responses are under nervous or hormonal control alone while in
others they are controlled by an interplay of both these agencies in varying proportions. Reviews by Healey (1967), Fujii (1966, 1969, 1971) and Fujii and Novales (1969) deal principally with physiological colour-change mechanisms while the literature concerning morphological (quantitative) colour changes has been reviewed by Udomne (1957) and Fujii (1969).

The role of hormones secreted by the pituitary gland (pars intermedia) in controlling colour changes is well established. The findings in this direction are critically discussed in reviews by Ricaurte and Alt (1957), Hall and baker (1969) and Abbott (1973).

Two hypotheses have been put forth in relation to innervation of melanophores. According to one, the control of melanophores is diencephalic i.e., each melanophore is connected with a pigment-aggregating as well as pigment-dispersing nerve fibre (Parker, 1948). The second hypothesis states mono-neuronic innervation of melanophores by means of only pigment-aggregating nerve fibre (Hogben, 1944; Waring, 1963). The findings in this respect are differently interpreted by means of many experimental approaches such as spinal section by means of which the path of chromatic fibres was transected or by introducing various pharmacological agents and thus determining the nature of chromatic nerve fibres. Such studies are of recent origin and reviewed by alikawa and Novales (1968), Fujii (1969), Eed et al. (1973b) and Eed and Finnin (1976).
Keeping in view the above aspects into consideration, an attempt has been made to investigate the colour change physiology in the perchid fish, *Aeglea hancocki* (hence) with the main emphasis on its chromatic control mechanism in order to add more to the present state of knowledge and fill up the lacuna in the field of study.

Recently some work has been done in India on animal behaviour, specially in respect of colour-change mechanism. In crustaceans the colour responses were described by Madhyastha and Gangadhar (1965), Haridasan et al. (1966), and Vasanthan et al. (1969, 1971) and Vasanthan (1970). A little is known about the pharmacology of amphibian melanophores (Shide and Gupta, 1965; Gupta and Shide, 1967). A single report on reptilian colour-change mechanism has been published by Panadalai et al. (1967) on *Calotes*. Similarly the information regarding the colour responses shown by teleostean species is limited to only four species. In two silurid fishes, *Apteronotus barbouri* and *Jacopephorus fossalis*, it has been studied by John and Alexander (1971). In *Lepisosteus platinocephalus* the rate of colour-change mechanism has been studied by Bhargava and Dwivedi (1970). In another freshwater cyprinid, *Rasbora daniconius* a systematic study covering various aspects of colour-change mechanism has been carried out by Dwivedi (1976).

The present study on the problem entitled ‘Studies on the colour-change mechanism in a fresh-water fish’, has been divided into four parts, I - normal colour pattern, II - quantitative
colour-change mechanism, III - transitory colour-change mechanism and IV - pharmacological colour-change mechanism.

A thorough attempt has been made to determine the disposition of the chromatophores responsible for the colour pattern of the fresh-water fish, *Hemibarbus manduca* under normal background conditions (i.e., the existence of dark vertical bands against dull shade of the general body surface and the darker shade of upper half of the fish against the shining silvery lustre of the lower half of the fish). The study involves the statistical assessment of chromatophores in 10 different sites of the fish chosen arbitrarily (pages 7 to 33).

The present investigation includes the study of rate (\%) of decrease or increase in the number of melanophores from various sites of the fish, placed on illuminated normal, black and white backgrounds for 75 days. The rate of recovery of the degenerated melanophores from the fish of 'white history' and rate of degeneration of melanophores from the fish of 'black history' has also been studied. By analysing these results an attempt has been made to know the nature of control of colour-change mechanism in the fish, *Hemibarbus manduca* (dam.), besides knowing the factors promoting the increase in the melanophore number (pages 34 to 63).

An attempt has been made to locate the cells and their cellular changes in the *pars intermediata*, if any, after long-term normal, black and white background adaptations. This was
intended to correlate the cellular changes with the background adaptation in order to understand the nature of hormone (aggregating/dispersing) implicated in the normal physiological colour-change mechanism of the fish (pages 64 to 78).

A detailed account on the methods adopted in the present study along with all other methods devised to date has been given and the advantages and criticisms of the methods employed in the chromatic study of the fish, *Lepidodesmous* are also discussed (pages 79 to 94).

The study of rate of colour-change mechanism separately in the two regions, the general body surface (GAS) and the vertical bands, as a result of background response has been made. The differences in respect of rate of colour-change mechanism between the band and the GAS have been explained in the light of comparative analysis of morphological and quantitative variations in the melanophores present therein. The results from this study are helpful to some extent in knowing the nature of control of colour-change mechanism (pages 95 to 109).

The existence, nature and role of possible hormone(s) from the pituitary gland influencing the physiological colour change of the fish has been determined by injecting the pituitary extracts into the fish (i.e., in vivo) and by treating the melanophores on an isolated scale (i.e., in vitro) with the pituitary extract (pages 110 to 132).
An experimental study by way of spinal section of the fish has been made to determine the existence and nature of chromatic nerve fibres and the vertebral level of their exit from the spinal cord. The chromatic (anterior) spinal-sectioned fishes were treated with adrenaline to determine the nature of chromatic fibres. Further, the presence of paling hormone (MAH/MCH), the only hormone participating in the colour change physiology of the fish, has been demonstrated by studying the response of spinal sectionised fishes to different backgrounds (pages 139 to 156).

The action of various pharmacological drugs (sympathomimetic, sympatholytic, parasympathomimetic, parasympatholytic and miscellaneous), known to affect the mammalian autonomic nervous system, were used to study the colour-change mechanism of the fish both in vivo and in vitro. An attempt is made, with the help of the results, to interpret the nature of nerve fibres innervating the melanophores (i.e., whether sympathetic/parasympathetic, aggregating/dispersing and adrenergic/cholinergic). In addition the sites of action of drugs and the nature of melanophore receptors involved in the neural control of colour-change mechanism have been discussed (pages 157 to 215).