

Study of Distribution of Interrenal and chromaffin cells in teleost of *Barbus pulchellus*

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Abstract: *The studies on the interrenal glands and chromaffin cells in Indian teleosts are limited to a few species. The interrenal gland in some cyprinids was referred, while experimenting with zinc compounds on hypothalamo-hypophysial interrenal axis by Roy (1964). The structure and distribution of the interrenal gland and chromaffin cells in 12 species of teleosts representing 9 families has been reported by Banerji (1973). Hooli and Nadkani (1971, 72, 74a, b and 1975) have described the distribution of interrenal gland and chromaffin cells in twenty-one species belonging to thirteen families of teleosts. Later studies on the histology and histochemistry of interrenal gland in a few teleosts have been reported (Bhujale and Nadkarni, 1973; Singh et.al. 1974; Hooli and Nadkarni, 1976, 77; Shanbhag and Nadkarni, 1977; Agarwal and John, 1977; Padney and Haider, 1982). Considering the large number of teleosts so far carried out on the interrenal gland and chromaffin cells is limited to a very small number of teleosts. Therefore it was thought worthwhile to examine one more teleost found in Indian waters to investigate the degree of variability of the interrenal structure.*

Key Words: *Interrenal glands, chromaffin cells, teleosts and *Barbus pulchellus*.*

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I. INTRODUCTION

Giacomini in 1902 first described the interrenal gland of teleosts and laid the foundation on the anatomy and histology of the interrenal glands in teleosts by his numerous papers and articles. The interrenal gland in teleosts is located in the head kidney in a diffused form, associated with the postcardinal vein or its tributaries (Chester Jones., 1957)

To in search view of the mammalian adrenocortical homologue in teleosts the first reference to the interrenal (adrenal) gland in teleosts was quoted by Rathke, who presumed that the head kidney in Cyprinids was the mammalian adrenocortical homologue (Chester Jones., 1951). This was further confirmed by Stannius (1954) that the head kidney in cyprinids was of the mammalian adrenocortical homologue. The epithelial structures found in the lymphoidal mass of the head kidney were considered as the teleostean adrenal gland by Weldon (1884, 1885) and if was put forth that the lymphoidal mass of head kidney in teleosts as is the adrenocortical homologue by Groszlik (1885, 1886) by considering the epithelial structures in the head kidney as were considered the remnant of the pronephros, which lacked in the adult. However Weldon and Groszlik's view found less acceptance mainly because of the epithelial structures referred to by Weldon (1884) represent the pronephric tubules and lymphoidal tissue referred to as the interrenal tissue by Groszlik (1885, 86) is the real lymphoidal tissue of the head kidney of teleosts.

Vascularised epithelial structure in the head kidney of teleosts was detected by Giacomini (1902) which resembled the structure of corpuscles of Stannius (1839) and Diamare (1896). In 1908 Giacomini further found glandular tubules along the anterior part of the posterior cardinal veins and the posterior part of the anterior cardinal veins in adult *Anguilla anguilla*. Histologically similarities of anterior and posterior systems and the corpuscles of Stannius made Giacomini to consider them as one system and call it as "Systema interrenale". He also recognized it as homologous with the interrenal organs of elasmobranchs and therefore the two parts of this system were called "interrenal anterior" which was found in the head kidney and the "interrenal posterior", the corpuscles of Stannius, found in the posterior region. Both anterior and posterior structures were regarded as one interrenal system was continued to be regarded by Giacomini (1910q, 1911q, b). He also investigated (1912) the development of these two tissues in Salmonids and found that the corpuscles of Stannius originated as evaginations of the pronephric ducts and the anterior interrenal developed from the coelomic epithelium on either side of the dorsal mesentery. So he concluded that the anterior interrenal in teleosts is a true homologue of the adrenal cortex of other vertebrates and that the corpuscles of Stannius were the organs known only from the teleosts (1920, 21, 22). His views were further confirmed by Vincent and Curtis (1927) and Garret (1942).

Vincent and Curtis (1927) have concluded that the “anterior interrena” of Giacomini is the true homologue of the adrenal cortex and that the corpuscles of Stannius had no relationship whatever to the anterior interrenal.] Giacomini(1902) for the first time in teleosts has described medullary homologues and called them “Sostanza midollare”. These cells had swollen nuclei and they were chromaffin positive. It was also reported that the chromaffin cell groups are found around the anterior parts of the posterior cardinal veins in *Ameiurus cotus* Giacomini (1905). Giacomini (1908,1907,1910,1911a) has referred to the chromaffin cells as “Sostanza feachromo” or “tessuto chromaffine”. Based on embryology and histology the above said studies have cleared the doubts with regards to the mammalian adrenocortical homologue, the interrenal tissue and the adrenomedullary homologue, the chromaffin cells in teleosts. To show that the interrenal gland of teleosts is the adrenocortical homologue of mammals evidences have been brought by ultra structural, histochemical, biochemical and other experimental studies. The ultra structural studies of the interrenal gland of teleosts with that of mammalian adrenocortical tissue (Ogawa,1967) histochemical demonstration of lipids, ascorbic acid, hydroxysteroid dehydrogenases in the interrenal tissue of teleosts similar to those of mammalian adrenocortical tissue (Founataine and Hatey; 1954) Pickford and Atz,1957; Spalding and Chester Jones, 1957; Krauter,1958; Chieffi and Botte, 1963, Chavin 1966; Bara, 1968,1972; Hooli and Nadkarni, 1974,1975); biochemical identification and production of corticosteroids in the teleostean interrenals (Idler and Truscott;1972; Butler, 1973; Chester Jones et.al 1969), the existence of pituitary –interrenal axis (Ball and Olivereau,1966; Fagerlund et.al 1968; Ball 1982; Chester jones ,1987) maintainance of water and electrolyte homeostasis by the teleostean interrenal (Chan. Et.al.,1967) and the response of interrenals to various stress factors (Mohan et.al,1962) have pointed out that the interrenal gland of teleosts is homologous to the mammalian adrenal cortex. The distribution of interrenal tissue and chromaffin were studied by Baekar (1928). It was found that the interrenal gland was confined to the head kidney. In these species either as small cell groups or as isolated cells and the chromaffin tissues was present and scattered in the interrenal tissue or situated near the vein lumen and sometimes even in the vein wall. The presence of chromaffin cells in the anterior parts of the kidney was also shown by Giardino(1955,56). The distribution of chromaffin cells in five species of teleosts was described by Krauter (1951,58) and Oguri (1960) has described the structure and distribution of interrenal tissues and chromaffin cells in a few species of teleosts from Japan. Van Overbecke (1960) and Nandi (1962) have done important morphological studies on the interrenal gland and chromaffin cells. The detailed structure, distribution of interrenal glands and chromaffin cells in 18 species from 12 families of teleosts was given by Van Overbecke (1960). Nandi (1962) has given an exhaustive account of the structure and distribution of the interrenal gland and chromaffin cells in 129 species representing 55 families of teleosts. He has also classified the interrenal tissues into four categories and chromaffin cells into five categories based on their location and morphology. The histology and histochemistry of the interrenal gland and chromaffin cells in a few species of teleosts are described by Chawin (1956,66) and Oguri (1973).

II. MATERIALS AND METHODS

In the present investigation *Barbus pulchellus* commonly called Hargi was collected from Yallammawadi tank of Athani, District Belgaum Karnataka State. The collected fish were reared in the department of Zoology, SSMS college of Athani. The fishes were identified with the help of the keys given by Day (1958).

Order : **Teleosti**
Family : **Cyprininae**
Type : ***Barbus pulchellus***

The specimens were killed by decapitation and the kidneys were exposed as rapidly as possible. The head kidneys containing the interrenal gland were dissected out and fixed in Bouin’s fluid for 20-40 hours and then washed in distilled water, upgraded in alcohol series up to 70% alcohol before being embedded in paraffin. The tissues after storage in 70% alcohol were placed in two changes of 90% and 100% alcohols and then cleared in benzene and embedded in paraffin. The embedded tissue was sectioned at 5 to 6 μ thick sections were obtained. Representative sections from different regions of the head kidney were prepared. The sections were stained with haematoxylin-eosin (H.E.) following the histological procedure. The chromaffin cells were identified mainly based on their location and eosinophilic reaction. Specific chromaffin reaction was not carried out to identify the chromaffin cells. In the present study the structure and distribution of the interrenal tissue and chromaffin cells is studied in one species of teleost belonging to family pulchellus. The interrenal tissue and chromaffin cells are classified according to the classification of Nandi (1962). Therefore, a brief account of the classification of the interrenal tissue and chromaffin cells (Nandi, 1962).

CLASSIFICATION OF INTERRENAL TISSUE ACCORDING TO NANDI (1962)

Type I: Interrenal tissue surrounds the post cardinal vein or their largest branches.

Type II: Interrenal tissue surrounds small or medium sized branches of veins and therefore is rather widely dispersed through the anterior part of the kidney.

Type III: Interrenal tissue is associated with various Sinuses within the anterior kidney tissue. It often forms strands or cords of cells, some time scattered through the haemopoietic tissue and some time appearing to replace large areas of the latter. Interrenal cells do not surround the vein.

Type IV: Interrenal tissue forms a solid mass of cells in localized areas.

Type V: Interrenal tissue surrounds small or medium sized branches of veins; it is distributed throughout the haemopoietic tissue. In addition to these Nandi has proposed intermediate form such as I and II in which interrenal tissue surrounds post cardinal vein and their largest branches and also the medium sized or small veins.

CLASSIFICATION OF CHROMAFFIN TISSUES (NANDI, 1962)

Type I: Chromaffin cells are embedded in the vein walls; none occurs in the region where interrenal tissues are situated.

Type II: Chromaffin cells are embedded in the vein walls and occur in the area containing interrenal cells as well as other regions of the anterior kidney.

Type III: Chromaffin cells are embedded in the vein walls but only in the region where interrenal cells are situated.

Type IV: Chromaffin cells are embedded in the vein walls and are also interspersed among interrenal cells.

Type V: Chromaffin cells are found only interspersed among interrenal cells.

Type VI: Chromaffin cells are embedded in the vein walls in the absence of interrenal tissues. They find their place in between the regions of interrenal cells.

III. OBSERVATION OF RESULTS

Apart *Barbus pulchellus* from the interrenal tissue and chromaffin cells the head kidney of *Barbus pulchellus* consists of haemopoietic tissues. Each interrenal cell has a nucleus. These belong to type III of the classification. The chromaffin cells are round in shape and occur in groups or singly in the post cardinal vein – wall where the interrenal tissue does not occur.

The head kidney of *Barbus Pulchellus* consists of haemopoietic tissue, interrenal tissue and chromaffin cells. Around the small branches of the post cardinal vein associated with various sinuses and haemopoietic tissue the interrenal gland occurs. The interrenal gland occurs. The interrenal cells are cuboidal type, each with a centrally located nucleus and nucleoli are not distinct. The tissue is belonging to type III described earlier that is sometimes the interrenal cells are associated with various sinuses within the anterior kidney it often forms strands or cords of cells sometime scattered through the haemopoietic tissue and sometimes present in large areas of the haemopoietic tissue. Chromaffin cells are found singly or in groups interspersed among interrenal cells and belonging to type V. chromaffin cells are oval round with translucent cytoplasm.

Fig: 1. Cross section of Head Kidney Haemopoietic Tissue of hemophytic tissue of *Barbus Pulchellus* (10 X100). H – Hemophytic cells.

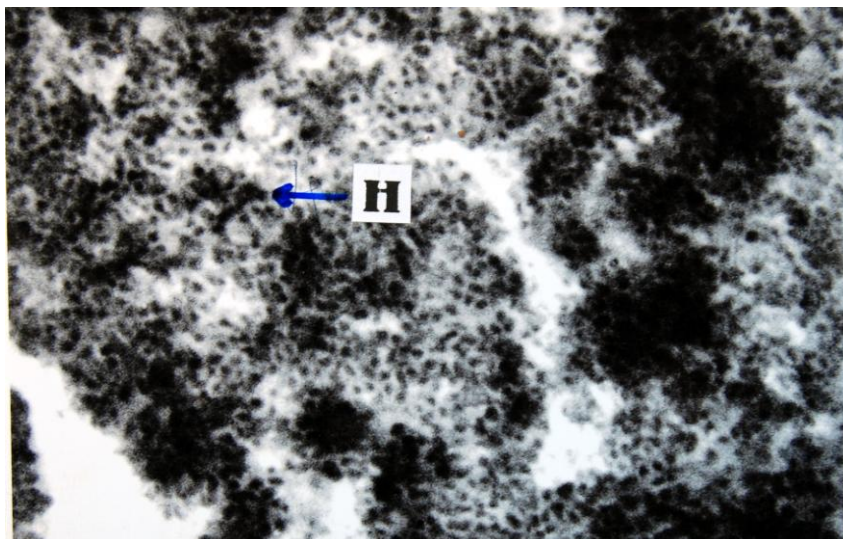


Fig: 2. Cross section of head kidney of *Barbus Pulchellus* (10 x 100)
I–Interrenal cells. C–Cromaffin cells.

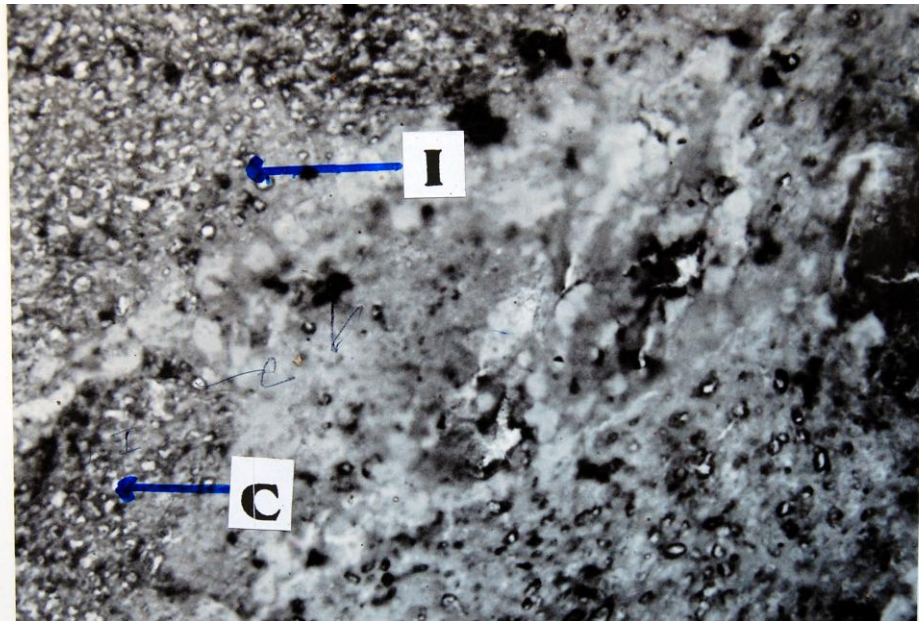


Fig: 3. Cross section of inter renal cells of kidney of *Barbus pulchellus* (10 x 100) I–Interrenal cells.

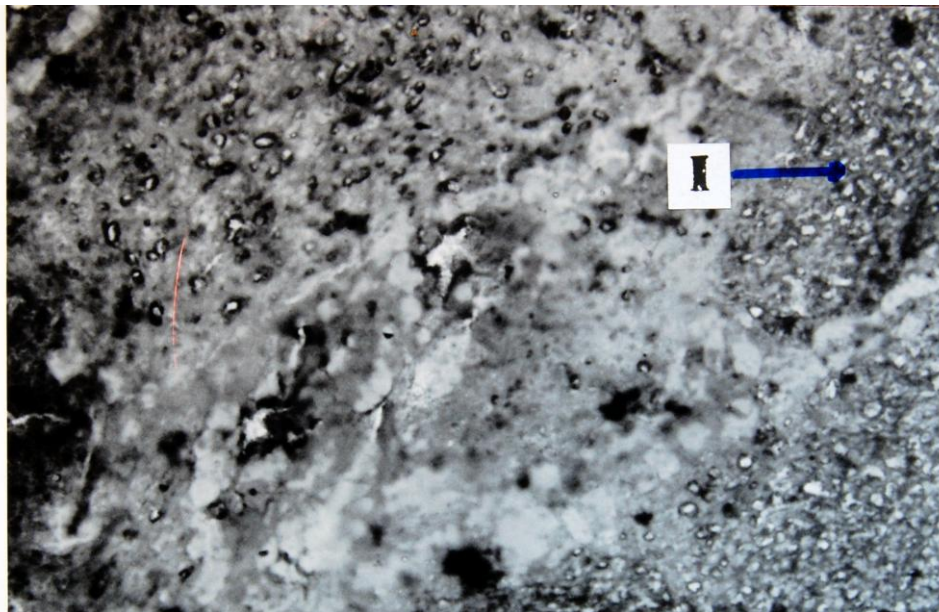
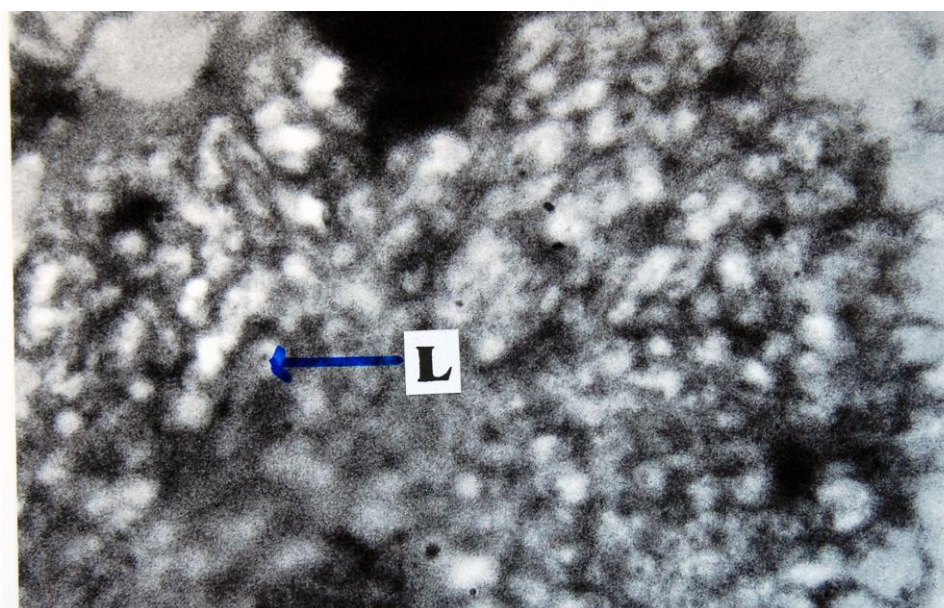


Fig: 4. Cross section of lobules of kidney of *Barbus pulchellus*
L – Lobules (10 x 100)



IV. DISCUSSION

The cells that are considered to be homologous with the adrenocortical cells and the chromaffin cells considered to be homologous with the adreno-medullary cells of higher vertebrates are referred as interrenal gland or tissue (Nandi,1962). These two components in teleosts are usually found in association with post-cardinal veins in the head kidney and are intimately associated with each other. In a single gland as found in tetrapods the interrenal and chromaffin cells are not localized. Haemopoietic tissue, pigment cells and sometimes renal tubules in addition to interrenal and chromaffin tissues are the components of the head kidney. The renal tubules are of mesonephric origin as the embryonic pronephros degenerates in teleosts.

Depending upon its location in the head kidney the interrenal gland of teleosts was classified into four categories by Nandi in 1962. According to this classification the interrenal glands of *S.vermiculatus* is intermediate between I and II type as the interrenal gland is found around the major and minor branches of the post cardinal veins. The interrenal gland types described in the present study are similar to the corresponding types described by previous workers.(Nandi,1962; Bhujale and Nadkarni,1973;Singh *et.al.*1974; Hooli and Nadkarni,1976, 77; Shanbhag and Nadkarni,1977; Agarwal and John, 1977; Padney and Haider,1982)

Depending upon the distribution the chromaffin cells were classified by Nandi (1962) into five categories. According to the classification, the chromaffin cells of *G.filamentosus* and *P.insidator* belong to the I type as these cells occur in the vein walls and none occurred in the region where the interrenal tissue are situated. The chromaffin cells of *P.niger*, *L.lactarius* *S.vermiculatus* belonged to the III type III, as these chromaffin cells occur in the vein walls where the interrenal gland is present. The chromaffin cell types described in the present study, as in case of interrenal gland, are also similar to the corresponding chromaffin cell types described by previous authors. (Nandi, 1962; Bhujale and Nadkarni,1973;Singh *et.al.*1974; Hooli and Nadkarni,1976,77;Shanbhag and Nadkarni,1977; Agarwal and John, 1977; Padney and Haider,1982). The interrenal gland described in the present study belongs to type III as per the classification done by Nandi in 1962. The chromaffin cells described in the present study belong to type V as per the classification of Nandi (1962).

Considering the work of the previous workers Nandi,1962; Bhujale and Nadkarni,1973;Singh *et.al.*1974; Hooli and Nadkarni,1976,77;Shanbhag and Nadkarni,1977; Agarwal and John, 1977; Padney and Haider,1982) and the results of the present study it can be suggested that there is considerable variation in the distribution of the interrenal gland and chromaffin cells in teleosts. Nandi (1962), considering the morphological variation in the distribution of interrenal gland and chromaffin cells in teleosts has come to the conclusion that the types described for these glands, based on their distribution, are artificial as the physiological activation or inactivation can change the micro anatomic arrangements of the interrenal gland (Robertson and Wexler, 1959,1960). Sometimes closely related species show considerable differences in their interrenal histology.

(Nandi 1965, cited by Banerji,1973). No phylogenetic trend exists in the interrenal gland of teleosts was concluded by Nandi (1962). Similar conclusion was also reached by Banerji (1973).

In view of their separate embryological origin it is curious to know the common anatomic location of the interrenal and chromaffin tissues. These tissues are associated with one another only in higher vertebrates and are separated in elasmobranchus.(Charles Jones,1957). Variation in the degree of association of the interrenal and chromaffin tissues has reported in a number of teleosts. (Giacomini;1908 ,1909; Baecker, 1928, Van Overbeeke,1960, Oguri 1960, Nandi,1962,Banerji,1973; Hooli and Nadkarni,1971-74; Shanbhag and Nadkarni, 1977). The interrenal tissue of *G.filamentosus* and *P.insidator* is separated from the chromaffin tissues as reported in a few species of teleosts (Nandi ,1962, Banerji,1973, Hooli and Nadkarni, 1971-74).According to Nandi (1962) the separation of the two tissues results from change in the position of interrenals while chromaffin cells generally retain the primitive anatomic location , the vein walls. The chromaffin cells in the remaining three species occur in the vein walls or by the side of vein wall where the interrenal tissue is present. However these results show that the two tissues are closely associated with each other , if not so close as those of adrenal gland of tetrapods as per Chester Jones (1957).

In teleosts the existence of pituitary –interrenal axes similar to the pituitary-adrenal axis of mammals has been reported.(Ball and Olivereau,1966; Fagurland *et.al*, 1968;Chester Jones *et.al* 1969,1987: Ball, 1982).The maintenance of water and electrolyte homeostasis similar to that found in higher vertebrates by the adrenal gland, has been reported by the interrenal gland in teleosts (Chan *et.al*,1967). The response to various stress factors as in case of adrenal gland of mammals the interrenal gland of teleosts. Have also responded (Mohan *et. Al* 1962). In higher vertebrates the presence of Δ^5 - $3\beta'$ - hydroxysteroid dehydrogenase, 17β - hydroxysteroid dehydrogenase and 11β - hydroxysteroid dehydrogenase are involved in biosynthesis of biologically active steroid (Baillie *et.al*,1966) have shown to occur in the interrenal gland of teleosts (Bara ,1968,1971,Varon,1970; Hooli and Nadkarni,1974b,1975). In identifying these cells as homologous with the adrenocortical cells of mammals the histochemical demonstration of these enzymes in the interrenals of lower vertebrates are found useful (Lofts and Bern,1972). The production of cortisol, cortisone and aldosterone by the interrenal cells of teleosts have been revealed by biochemical studies (Butler,1973, C.Jones 1969). All these studies indicate that the interrenal gland of teleosts is homologous with the mammalian adrenal cortex.

To identify chromaffin cells in the head kidney of teleosts chromaffin reaction has been used (Giacomini;1908 ,1909; Baecker, 1928, Van Overbeeke,1960, Oguri 1960, Nandi,1962,Banerji,1973; Hooli and Nadkarni,1971-74).The nature of substances resulting in chromaffin reaction is not known with certainty was stated by Nandi ,(1962); Potassium positive reaction in chromaffin cells of a few teleosts have been shown by Chavin (1966) and Banerji (1973). Yaron(1970) has shown the possible secretion of nor-adrenaline by the chromaffin cells of *Acanthobrama terrasanctae* by using resprine treatment .These results show that the chromaffin cells of teleosts secrete some biologically active catecholamines probably similar to those of mammalian adrenal medulla.. Therefore the chromaffin cells of teleosts may be considered homologous with the adrenal medulla of mammals.

Burbus Pulchellus head kidney consists of haemopoietic tissue in interrenal glands and chromaffin cells. Pigment cells were not present. Internal cells are distributed around the sinuses and in the haemopoietic tissue. Chromaffin cells are found only interpressed among interrenal cells. The head kidneys of *P. insidator* and *S.vermiculatus* consists of all the structure described above for the three species except the pigment cells and the renal tubules respectively. (Hooli 1975) Many variations in the composition of head kidneys in teleosts, have been reported by previous workers (Nandi,1962.Nadkarni,1967;) The present investigation, considering the variation in the distribution of interrenal gland and chromaffin cells in this species of teleost, seems to support the views of Nandi (1962) and Banerji (1973) that there is no phylogenetic significance for the interrenal and chromaffin cells types.

V. SUMMARY

The interrenal gland & its structure along with distribution of chromaffin cells has been studied in *Burbus pulchellus* of a teleost belonging to family Cyprininae in this present study The various research studies indicated that the interrenal gland is closely associated with the post cardinal veins of their branches & also extends into the haemopoietic tissues among the eel, *anguilla anguilla* the interior & posterior systems with corpuscle of stanius that found alike histologically among them is one system is called systema interrenale. Nandi (1962) had studied exhaustively & classified 129 species respectively.55 families of teleostes & also classified the inter renal tissue into 4 categories & chromaffin cells into five categories based on their location & morphology *Barbus Pulchellus* consists of haemopoietic tissue, interrenal tissue and chromaffin cells . Around the small branches of the post cardinal vein associated with various sinuses, the interrenal gland belonging to type III.

The chromaffin cells are distributed lonely or in the groups within the wall of post cordinal vein or their branches, they appear almost translucent with haematoxylin, eosin stain. These formed of lobules & strands interpressed with blood sinusoids. At the beginning they are found cuboidal type each with a centrally located nucleus & nuclei are not distinct. As belonging to type V. It is derived that the interrenal cells & chromaffin cells of teleost are homologous with the adrenocortical cells & adrenomedullary cells of adrenal gland of mammals respectively. There is no phylogenetic significance for the interrenal and chromaffin cells types.

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