CONCLUSIONS

The following conclusions can be drawn from this study on the interrenal and chromaffin tissues of freshwater fishes examined in the present investigations.

(1). Morphological differences in the ultrastructure of the interrenal and chromaffin tissues as well as differences in their distributional pattern are discernible in the carp and catfish fish species studied. While two types of interrenal cells- the light and dark cells and two types of chromaffin cells- the adrenaline cells and the noradrenaline cells occur in the carp *C. auratus*, only one type of interrenal cells - the light cells is found in the case of catfish. However, both types of chromaffin cells are seen in *H. fossilis*. A much closer and interdigitating nature of interrenal and chromaffin cell interaction implying paracrine nature of interaction is observed in *H. fossilis* as compared to *C. auratus*.

(2). As far as the distributional arrangement of the two tissues are concerned, the carps show a closer association of the interrenal and chromaffin tissues with the post cardinal veins and their tributaries. On the other hand in the catfishes, a rather diffuse arrangement of the two tissues are seen occupying positions in close vicinity of the veins and also dispersed in the haematopoietic tissues.

(3). Lack of a definite pattern of distribution of the adrenal tissues in the catfishes is comparable to holostean features than to carp features.

(4). Sparse innervation of the chromaffin tissues in the catfish, as opposed to carps appears to be a primitive feature.
(5). Presence of a separate head kidney in the catfish, not observed and reported in the carp, is of significance from an evolutionary point of view as it places the catfish group on a evolutionary dichotomy - a line that diverged from the teleosts towards the evolution of a discrete adrenal gland in tetrapods.

(6). Morphometric measurement of interrenal cells indicated interrenal hypertrophy as the first stress response following exposure to moderate hypoxia, which was seen only in the goldfish, after 12 hr exposure. In *H. fossilis* and *C. carpio*, significant (p<0.05) interrenal hypertrophy was noticed only after exposure to 5 hr of acute hypoxia. Exposure to 12 hr of acute hypoxia elicited degenerative changes in the interrenal cells of goldfish, as observed under EM whereas in *H. fossilis*, the ultrastructural changes were not so severe.

(7). While prolonged exposure to moderate hypoxia did not appear to be stressful to *Cyprinus carpio* and *Heteropneustes fossilis*, it elicited stress responses in *Carassius auratus*. Acute hypoxia, however, was found to be stressful to all the three species examined.

(8). Both the two carps and one catfish species examined are found to be resistant to hypoxia, though in varying degrees. Adaptive response involving interrenal activation sets in early in goldfish than in the common carp, which appears more tolerant of the two.

(9). With regard to stress responses to hypoxia, differences in the carps and catfish are attributable more to their habit or their biological requirements rather than to the characteristics of the groups to which these species belong. Avoidance/tolerance
(10). It is proposed that aquatic hypoxia acts as a stressor to fish causing an impairment of the enzyme, 17α-hydroxylase leading to interrenal hypertrophy.

(11). It is suggested that for the purpose of Environment Impact Assessment, *C. auratus*, *C. carpio* and *H. fossilis* may be used as biomarkers, indicative of low, moderate and acute hypoxia levels arising due to pollution in fish culture ponds.