Arab Gulf. J. scient. Res. **3** (1), pp. 331-354 (1985)

Studies on the Head-Kidney of Teleosts. II. Distribution of Adrenocortical and Chromaffin Tissues in Some Marine Fishes

N.A. Al-Asgah

Zoology Department, College of Science, King Saud University, Riyadh, Saudi Arabia

ABSTRACT. The morphology and histology of the endocrine tissues in the head-kidneys of 14 Red Sea teleost fishes were examined. Melanophore-macrophage complexes were observed in the haemopoitic tissue. The distribution of the endocrine tissues varied from species to species. Both adrenocortical and chromaffin tissues existed as sheaths around the major veins or as diffuse masses of tissues permeated by minor sinusoidal branches of veins draining the head-kidney into the heart. The adrenocortical and chromaffin tissues laid either intermingled or in seperate layers around the vessels. Little evidence was found of taxonomic-morphological correlation; each species has evolved independantly in this context.

The adrenal tissues of teleosts were first described by Giacomini (1902) as distinct epithelial cell-layers along the walls of the cardinal veins in the head-kidney. The adrenocortical tissue of teleosts is homologous to the mammalian adrenal cortex and is well established as the source of adrenocortical steroids (Chester Jones and Phillips 1960, Nandi and Bern 1960, Hane *et al.* 1966, Fuller *et al.* 1976). The chromaffin tissue is homologous to the mammalian adrenal medulla. Oguri and Hibiya (1957a, b) and Oguri (1960 a, b) made comparative studies on many teleosts, noting the degree of variability between the adrenocortical and chromaffin cell groups. A comparative histological investigation on the adrenocortical tissue of eighteen teleosts was then published by Overbeeke (1960). Nandi (1962) made the most important studies on the structure of the head-kidney by examining 129 species. The presence of chromaffin tissue has been demonstrated clearly by chromaffin reaction (Kranter 1951, 1958, Overbeeke 1960, Nandi 1962, Banerji and Ghosh 1975, Chavin 1966). Nandi (1962) classified the various types of adrenocortical tissue into four types: (1) tissues surround the postcardinal veins or their largest branches, (2) tissue surrounds small or medium sized branches of the

veins, and therefore rather widely dispersed throughout the anterior parts of the kidney, (3) tissues associated with venous sinuses within the anterior kidney tissue often forming strands or cords of cells, sometimes scattered through the haemopoietic tissue and sometimes appearing to replace large areas of the latter, but not surround the veins, and (4) tissues forming a solid mass of cells in a localized area.

Nandi (1962) also classified the various types of chromaffin tissue into five categories: (1) cells embedded in the vein walls; none occurring in the region where adrenocortical tissue is situated, (2) cells embedded in the vein walls, but occurring in areas containing adrenocortical cells as well as in other regions of the anterior kidney, (3) cells embedded in the vein walls, but occur only in the region where adrenocortical cells are situated, (4) cells embedded in the vein walls, and also interspersed among adrenocortical cells, and (5) cells found only interspersed among adrenocortical cells.

Nandi (1962) categorized adrenocortical and chromaffin distribution separately, though the two tissues were always spatially associated for biochemical reasons.

Moreover, a considerable range in the anatomical configuration of the head-kidneys and the trunk-kidneys have been, reported in many teleost fishes (Nandi 1962). The head-kidney may be separate from the trunk-kidney, completely fused with it, or intermediate in form. Haemopoietic tissue may occupy most of the head-kidney, and functional renal elements may be absent.

Present study describes the morphlogy and histology of the head-kidney, the trunk-kidney and their haemopoietic tissue in 14 Red Sea teleost fishes never before examined.

Material and Methods

All fishes were collected from the Red Sea close to the coast of Saudi Arabia; adult specimens of both sexes were used. The following species were used: family Acanthuridae: *Zebrasoma veliformis*; family Atherinidae: *Hepsetia pinguis*; family Clupeidae: *Herklotsichthys punctatus*; family Labridae: *Thalassoma lunare, Cheilinus diagramus, Thalassoma amblycephalus;* family Lethrinidae: *Lethrinus harak*, family Monodactylidae: *Monodactylus argenteus*; family Plectorhynchidae: *Gaterin gaterinus*; family Scaridae: *Scarus frenatus*; family Serranidae: *Variola louti, Cephalopholis miniatus*; family Siganidae: *Siganus rivulatus;* family Sparidae: *Acanthopagrus bifasciatus, Crenidens crenidens*.

Following decapitation, the anterior parts of the kidneys (head-kidneys) were removed and fixed in Bouin's fluid. After embedding in paraffin, serial sections were cut at a thickness of 5 μm and stained with Masson's trichrome (Humason 1972).

Results

A comparative summary of the morphology and histology of the head-kidney in the examined fishes is shown in Table 1.

Morphology

Apart from some minor differences in length and thickness, the kidneys in all families are bilobed anteriorly. It is an elongated organ that extends from the heart region to the most posterior end of the body cavity, and thickens anteriorly where it divides into two distinguishable lobes.

The head-kidney can be distinguished externally by two projections (lobes) in the heart region. Internally, it is distinguished by the presence of adrenocortical and chromaffin tissues or the absence of renal tubules which vary according to species. Moreover, the quantity of renal elements in the head-kidney also varied from species to species. In *Acanthopagrus* (Sparidae), for example, the renal tubules were very few, whereas in *C. crenidens* (Sparidae) they were abundant and scattered throughout the tissue of the head-kidney; the same was found in other diverse families like Siganidae (*S. siganus*) and Lethrinidae (*L. harak*).

Histology

(adrenocortical and chromaffin tissues).

The type of adrenocortical tissue in most species examined is Nandi's I; exceptions are in *Variola louti* (Serranidae) where it is intermediate between types I and III, and in *Siganus rivulatus* (Siganidae) where it is intermediate between types I and II.

The chromaffin tissue, however, shows greater variations among and between the families examined; all the types (Nandi's Types I to V) were recorded in all species examined collectively.

The diameters of the nuclei of the adrenocortical tissue varied from 2.4 to 3.8, mostly 3.3-3.6. The diameters of the nuclei of the chromaffin tissue were somewhat larger and ranged from 4.0 to 4.7 (Table 1).

A great difficulty was encountered in discussing the histological features of the head-kidneys in all fishes examined; each species is, therefore, presented separately:

Table 1. Morphology and histology (adrenocortical and chromaffin tissue) of the head-kidney in some marine teleostian fishes.

Taxonomy	Kidney shape	Adrenal Type (Nandi 1962)	Tissue Diameter of nuclei (μm)	Chromaffin Type (Nandi 1962)	Tissue Diameter of nuclei (μm)
Family Acanthuridae					
Zebrasoma veliformis	Bilobed anterioly	I	3.61 ± 0.09	II	2.28 ± 0.24
Family Atherinidae					
Hepsetia pinguis	Bilobed anterioly	I	3.73 ± 0.13	I	4.69 ± 0.21
Family Clupeidae					
Herklotsichthys punctatus	Bilobed	I	2.89 ± 0.13	V	4.07 ± 0.23
Family Labridae	Bilobed anterioly				
Thalossoma lunare		–	3.11 ± 0.2	–	4.30 ± 0.21
T. amblycephalus		–	3.3 ± 0.14	IV	4.20 ± 0.16
Cheilinus diagramus		I	3.69 ± 0.17	II	4.71 ± 0.27
Family Lethrinidae					
Lethrinus harak	Bilobed anterioly	I	3.71 ± 0.08	II	4.15 ± 0.19
Family Monodactylidae					
Monodactylus argenteus	Bilobed anterioly	I	3.8 ± 0.17	II	4.21 ± 0.17
Family Plectorhynchidae					
Gaterin gaterinus	Bilobed anterioly	I	2.43 ± 0.12	II	3.79 ± 0.22
Family Scaridae					
Scarus frenatus	Bilobed anterioly	I-II	3.98 ± 0.24	II	4.92 ± 0.18
Family Serranidae					
Variola louti	Laterally bilobed anterioly	interradiate between II & III	3.32 ± 0.13	Rarely observed	4.24 ± 0.08
Cephalopholis miniatus	Bilobed anterioly	between II & III	3.4 ± 0.14	I-III	4.45 ± 0.2
Family Siganidae					
Siganus rivulatus	Bilobed anterioly	I-II	3.28 ± 0.08	I	4.63 ± 0.28
Family Sparidae					
Acanthopagrus bifasciatus	Bilobed anterioly	I-II	3.77 ± 0.13	II	4.38 ± 0.14
Crenidens crenidens	Bilobed anterioly	I-II	3.59 ± 0.08	II	4.61 ± 0.25

Family *Acanthuridae* (Plate I A, B, C)

Zebrasoma veliformis

Adrenocortical tissue is associated with the posterior cardinal veins. The adrenocortical cells are found lying in the vein walls closely applied to the endothelium. They form a single irregular layer of one to two cells thick, of Nandi's Type I. The diameter of the nuclei of adrenocortical cells was measured 3.61 ± 0.09 μm.

Chromaffin tissue is of Nandi's Type II, individual cells amongst the adrenocortical cells in the anterior part of the head-kidney and groups of two to five cells lying in the vein walls in the posterior part of the head-kidney where there is no adrenocortical tissue. Chromaffin cells are more abundant in the posterior part of the head-kidney than in the anterior part. The diameter of the nuclei of chromaffin cell was 4.28 ± 0.24 μm.

Family *Atherinidae* (Plate I D)

Hepsetia pinguis

The adrenocortical tissue is associated with the anterior cardinal vein as it passes through right wing of the head-kidney. It does not encircle the vein, but forms an irregular cord. It is of Nandi's Type I. The diameter of the nuclei of adrenocortical cells was 3.73 ± 0.13 μm.

The chromaffin tissue is associated with the right posterior cardinal vein of Nandi's Type I. It forms groups of two to four cells or individual cells embedded in the vein wall. The chromaffin cells extend with the vein to the extreme posterior part of the head-kidney. The diameter of the nuclei of chromaffin cells was 4.69 ± 0.21 μm.

Family *Clupeidae* (Plate I E, F)

Herklotsichthys punctatus

The adrenocortical tissue is of Nandi's Type I, surrounding the posterior cardinal veins and their major branches, forming a collar of one or two cells thick around the vessel. The adrenocortical cells are situated directly under the vein endothelium. The diameter of the nuclei of adrenocortical cells was 2.89 ± 0.13 μm. There is very little connective tissues in the vein wall.

The chromaffin tissue is in the form of a small number of cells scattered through the adrenocortical tissue. It is of Nandi's Type V. The diameter of the nuclei of chromaffin cells was 4.07 ± 0.23 μm.

Family *Labridae*

Thalassoma amblycephalus (Plate II A, B)

The adrenocortical tissue is intermediate between veins and branches. This tissue in the anterior part of the head-kidney forms a mass of tissue covering most of the area and the veins of all sizes run through this mass. The diameter of the nuclei of adrenocortical cells was 3.3 ± 0.14 μm.

The chromaffin tissue if of Nandi's Type IV, distributed throughout the adrenocortical tissue and embedded in the vein walls. The chromaffin tissue extends farther posteriorly than the adrenocortical tissue. The diameter of the nuclei of chromaffin cells was 4.2 ± 0.16 μm.

Thalassoma lunare (Plate II C, D)

The adrenocortical tissue and chromaffin tissue are similar to that of *T. amblycephalus* but they occupy less area in the anterior part of the head-kidney in relation to its size than in *T. amblycephalus*. The diameter of the nuclei of adrenocortical cells was 3.11 ± 0.2 μm; the diameter of the nuclei of chromaffin cells measured 4.3 ± 0.21 μm.

Cheilinus diagramus

The adrenocortical tissue is of Nandi's Type I, associated with the posterior cardinal veins and their major branches. The diameter of the nuclei of adrenocortical cells was 3.69 ± 0.17 μm.

The chromaffin tissue is associated with the posterior cardinal veins and their branches. It lies within the vein walls as individual cells or groups of cells, and extends farther posteriorly than the adrenocortical tissue. It is of Nandi's Type II. The diameter of the nuclei of chromaffin was 4.71 ± 0.27 μm.

Family *Lethrinidae* (Plate II E, F)

Lethrinus harak

The adrenocortical tissue is of Nandi's Type I forming a mass of tubules associated with the posterior cardinal veins. In some areas, this mass is expanded into the haemopoietic tissue, where in the posterior region it is totally absent. Adrenocortical mass is penetrated by blood capillaries. The diameter of the nuclei of adrenocortical cells measured 3.71 ± 0.08 μm.

The chromaffin tissue is of Nandi's Type II associated with the posterior cardinal veins and their branches. The chromaffin cells are embedded in the vein walls at different depths and sometimes protrude into the vein lumen. They occur in the

same regions as the adrenocortical tissue and also in isolation. The diameter of the nuclei of chromaffin cells measured 4.15 ± 0.19 μm.

Family *Monodactylidae* (Plate III A)

Monodactylus argenteus

Adrenocortical tissue is of Nandi's Type I, associated with the posterior cardinal veins and their main branches. It is embedded in the vein walls in the form of single or groups of two to five cells. The diameter of the nuclei of adrenocortical cells measured 3.8 ± 0.17 μm.

Chromaffin tissue is embedded in the vein walls where the adrenocortical cells are present and in the posterior part of the head-kidney where the adrenocortical cells are absent. It is of Nandi's Type II. The diameter of the nuclei of chromaffin cells was 4.21 ± 0.17 μm.

Family *Plectorhynchidae* (Plate III B, C, D)

Gaterin gaterinus

The adrenocortical tissue is concentrated in the outer zone of the head-kidney lobe in association with the main vein (Nandi's Type I). Adrenocortical cells are absent in the posterior part of the head-kidney but occur on the inner wall of the vein, but only where the renal elements are not close to the vein itself. The adrenocortical tissue forms mass of tissue containing sinusoids and blood capillaries. (Pl. IV B). The diameter of the nuclei of adrenocortical cells was 2.43 ± 0.12 μm.

The chromaffin tissue is of Nandi's Type II, as palely-stained cells embedded in the walls of the posterior cardinal veins and associated also with the small vein branches. Sometimes the chromaffin cells protrude into the vein lumen. The diameter of the nuclei of chromaffin cells was 3.79 ± 0.22 μm.

Family *Scaridae* (Plate IV)

Scarus frenatus

The adrenocortical tissue is associated with the posterior cardinal veins and their major and medium-sized branches, as one to three cell-layers in thickness and of Nandi's Type I and II. They lie in the vein endothelium, protruding into the vein lumen. The diameter of the nuclei of adrenocortical cells was 3.98 ± 0.24 μm.

The chromaffin tissue forms one layer of cells lying separate from the adrenocortical tissue. It is of Nandy's Type II. The diameter of the nuclei of chromaf-

fin cells was 4.92 ± 0.18 μm. The vein wall is very thick at areas where adrenal tissue exists thus seperating it from the rest of the head-kidney.

Family *Serranidae* (Plate V A, B)

Variola louti

The adrenocortical tissue is intermediate between Nandi's Types II and III, consisting of irregular cords of cells associated with the posterior cardinal veins branches and also of cords or strands of cells running through the surrounding tissue. Expanded sinusoids are visible between the cords. The tubular arrangements were observed. The diameter of the nuclei of adrenocortical cells was 3.32 ± 0.13 μm.

The chromaffin tissue is only rarely observed. It comprises individual cells, embedded in the vein walls. The diameter of the nuclei of chromaffin cells was 4.24 ± 0.08 μm.

Cephalopholis miniatus (Plate V C, D)

The adrenocortical tissue is intermediate between Nandi's Types I and III, forming clumps and tubules associated with the largest and medium-sized veins. In some areas, the adrenocortical clumps comprise relatively large masses of tissue, penetrated by blood capillaries. The diameter of the nuclei of adrenocortical cells was 3.4 ± 0.14 μm.

The chromaffin tissue is associated with the largest branches of the posterior cardinal veins in the form of individual cells embedded in the vein walls where adrenocortical tissue exists and also with small branches where adrenocortical cells are absent. The diameter of the nuclei of chromaffin cells was 4.45 ± 0.2 μm.

Family *Siganidae* (Plate VI A)

Siganus rivulatus

The adrenocortical tissue is intermediate between Nandi's Types I and II, situated alongside the main posterior cardinal veins and branches. The main vein is not entirely surrounded by adrenocortical tissue. The adrenocortical tissue forms a mass of tissue at the junction of the branches with the main vein. This mass is composed of irregular cords penetrated by blood capillaries. The diameter of the nuclei of adrenocortical cells was 3.28 0.08 μm.

The chromaffin tissue is of Nandi's Type II, associated with the posterior cardinal veins and their branches; both in association with the adrenocortical tissue, and separately. The diameter of the nuclei of chromaffin cells was 4.63 ± 0.28 μm.

Family *Sparidae* (Plate VI B, C)

Acanthopagrus bifasciatus

Crenidens crenidens

The adrenocortical tissue is intermediate between Nandi's types I and II. It is associated with the posterior cardinal veins and their main branches, forming a mass of tissue around, but not completely encircling them. This mass of tissue is composed of irregular strands of cells separated by large sinusoids, and sometimes they are in tubular arrangement. The strands of adrenocortical tissue occasionally extend into the thick wall of the vein, so that the connective tissue of the vein wall appears between the strands. In *A. bifasciatus*, the diameter of the nuclei of adrenocortical cells was 3.77 ± 0.13 μm and in *C. crenidens* was 3.59 ± 0.08 μm.

The chromaffin tissue is of Nandi's Type II, embedded in the walls of the posterior cardinal veins and their main branches. In *C. crenidens*, chromaffin cells appear in the smaller branches as well. Chromaffin tissue occurs where the veins pass through the mass of adrenocortical tissue as well as in other regions of the veins. The chromaffin cells sometimes protrude into the lumen of the vein, so it is possible to see chromaffin cells separated by the vein wall from the adrenocortical cells outside it. In *A. bifasciatus*, the diameter of chromaffin cells was 4.38 ± 0.14 μm and in *C. crenidens* was 4.61 ± 0.25 μm.

Discussion

The teleost kidney is divided into three regions; the anterior kidney (pronephros), the middle kidney (mesonephros) and the posterior kidney (metanephros) according to Audige (1910).

The middle and the posterior kidneys are considered to be structural equivalent to the mesonephros of other vertebrates (Fraser 1950). The terms 'head-kidney' and 'trunk-kidney' are now generally used without implying their embryonic origin. In all species, the shape of the kidney is distinguished as bilobed anteriorly. The head-kidney can only be distinguished externally by the occurrence of certain projections at its lobes. The presence of renal elements seems to vary from species to species; in some they are absent, while in others they are found in the head-kidney. A complete range of morphological types also exist, from the extreme case of a discrete head-kidney without renal elements, to the other extreme in which renal elements extend to the anteriormost end of the kidney and the head-kidney. Studies on more species of teleosts have proved that the classification according to Nandi (1962) does not always work, because he did not consider the quantity of the renal elements in the head-kidney.

In the present study, the quantity of renal elements was found to vary among the families examined and also species of the same family. This indicates that the classification of the head-kidney should also consider the quantity of renal elements in this region.

The chromaffin cells and adrenocortical cells are easy to distinguish by staining with Masson's trichrome. In some species, however, the differences between these two endocrine cell-types are less marked, and in some species the chromaffin cells are rare and many go unnoticed. Apparently, a great variation in the relative abundance of chromaffin and adrenocortical tissues in different species does exist. Chromaffin tissues were particularly rare in *Herklotsichthys* (Clupeidae) and in *Hepsetia* (Atherinidae). Such variations in abundance might not be a regular feature of the species. The two endocrine cell-types can also be readily distinguished by a comparison of cellular detail. For example, the nuclear size of adrenocortical cells was significantly smaller than that of chromaffin cells, Table 1. Consequently, it is easier to use the nuclear size to separate the cell type than using histochemical methods, such as the 3 B-ol steriod dehydrogenase technique (Wattenberg 1958, Chieffi and Botte 1963) or the reaction of potassium dichromate with the chromaffin cells (Hillarp and Hokfalt 1955).

References

Audige, J. (1910) Contribution a l'etude des reins des poissons teleosteens, *Archs Zool. exp. gén.* **44**: 275-624.

Banerji, T.K. and **Ghosh, A.** (1975) *Proceeding, trends in Animal Morphology,* Ujjain, 61.

Chavin, W. (1966) Adrenal histochemistry of some freshwater and marine teleosts, *Gen. comp. Endocr.* **6**: 183-194.

Chester, Jones, I. and **Phillips, J.G.** (1960) Adrenocorticosteroids in fish, *Symp. zool. Soc. Lond.* **1**: 17-32.

Chieffi, G. and **Botte, V.** (1963) Histochemical reaction for steroid-3-Bol-dehydrogenase in the interrenal and corpuscles of stannius of *Anguilla anguilla* L. and *Conger conger* L. *Nature, Lond.* **200**: 793-794.

Fraser, E.A. (1950) The development of the vertebrate excretory system, *Biol. Rev.* **25**: 159-187.

Fuller, J.D., Scott, D.B.C. and **Fraser, R.** (1976) Gas-liquid chromatography of corticosteroids in plasma of Salmonidae, *J. Endocr.* **71**: 163-164.

Giacomini, E. (1902) Sulla esistenza della sostanza midollare nelle capsule surrenali dei Teleostei, *Monitore zool. ital.* **13**: 183-189.

Hane, S., Robertson, O.H. and **Wexler, B.C.** (1966) Adrenocortical response to stress and ACTH in Pacific salmon and Steel-head trout at successive stages in the sexual cycle, *Endocrinology* **78**: 791-800.

Hillarp, N.A. and **Hokfalt, B.** (1955) Histochemical demonstration of noradrenalin and adrenalin in the adrenal medulla, *J. Histochem. Cytochem.* **3**: 1-5.

Humason, G.L. (1972) *Animal Tissue Techniques*, 3*rd*. ed., W.H. Freeman and Co., San Fransisco.

Krauter, D. (1951) Zur histologie der nebennieren der knochenfische, *Mikrokosomos.* **41**: 10-12.

Krauter, D. (1958) Experimentellen untersuchungen uber das interrenalorgan von knochenfische, *Arch. EntwMech. Org.* **150**: 607-637.

Nandi, J. (1962) The structure of the interrenal gland in teleosts, *Univ. Calif. Publs Zool.* **65**: 129-212.

Nandi, J. and **Bern, H.A.** (1960) Corticosteroid production by interrenal tissue of teleost fishes, *Endocrinology* **66**: 295-303.

Oguri, M. (1960a) Studies on the adrenal glands of teleosts. III. On the distribution of chromaffin cells and interrenal cells in the head-kidneys of fishes, *Japan. Soc. scient. Fish. Bull.* **26**: 443-447.

Oguri, M. (1960b) Studies on the adrenal glands of teleosts. VI. On the interrenal tissue of chum salmon, *Oncorhynchus neta* (Walbaum), migrating up river to Span. *Ibid.* **26**: 981-984.

Oguri, M. and **Hibiya, T.** (1957a) Studies on the adrenal glands of teleosts. I. Some observations from the viewpoint of comparative histology, *Bull. Jap. Soc. scient. Fish.* **22**: 621-625.

Oguri, M. and **Hibiya, T.** (1957b) Studies on the adrenal glands of teleosts. II. On the adrenal tissues in 15 species of fishes, *Bull. Jap. Soc. scient. Fish.* **23**: 144-149.

Overbeeke, A.P. van (1960) *Histological Studies on the Interrenal and the Phaeochromic Tissue in Teleostei*, Amsterdam: Van Munster's Drukkerijen N.V.

Wattenberg, L.W. (1958) Microscopic Histochemical demonstration of steroid-3B-ol-dehydrogenase in tissue sections, *J. Histochem. Cytochem.* **6**: 225-232.

(Received 25/10/1983;
in revised form 18/07/1984)

Plate I

A) Section through anterior region of kidney of *Zebrasoma veliformis* showing adrenocortical cells (A) in wall of posterior cardinal vein (PCV) and tulubes (T). (× 160).

B) Section through kidney of *Z. veliformis* showing chromaffin cells (C) in wall of posterior cardinal vein (PVC). (× 160).

C) Section through head-kidney of *Z. veliformis* showing adrenocortical cells (C) in the vein wall (PCV). (× 160).

D) Section through anterior region of head-kidney (right wing) *Hepsetia pinguis* showing posterior cardinal vein (PCV) with adrenocortical cells (A) and chromaffin cells (C) in its wall, and renal tubules (T). (× 160).

E) Section through the anterior region of the kidney of *Herklotsichthys punctatus* showing posterior cardinal vein (PCV), adrenocortical cells (A) and renal tubules (T) (× 100).

F) Section through posterior part of head-kidney of *Herklotsichthys punctatus*, showing a few chromaffin cells (C) and adrenocortical cells (A) embedded in haemopoietic tissue (H) associated with small vein (VB) and renal tubules (T). (× 250).

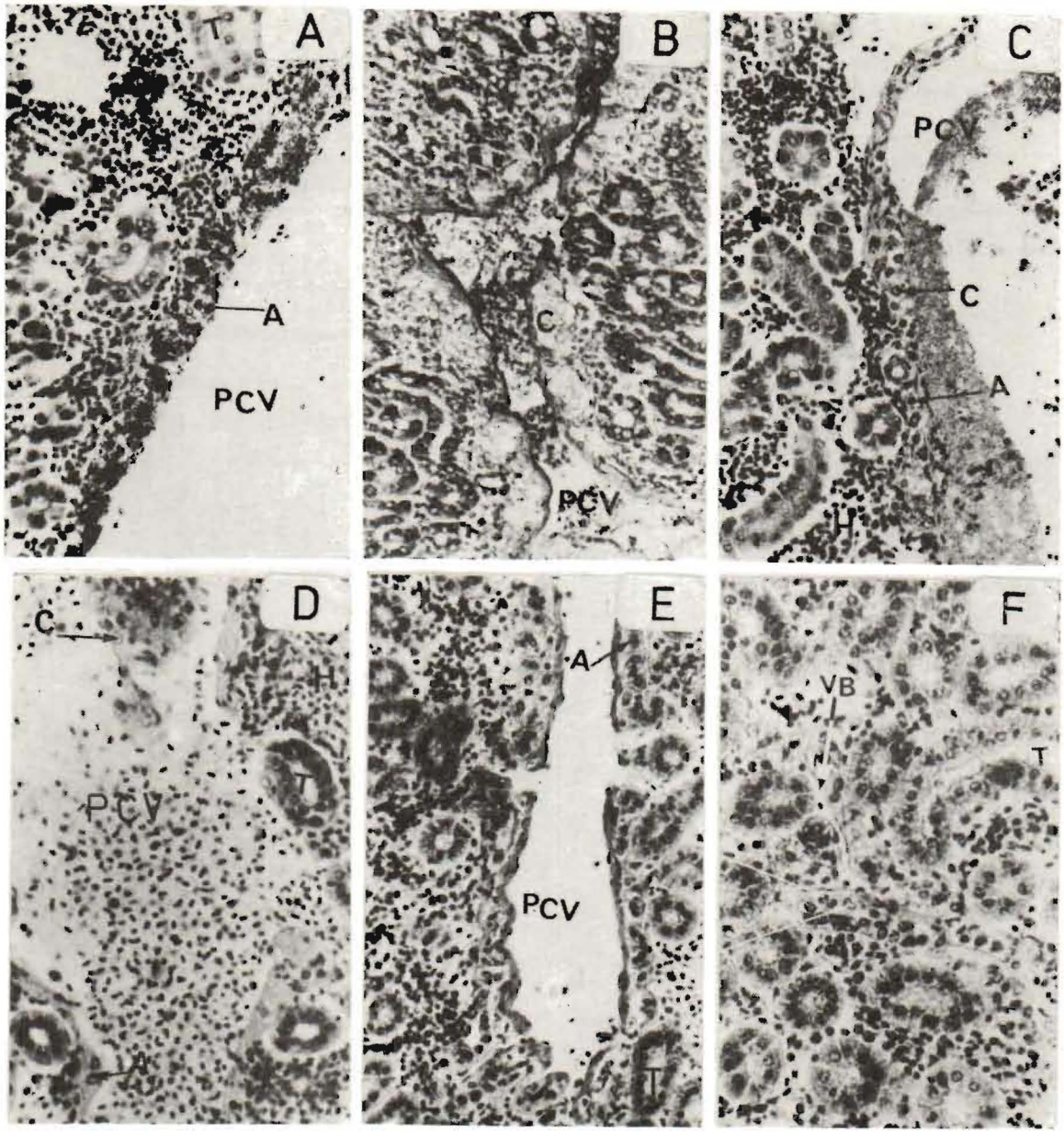

A
T
A
PCV
B
C
PCV
C
PCV
C
A
H
D
C
H
PCV
T
A
E
A
PCV
T
F
VB
T

Plate II

A) Section through anterior region of kidney of *Thalassoma amblycephalus*, showing posterior cardinal vein (PCV) lined with adrenocortical (A) and chromaffin cells (C) and renal tubules (T). (× 160).

B) Section through posterior part of the anterior region of kidney of *T. amblycephalus*, showing chromaffin cells (C) within the vein wall (PCV) and renal tubules (T). (× 160).

C) Section through anterior region of kidney of *Thalassoma lunare*, showing groups of adrenocortical cells (A) and chromaffin cells (C) in a framework of connective tissue and extensive sinusoids. (× 250).

D) Section through posterior part of anterior region of kidney of *T. lunare* showing haemopoietic tissue (H); posterior cardinal vein (PCV) with groups of chromaffin cells (C) in its walls. Renal elements are present. (× 160)

E) Section through head-kidney of *Lethrinus harak* showing adrenocortical follicles (A) renal tubules (T) and chromaffin cells (C) in vein wall. (× 160).

F) Section near posterior end of head-kidney of *L. harak* showing many chromaffin cells (C) and few renal tubules (T). (× 160).

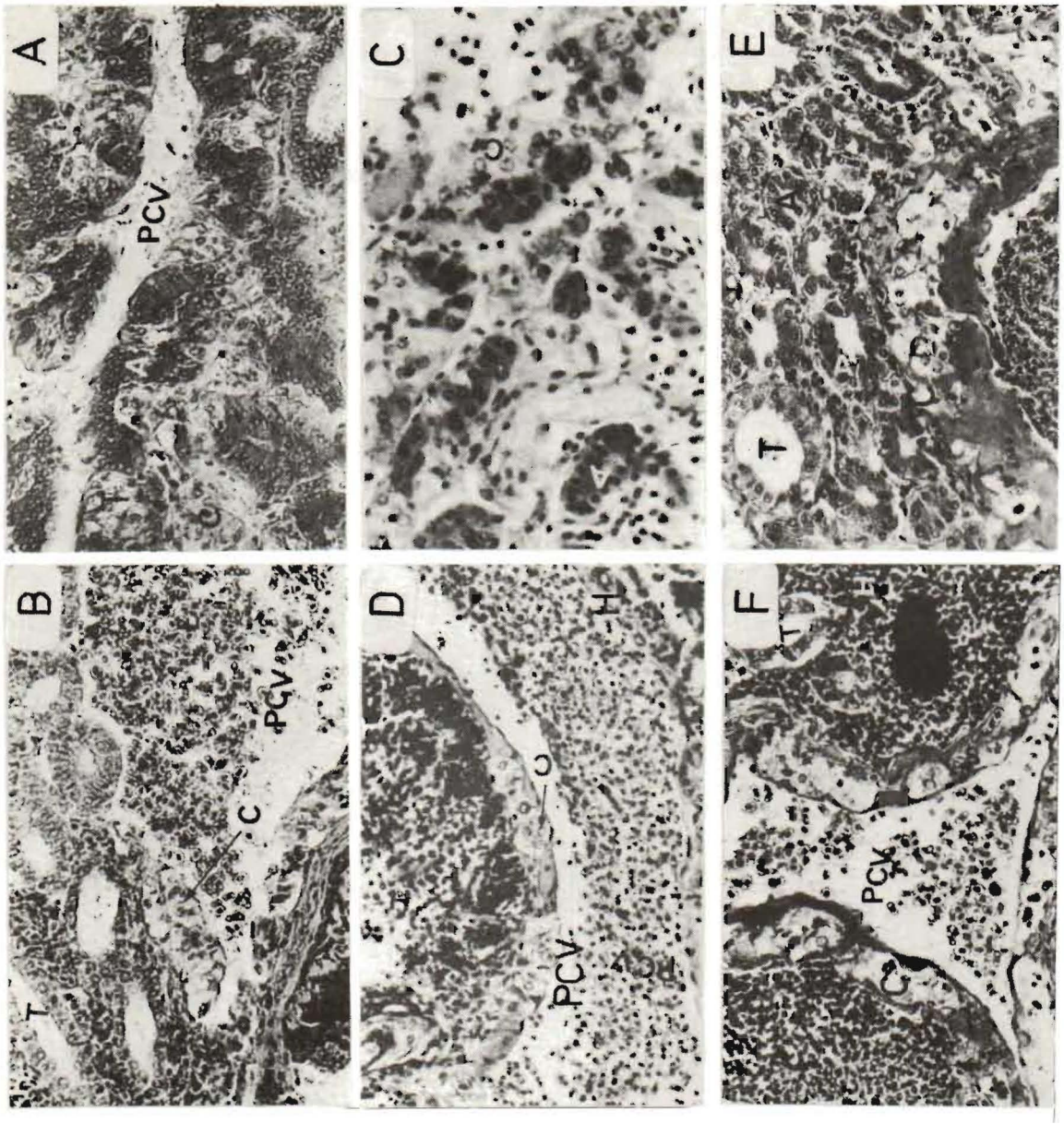

A
PCV
C
C
E
A
T
B
PCV
C
T
D
H
C
PCV
F
T
PCV
C

Plate III

A) Section through anterior region of kidney of *Monodactylus argenteus* showing posterior cardinal vein (PCV), with adrenocortical cells (A) and chromaffin cells (C) in its wall and renal tubules (T). (× 160).

B) Section through anterior region of kidney of *Gaterin gaterinus* showing renal elements (T) concentrated on one side of the posterior cardinal vein (PCV) and haemopoietic tissue (H) with adrenocortical tissue (A) and chromaffin cells (C) within the vein wall. (× 40).

C) Section through anterior region of the kidney of *G. gaterinus* showing adrenocortical cells (A) Sinusoids (SD) and group of chromaffin cells (C) protruding into lumen of vein (PCV). (× 160).

D) Section along posterior cardinal vein (PCV) near posterior end of head-kidney of *G. gaterinus*. Chromaffin cells (C) in the walls of the vein and renal tubules (T) on both sides of the vein. (× 100).

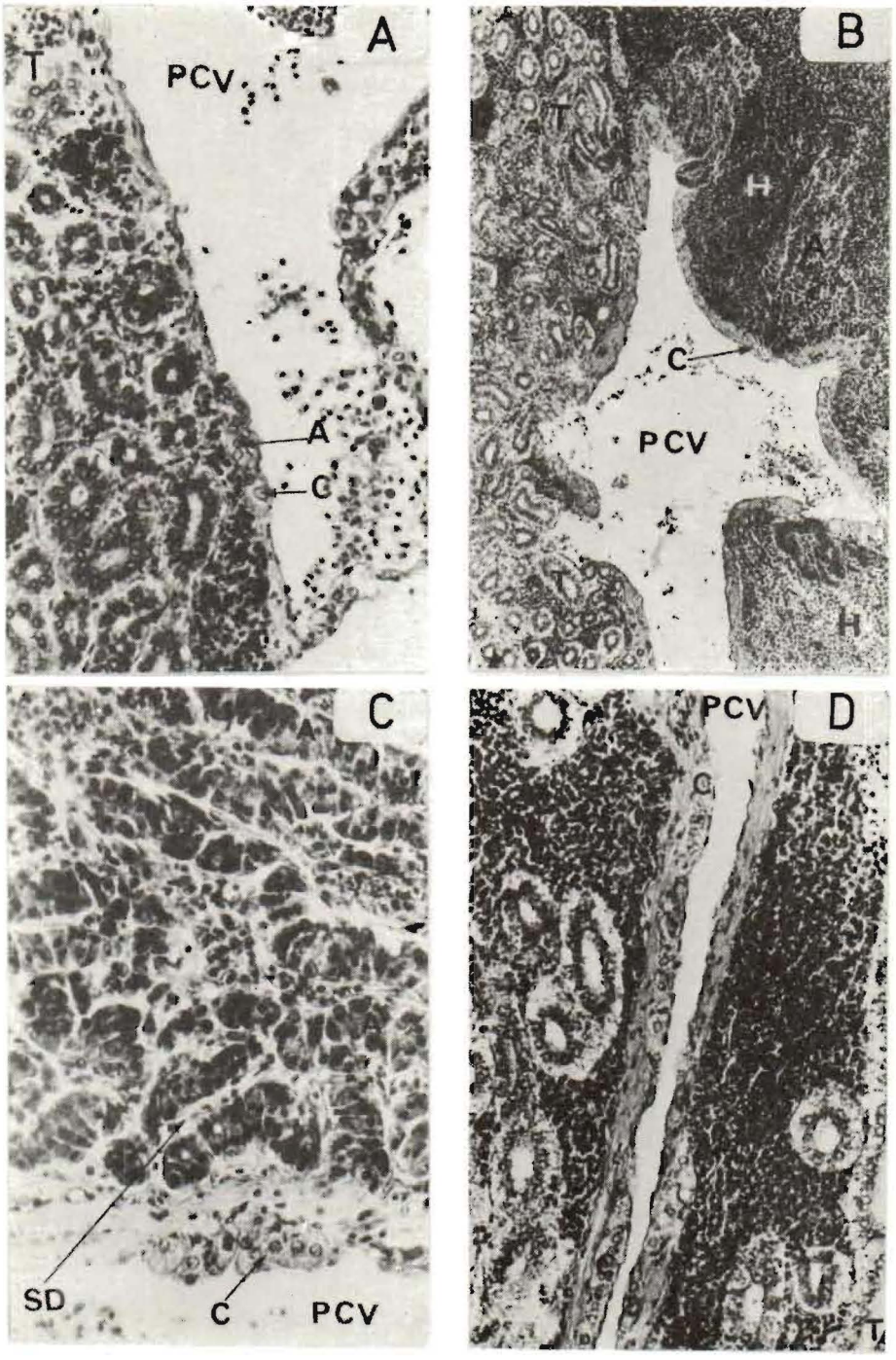

A
T
PCV
A
C
B
H
A
C
PCV
H
C
C
SD
C
PCV
D
PCV
C
T

Plate IV

Section through the anterior region of the kidney of *Scarus frenatus* showing posterior cardinal vein (PCV) and adrenocortical cells (A) embedded in haemopoietic tissue (H), chromaffin cells (C) and renal tubules (T). (× 250).

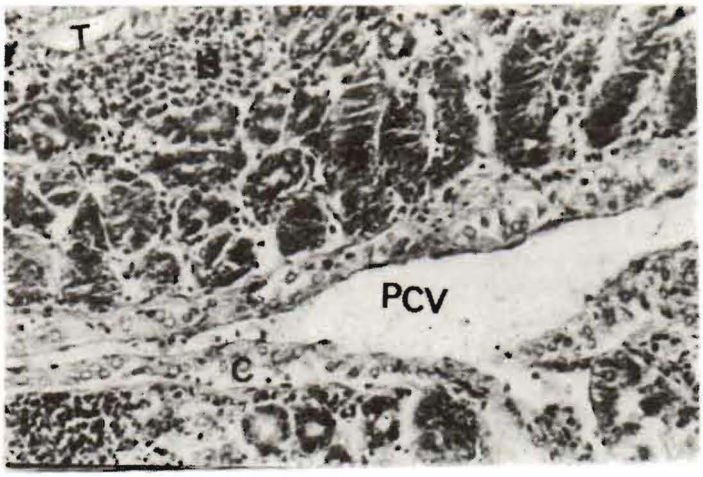

T
B
PCV
C

Plate V

A) Section through head-kidney of *Variola louti*, showing 2 branches of posterior cardinal vein (VB), adrenocortical cells (A) round veins and melanophores (M). (× 40).

B) Section through head-kidney of *V. louti* showing adrenocortical cells (A) near the main posterior cardinal vein (PCV). (× 160).

C) Section through head-kidney of *Cephalopholis miniatus* showing posterior cardinal vein (PCV) associated with small vein (VB), adrenocortical cells (A) arranged in follicles separated by sinusoids (SD). Chromaffin cells (C) lie in vein wall. (× 160).

D) Section through head-kidney of *C. miniatus* showing branch of posterior cardinal vein (VB) with chromaffin cells (C) embedded in its wall. (× 160).

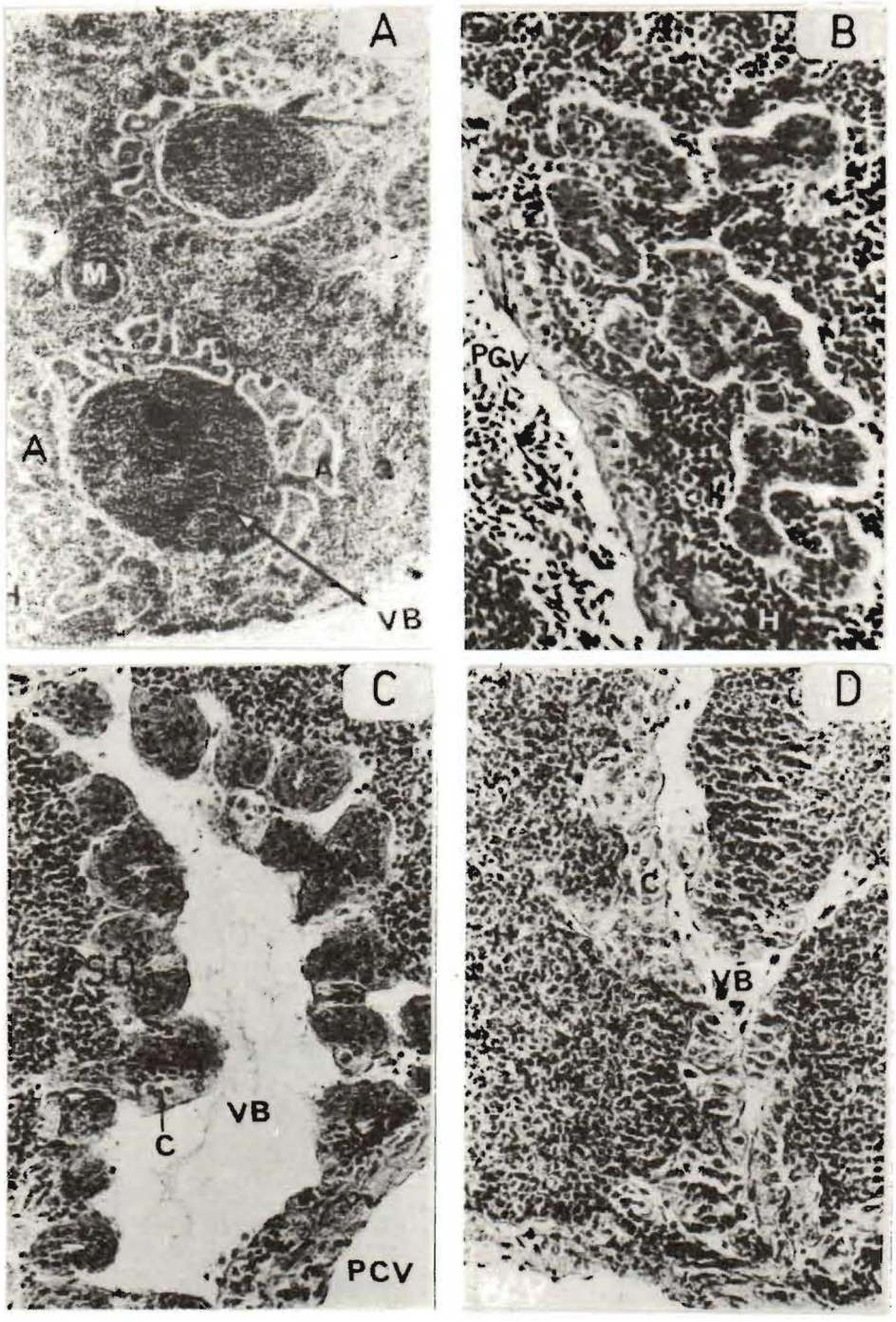
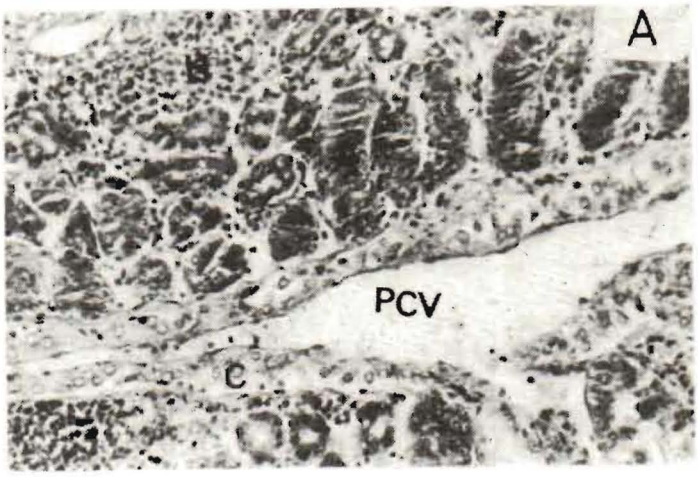

A
M
A
A
VB
B
PGV
H
H
C
SD
C
VB
PCV
D
C
VB

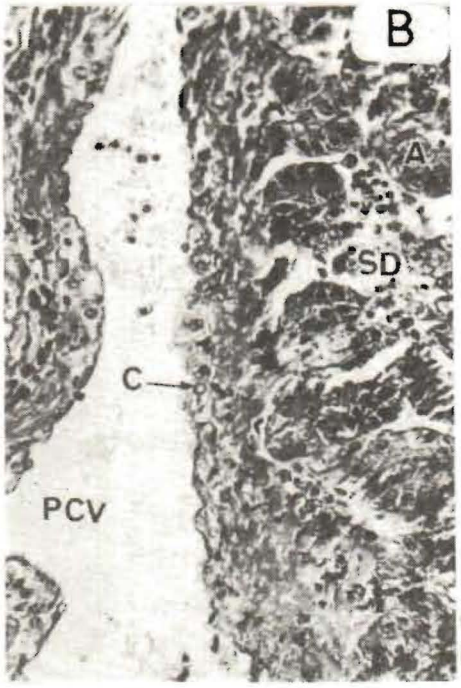
Plate VI

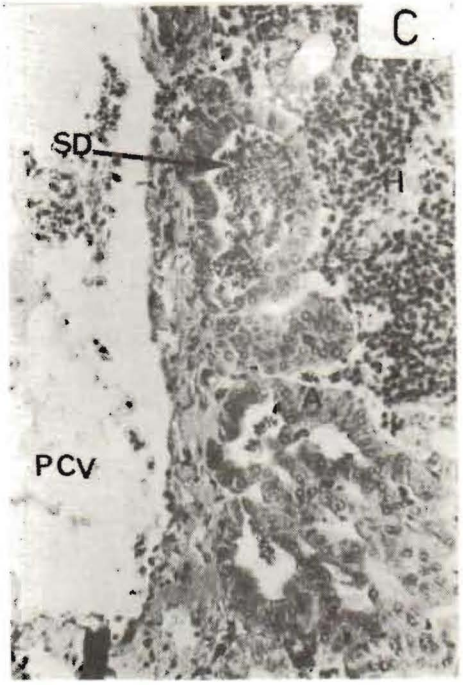
A) Section through anterior region of kidney of *Siganus rivulatus* showing strands of adrenocortical cells (A) in haemopoietic tissue (H) and chromaffin cells (C) in vein wall (PCV). (× 160).

B) Section through anterior region of the kidney of *Acanthopagrus bifasciatus*, showing empty posterior cardinal vein (PCV), strands of adrenocortical cells (A) permeated by small sinusoids (SD), and chromaffin cells (C). (× 160).

C) Section through the head-kidney of *Crenidens crenidens* showing posterior cardinal vein (PCV), adrenocortical cells (A) embedded in haemopoietic tissue (H) and sinusoids (SD). (× 160).


A
PCV
C


B
A
SD
C
PCV


C
SD
I
A
PCV

دراسة الكلية الأمامية فى الأسماك العظمية ٢ . توزيع الأنسجه ذات الإفرازات الداخلية والنسيج الصبغي فى بعض الأسماك البحرية

ناصر عبد الله الأصقه

قسم علم الحيوان - كلية العلوم - جامعة الملك سعود - الرياض - المملكة العربية السعودية

يدرس هذا البحث الشكل الخارجي وتركيب الأنسجه الغدية ذات الأفراز الداخلي فى الكليه الأماميه لأربعة عشر نوعا من أسماك البحر الأحمر. من خصائص التركيب النسيجى وجود خلايا ملونة كبيرة الحجم فى النسيج الحيوي الدموي . توزيع الأنسجة ذات الإفرازات الداخلية يختلف من نوع لآخر، كما أن القشرة الكظرية والنسيج الصبغي توجد إما على شكل أغلفة حول الأوعية الرئيسية أو على شكل كتل متناثرة تتخللها شعيرات دموية متفرعة تتجمع لتصب فى القلب. يلا حظ أيضا أن أنسجة القشرة الكظرية والأنسجة الصبغية توجد أما متداخلة مع بعضها البعض أو على شكل أغشية منفصلة وتغطى الأوعيه الدموية . لم يلاحظ وجود دليل كافٍ على ترابط كل نوع مع الآخرمن ناحية الشكل العام وتركيب الأنسجة فى الكلية الأماميه وعليه درس كل نوع على حدة.