SUMMARY

1. In *Rasbora daniconius* (Fam.) the morphological colour pattern of the normal fish is studied.

(a) The dorsal half of the fish, termed here as the 'General Body Surface' is brown in colour due to a high percentage of micromelanophores of small size, wide inter-spacing in between the epidermal melanophores, sparse distribution of negligible number of dermal melanophores and heavy population of the xanthophores throughout this region.

(b) The band stretching throughout the mid-lateral line of the fish appears 'darker' on account of large percentage of the macromelanophores, greater dispersion capacity and dense arrangement of the epidermal and dermal melanophores having high content of the black melanin-granules, reduced number of the xanthophores in the epidermis and their complete absence in the dermis of this region.

(c) The lustrous silver shining of the ventral half of the body, termed here as the 'silver zone' is accounted for by the complete absence of the melanophores throughout this region, reduction in the number of xanthophores, high accumulation of the guanophores and fairly large number of the iridophores in this region.

(d) Five morphological types of melanophores are recognised and classified as the melanophores 'A', 'B', 'C' - all macromelanophores with profuse branching and prominent centre,
and the melanophores 'D' and 'E' - both being micromelanophores, with an indistinguishable centre and a poor-branching which never fuse.

(e) As regards the differential distribution of these five types of melanophores in a scale of the GRS and that of the band regions, the dorsal epidermal covering of the scale in these two regions includes only the micromelanophores i.e., the types 'D' and 'E' only, whereas the ventral epidermal covering of the scale contains the melanophores of all the five types.

(f) The pigmented area belonging to the ventral epidermal covering of the scales of the GRS is always in the form of a narrow and curved strip along the posterior border of the scale while in the scale of the band region it is triangular in outline. The melanophores of the type 'A' are always present towards the anterior side, the types 'B' and 'C' are distributed throughout the pigmented area and the types 'D' and 'E' tend to lie towards the posterior border of the ventral epidermal covering of the scale in the GRS and the band regions.

2. (a) The observations regarding the quantitative changes in the number of the melanophores as a result of prolonged background adaptation to a normal, black and white backgrounds appear to support the presence of a melanophore-aggregating hormone concerned in the hormonal control of the colour change mechanism in this fish. The white background stimulus works as a favourable factor for the release of the aggregating
hormone which at first aggregates the melanophores, then retards the formation of melanophores, and this ultimately favours a loss in the number of melanophores when maintained as such for a long period of 90 days. A decrease in the total number of melanophores is, therefore, observed in such fishes having white background adaptation of 90 days. On the other hand, the black background stimulus acts against any further release of the melanophore-aggregating hormone thus dispersing the melanophores to their maximal stage in the beginning and making the fish completely dark. When continuously maintained for a long period of 90 days, such a condition starts to function as a favourable factor for the formation of melanin and new melanophores resulting ultimately into an increase in the total number of the melanophores. If any active dispersing mechanism (hormonal or neural or both) for the control of melanophores were also operating in this fish, the average % loss in the number of melanophores on white background would have been approximately equal to the average % increase in the number of melanophores on black background. Contrary to this, the observations show that the former value is nearly double than the latter. The observations pertaining to the reversal of the backgrounds after 90 days from black to white and vice-versa also support this finding because the average % loss of the melanophores on white background is more than 1.5 times greater than the average % increase of the number of melanophores on black background within a period of 30 days. The decrease in the number of melanophores as a result of long-term adaptation
on a normal background is attributed to the lack of a true white background stimulus and the absence of a true black background stimulus thus presenting a middle-stage condition which neither completely favours nor completely stops the release of the melanophore aggregating hormone. In this way, a small quantity of aggregating hormone is released as a normal metabolic phenomenon, thus causing aggregation to some extent and also a slight loss in the number of melanophores.

(b) The degranulation, vacuole-like structures and ultimately degeneration of the cells is observed in the pars intermedia cells of the fishes which were kept on the illuminated white background for a period of 72 days. These cellular changes in the pars intermedia suggest that this long-term background stimulus has been working as a favourable factor for the release of the aggregating hormone. On the contrary, the black background stimulus seems to function against the secretion of the aggregating hormone and thus no change is observed in the pars intermedia cells of the fishes which were kept on the illuminated black background for 72 days. The pars intermedia cells also show no change in their cellular condition in the fishes which were maintained on the illuminated normal background. It appears that normal background stimulus causes the release of the aggregating hormone at a normal metabolic rate (and not at an increased rate as seen in case of fishes placed on white background) so that the pars intermedia cells remain unchanged and no indications of hyperactivity and degeneration are noticed in such fishes. Thus, the presence of a melanophore aggregating
hormone implicated in the hormonal control of colour change mechanism in this fish is further supported.

3. (a) In Rasbora daniconius (Ham.) the GRS region develops the average maximum pallor i.e., 0.5 of 'Derived Ostwald Index' (D.O.I.) within 48 hrs. and attains the average maximum darkening i.e., 6.5 of D.O.I. within 5 hrs. On the other hand the band region of the fish attains the average maximum pallor i.e., 1.30 of D.O.I. within 12 hrs. and acquires the average maximum darkening i.e., 7.62 of D.O.I. within 24 hrs. It is seen that the GRS region shows a greater paling at a faster rate than that of the band region. This difference seems due to the overall small size of the melanophores, presence of brown melanin granules in the melanophores, greater percentage of micromelanophores, presence of a negligible number of small dermal melanophores and presence of a high and dense xanthophore population in the GRS region. Besides the reciprocal effects of these features, the greater darkening at a faster rate in the band region than that of the GRS region can be attributed to the high percentage of the macromelanophores, greater density of the melanophores, high content of black melanin granules in the melanophores and a small number of the xanthophores in this region. When considered for the entire fish, the rate of paling is faster than the rate of darkening. This fact points out that the process of paling is under active nervous control at least in its initial stages while the hormonal control seems to supplement in later stages of this process.
(b) The observations that the completely black-adapted fishes become pale on a black background on injecting the pituitary-extract from a completely white-adapted fish, that the blinded fish showing maximum darkening turn pale on injecting the pituitary-extract from a normal fish, and, that the fish having a black background adaptation of 7 days change their shade of maximum darkening to a pale stage on even black background after the injection of pituitary extract from the fish also having a white background adaptation of 7 days reveal the presence of a melanophore stimulating hormone of an aggregating tendency within the pituitary gland. The aggregation of the melanophores in the isolated scales to a maximum from the stage of maximum dispersion on pouring the normal pituitary-extract upon them also supports the presence of a pituitary-borne hormone of an aggregating nature only (and the absence of a dispersing-hormonal-mechanism) and constituting the hormonal control of colour change process in this fish. The absence of any dispersing effect of this hormonal principle is further shown by the facts that no darkening is caused in the completely white-adapted fish placed on white background and injected with the pituitary-extract from a completely black-adapted fish, nor any darkening is seen in the fish of white background adaptation of 7 days on injecting the pituitary-extract from the fish having a black background adaptation of 7 days.

(c) The fish becomes completely dark immediately after transecting the spinal cord anywhere between 1st—15th
vertebra and this clearly shows the presence of chromatic nerve fibres within the spinal cord of this fish. Since no change in the shade occurs on spinalectomising the fish anywhere after 15th to the last vertebra confirms that these chromatic nerve fibres come out of the spinal cord at about the level of 15th vertebra. The maximum darkening resulted due to spinalectomy (anywhere between 1st to 15th vertebra) points out that the course of these nerve fibres through the spinal cord has become interrupted making the melanophores free from any nervous control so that they come to resting stage of full dispersion and turn the fish completely dark. Thus, the aggregating nature of these nerve fibres innervating the melanophores is clearly demonstrated. The adrenergic nature of these aggregating nerve fibres is further supported by the maximum pallor which a spinalectomised fish (showing maximum darkening) attains within 10 minutes on injecting the adrenalin. Since the nervous mechanism is completely made out of action due to spinalectomy leaving the hormonal agencies to remain functional, the maximum pallor obtained by the spinalectomised fish on placing it on an illumin-ated white background again shows the presence of a paling hormone constituting the hormonal control of mechanism of the colour change behaviour in this fish.

4. The complete paling obtained on injecting the adrenergic i.e., the sympathomimetic drugs (like adrenalin, etc.) and the complete darkening shown on injecting the adrenergic blocking i.e., the sympatholytic drugs (like tolazoline hydrochloride etc. confirms the presence of only an aggregating nervous mechanism
through the adrenergic nerve fibres controlling the process of colour change in this fish. The cholinergic i.e., parasympathomimetic drugs (like acetylcholine, etc.) caused an uneven darkening and proved to be toxic to the fish. Since these blocking drugs are known to check the functioning of the corresponding nervous component (vis. cholinergic or adrenergic, as the case may be), the cholinergic-blocking agent would have produced palings of the fish by blocking the cholinergic dispersing mechanism in a way similar to the darkening observed on injecting the adrenergic blocking i.e., the parasympatholytic drugs (such as atropine) resulted into the darkening instead of palings of the fish. This fact again confirms the total absence of the colour change mechanism in this fish.