A NEUROHISTOLOGICAL STUDY OF NORMAL AND PATHOLOGICAL ADRENAL GLANDS

by

TAKASHI AOKI

From the 2nd Surgical Division, Kyoto University Medical School
(Director Prof. Dr. YASUMASA AOYAGI)

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INTRODUCTION

Since the nineteenth century, a number of authorities, such as SWINYARD (1939), HOSHI (1927), DOSTOJEWSKY (1886), EVANS (1947), HOLLINSHEAD (1936), KOLLOSSOW (1930), HIRT (1930), ALPERT (1931), DOGIEL (1894), FUSARI (1891), KISS (1951), KOLMER (1918), LEVER (1953), NAGEL (1836), PINES and NAROWTSCHATOWA (1931), STOEHR (1935), and SARTER (1954), have described a lot on the nervous control of adrenal gland, and yet they are greatly different in opinions from each other. Nevertheless, the prompt reaction in the function of adrenal gland which has been clarified by the recent progress of neurology and endocrinology, suggests the existence of the nervous stimulation of the adrenal cortex as well as the humoral one.

STOEHR (1957) demonstrated many nerve elements in the adrenal cortex including the nerve cell. However, concerning the terminal nerve network in his description, some authors expressed opposite opinions in regarding them as nerve elements. On existence of the nerve cells in adrenal cortex, the author was somewhat doubtful whether all of them belonged to the proper structure of the adrenal cortex, or they could be considered as an aberration of the nerve cells from the medulla into the cortex.

The author tried to examine his description and to establish the nerve innervation of the adrenal cortex and medulla.

Next, the author has studied the nerve elements in the functioning adrenal tumors, such as an adrenocortical adenoma removed from a patient of aldosteronism and a pheochromocytoma of a patient suffering from adrenal hypertension.

From these findings the author tried to clarify the role of the adrenocortical nerve, if they exist, playing a role in the activity of these tumors.

MATERIALS AND METHODS

Disclosed the adrenal glands of a healthy adult dog, and after injecting hyaluronidase into the glands, bleeding out to death, while injecting physiological salt solution from the abdominal artery, immediately removed the glands. After

fixing them at least two months in the 10% neutral formalin solution and slicing these preparations with freezing microtome of 15–30 micron, kept them in the 10% neutral formalin solution at least further two months and made silver impregnated preparations with SUZUKI's modification of BIELSCHOWSKY's method.

Preparations of aldosteronism and pheochromocytoma were made from the operatively resected specimens by the same method.

NEUROHISTOLOGICAL OBSERVATION

Adrenal gland consists of the cortex and the medulla. The adrenocortical cells, which developed from the ectodermal cells closed to the pronephros, form three zones according to the pattern of their arrangement : glomerular zone, fascicular zone and reticular zone.

The medulla of the gland is differenciated from the sympathogonia. The sympathogonia differenciate into two kinds of cells, i. e., the ganglion cells and the pheochromocytes. Pheochromocytes and sympathetic ganglion cells are gathered in cell groups in the medulla surrounded by the nerve fibers and net of the connective tissues.

In the cortex, the glomerular zone is located close to the surface, where the cells arrange in a glomerular form. Fascicular zone is the middle and the thickest zone in the cortex, where the cells arrange in a column. Reticular zone is the internal zone, where the cell groups having yellowish brown granules are connected each other in a reticular structure.

The nerve structures of the capsule and three zones will be described separately.

i) The capsule

Large sized nerve bundles (Fig. 1) consisting of thin nerve fibers, median sized nerve bundles (Fig. 2) of comparatively thick nerve fibers and small sized nerve bundles (Fig. 3. 4) of thick nerve fibers were observed.

The nerve bundles had short courses in the capsule. The large sized nerve bundles ran along the blood vessels through the glomerular, fascicular and retiuclar zones without giving rise of branches on the way and they reached the medulla. The median sized nerve bundles gave many branches on the way spread out in each zone. The small sized nerve bundles of thick nerve fibers branched off more finely and distributed in the capsule and in the subcapsular connective tissues. Some of them ended closely to the glomerular zone. The encapsulated KRAUSE's sensory receptors and nerve plexus were observed (Fig. 5).

ii) Glomerular zone

In the subcapsular part the thick nerve fibers were observed (Fig. 6). They ramified from median sized nerve bundles in the capsule (Fig. 7) and ran without any relation to blood vessels. A part of this thick nerve fibers was distributed in the connective tissues beneath the capsule in the cell groups of the glomerular zone. They came around the cell groups, sometime forming a loop (Fig. 8).

Neurofibrils with SCHWANN's nuclei were observable around the glomerular cell groups (Fig. 9). The relation between the thick nerve fibers and these neurofiberils was not demonstrable. The thick nerve fibers between the cell groups of glomerular zone ran along the glomerular connective tissues (Fig. 10), ramified with repeated duplications (Fig. 11) and finally changed into fine terminations. Some terminations entered the glomerular cell arrangement between these cells and ended on the cell surface (Fig. 12). Some seemed to end in the cell (Fig. 11, 12), but they might be distributed on the cellmembrane. And in the connective tissues between glomerular cell acini a fine nerve fiber with SCHWANN's nuclei (Fig. 13) and a median sized nerve fibers with a tongue-like expansion (Fig. 14) are observed. In the Fig. 15, there were the median sized nerve fibers and a small network composed of fine neurofibrils clearly connected with each other. This showed that the median sized nerve fibers distributed in the glomerular zone formed a small network.

In th network structure of neurofibrils, interstitial cells were located. In Fig. 16 a large cell with processes and nerve fibers on both sides of the cell body seemed to be a bipolar nerve cell or a interstitial cell.

iii) Fascicular zone

This is the zone comparatively poor in the nerve elements. The thick nerve bundles composed of thin nerve fibers passed through it to reticular zone and thin nerve fibers were also seen running paralleled with these nerve bundles along the cell column (Fig. 17).

In 1,000 times enlargement (Fig. 18), comparatively thin nerve fiber ran along the intercolumnar space with endothel cells. This nerve fiber was a branch from a nerve bundle (or wide nerve fibers) which went around a cell column in oblique direction (Fig. 19). This nerve bundle sometimes made a loop on the course (Fig. 20). Considering Fig. 19 and 20 together, this type of nerve bundles could take a spiral course around the cell column. Some other nerve bundles presented a large network in an oblique section consisting of thick and fine nerve fibers in the area bordering between the fascicular and the reticular zone (Fig. 21).

iv) Reticular zone

Median sized nerve bundles of thick nerve fibers reaching this zone from the capsule spread out in a particular form; the nerve bundles swelled up and the fibers in the bundle came loose in passing the corticomedullar border, again they formed dense bundles, and spread out in the medulla (Fig. 22, 23). In a particular case they presented a reel-like figure at the border.

Comparatively thin nerve fibers and their bundles were also seen in this part (Fig. 22). The nerve fibers arising from medullar border and the thick nerve fibers reached the reticular zone beyond the border (Fig. 25, 31), and some of them made plexus (Fig. 32, 33 and 34).

Besides the fine and median sized nerve fibers forming a thin and loose nerve bundle connected the cortex and the medulla (Fig. 35). The nerve fibers in this

nerve bundle had an expansion on the way. The nerve fibers which traversed the border from the reticular zone to the medulla spread out with various forms. They reached the cells of medulla or distributed near the sinus of the medulla (Fig. 38, 39).

The Nerve Structures in The Functioning Adrenal Tumors

Then the author proceeded the study on the observation of structures in the functioning adrenal tumors.

i) Adrenocortical adenoma presenting typical aldosteronism

Since the first description of primary aldosteronism in 1954 by J. W. CONN, about thirty cases have been reported up-to-date. Recently the author had an oppotunity of observing a patient with this disease, who showed the typical syndrome of primary aldosteronism and who had a adrenocortical adenoma of the left adrenal gland. The author tried to find the nerve elements in the tumor. Tsunoda and Akanuma reported first that malignant tumor had no nerve element, while benign one had the nerves.

According to YOSHINO (1959), in the benign tumor, the nerve fibers and cells as well as the vegetative network were observable, but these were in immature development. As for the functioning tumors, OKAMOTO (1959) found stimulated and degenerated nerve fibers in the thyroid gland of exophthalmic goiter, however, no description has been done on the nerve elements in the functioning adrenal tumor.

Clinical findings of this case was: A 27 aged man. On Feb. 1958, he first noticed muscular weakness of the right hand and additionally noted polydipsia, polyuria and nycturia until March, 1958. Occasionally he had generalized muscular weakness in major attacks. In the intervals between these attacks he suffered from headache and general fatigue.

On admission on March 18, 1958, blood pressure was 170/*Max.* to 104/*Min.*, in serum sodium increased to 165 *mEq/l.* with decreased potassium to 1.93 *mEq/l.*

In urine 40.6 *r*/24 *h.* of aldosteron were estimated (normal level being 2.2 to 12.0 *r*/24 *h.*).

In operation adrenocortical adenoma as large as $1.5\times1.9\times1.8$ cm and 2.1 g in weight was removed by the left adrenectomy. Microscopically there were many kinds of cell arrangement which resembled to each adrenocortical zone. An adenomatous cell arrangement was also observed. There was non-uniformity of size of the cells and nuclei.

Neurohistological observation of the nerve elements of the tumor with silver impregnation: The cells were so irregularlly arranged that it was impossible to distinguish to what zone the cells belonged (Fig. 40). Fig. 41 and 42 showed very huge sized tumer cells. Nerve bundles and fibers could not be observed in the part where these huge sized cells were located and only neurofibrils with SCHWANN's nuclei (Fig. 42, 43) were found out after very careful observation, i.

e. only the vegetative terminal structures were found there. In other areas there appeared the fibers (Fig. 44) and nerve fibers with SCHWANN's nuclei (Fig. 45). A tangled nerve fibers with an apperance of an arabesque (Fig. 46) and the nerve cells were found at the bordering area between the tumor and the medulla (Fig. 47).

These findings suggest that aldosteronism is caused by an adrenocortical adenoma, the activity of which is controled not only with humoral but also with nervous stimulus. However, comparing with the normal adrenal contex, the development of the nerve elements in this tumor are markedly poor. The nervous control of tumor, if it exists, must be very weak.

ii) Pheochrmocytoma

Clinical findings : A 24-year-old female. She had main complain of general fatigue and dullness. On Oct. 1956, she was detected hypertention with 160 mm Hg/*Max.* and glucosuia. On March of 1958, she suffered from sudden occurency of visual disturbance during pregnancy. Her maximal blood pressure was counted 140–230. She had cardiac arrest, frequent pulse, headache, perspiration and flushing. On admission in the 2nd internal Division of Kyoto Univ. Hospital, the blood pressure was 190/120 mm Hg.

Clinical Examination:

Blood : Hyperglycaemia with 268 mg/*dl*, residual nitrogen in serum 34, 8mg/*dl*. Serum electrolyte (*mEq/l*) K : 4. 49, Na : 144. 8,
Ca : 4. 7, Cl : 101.

Urine : proteine (+), sugar (++), noradrenaline 758 mEq/24h., adrenaline 0. 8 *mEq/24h.*

Other Examinations : Regitinetest (+). X ray examination with pneumoretroperitonenm gave a tumor in the left adrenal region. She was diagnosed as pheochromocytoma of the left adrenal gland, and the tumor was supposed to have an activity especially in noradrenaline secretion. A left adrectomy was carried out on 3, March 1959 and a left adrenal tumor 6. 5×6. 5×5cm. with 178g in weight was removed. The tumor tissues contained extremely great quantity of noradrenaline with subnormal adrenaline.

The histological examination proved a pheochromocytoma. After removal of tumor, the hypertension and other disorders disappeared perfectly.

Neurohistological observation in pheochromocytoma.

The argylophile elements were remarkably increased. The nerve cells with the large accessory cells (Fig. 49, 50 and 51) made cell groups around the extremely developed venous sinus (Fig. 55–63). Near the nerve cells a great number of argylophile cords were observed. They consisted of markedly widened and dark Schwann's cellsyncytia. At a glance, they seemed to be the nerve fibers, but with careful observation true nerve fibers were rather rare in these cords. These argyrphile cords could be considered as the collagen fibers, but they had intimate relation to the nerve cells or the interstitial cells. From this finding they seemed more favourable to be regarded as Schwann's cellsyncytia. Though

fewer than in normal medulla, there were median and small sized nerve fibers in the stroma especially around the cell groups (Fig. 64, 65).

The arrangement of the nerve fibers were very irregular. They rarely formed a nerve bundle and only a few of them had distant course in the feld. The nerve cells (Fig. 49, 50, 51, 65, 66 and 67) had disharmonic nerve processes, i. e., many branches at their roots. They had hyperchromasia, granules, and impregnability of the nerve roots. SCHWANN'S syncytia had abnormal deep stainability and they had various thickness in their courses (Fig. 68–72). They had not normal continuity each others and usually severed in fragments.

Summarizing these findings, a pheochrocytoma is composed of highly developed venous sinus, pheochromocytes, and SCHWANN'S cell elements including the accessory cells with rather poor number of nerve cells and fibers. This tumor, too, must be under a poor control of nervous systems.

DISCUSSION

The Capsule : The author has studied on the nerve elements in the adrenal glands of dogs as well as in the adrenocortical adenoma and pheochromocytoma of patients. Concerning the nerve structure in the normal adrenal gland the author agrees with STOEHR and SARTER'S report done in 1954–1957, except for the parts on the terminal network. The capsule of the adrenal gland has, as STOEHR already described, a great number of the nerve fibers forming bundles and plexus in the capsule. As the nerve bundles the author divided into three kinds :

a) The large sized nerve bundle consisting of fine nerve fibers,
b) The median sized nerve bundle of comparatively thick nerve fibers and
c) The small sized nerve bundle of thick nerve fibers.

Fine nerve fibers in bundle go through all adrenocortical zones and reach the medulla without giving rise of branches on the way. Comparatively thick nerve fibers in the median sized nerve bundles are found in all zones of the cortex and medulla.

Thick nerve fibers in the small sized nerve bundle found in the capsule, sub-capsular parts, reticular zone and in the medulla are supposed to be the sensory nerve.

The corpuscle showing in Fig. 3 is supposed to be KRAUSE'S sensory receptor.

STOEHR and SARTER described that the nerve plexus in the reticular zone consisted of two kinds of nerve fibers, one came from cortical region, the other from the medulla, and they communicated with each others in the reticular zone.

The author has another opinion on these in forming this, plexus, i. e., the nerve fibers of the plexus are composed of the thick nerve fibers in median sized bundle. After giving branches in each cortical zones and in the corticomedullar border the bundle come loose and forms a reel-like structure and joins again into a dense bundle. The median sized nerve fibers form large or fine network in the interacinous connective tissues of glomerular zone. In the nerve network the author clearly find SCHWANN'S nuclei and interstitial cells.

STOEHR did not describe on the SCHWANN's cell and interstitial cell there.

As for nerve cells in the cortical substance, they are relatively small and some of them are doubtful whether true nerve cells or not.

In the medulla the author finds many nerve structures and the nerve cells of DOGIEL's lst and 2nd types. These nerve cells have various sizes. The large nerve cells have relatively light neuroplasma, sometimes very faint. The neurofibrils in the neuroplasma are not found. They are surrounded by 7, 8 to 10 accessory nuclei. They are bipolar or multipolar and have some nerve fibers and in capsular area a special shape, i. e., bottle or ball-like terminal expansion (Endkorben by STOEHR).

The thick nerve fibers with few SCHWANN's nuclei duplicate repeatedly on the course and gradually come to very fine fibrils and end freely just beneath the glandular cells or enter the intercellular spaces. These nerves may possiblly be sensory in nature.

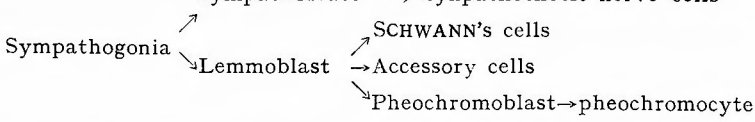
Concerning the adrenocortical adenoma of aldosteronism there are small number of fine nerve fibers with SCHWANN's nuclei or SCHWANN's plasmodium. They reach near the adenomatous cell groups and wrapp them. They may be vegetative nerve fibers.

The author cannot find median or thick nerve fibers in the adenoma. The fine fibers run with or without accompanying blood vessels. These facts suggest that the adenomatous cells are influenced by the nerve stimulation, though may not be so powerful.

The pheochromocytoma has peculiar structures from the neurohistological point of view. At a glance, it seems to have a great number of nerve fibers with many nerve cells. However, the author, by the careful examination find that most of the nerve fibre-like cords consist of remarkably proliferated SCHWANN's cells or SCHWANN's syncytia. These proliferated SCHWANN's syncytia have deep stainability and often they are misunderstood for the nerve fibers, but most of them do not keep any nerve fibers within them. They have very irregular thickness, length and shape. If, as JABANERO stated, the SCHWANN's syncytia without nerve fiber exist, these SCHWANN's cords in pheochromocytoma are very things that he detected. However, JABANERO meant his nerve syncytia without fiber as an autonomic nervous unit functioning in chemical transmission.

The present author do not consider the functional activity of these proliferated SCHWANN's syncytia in pheochromocytoma.

Table 1.



Considering the histogenesis of a pheochromocytoma, the chromaffine cell in this tumor are differentiated from the same mother cell as a SCHWANN's cell and an accessory cell, while a sympathetic nerve cell from another mother cell, as is shown in Tab. 1.

The proliferated sympathoblast or sympathetic nerve cells can form a sympathoblastoma or a ganglioneuroma, while the proliferated lemmoblasts a neurinoma, a Schwannmoma, and a pheochromocytoma. Therefore, it may be a matter of course that the proliferated SCHWANN's cells and accessory nerve cells are also found in a pheochromocytoma with nerve cells and nerve fibers not so increased in number.

Though the author found some of them were a mass of accessory cells without clear existence of nerve cell body in them, the author believes that these nerve cell-like structures have no nervous function. Except for the proliferated SCHWANN's cells including the accessory cells the nerve cell elements in this tumor are rather poor. Therefore, the pheochromocytoma is under the poor nervous control, even though it may be highly active in catecholamine secretion.

In the past the author had several patients of sympathogonioma and ganglioneuroma. The histological findings of them were a mass of a great number of mature and immature nerve cells with few chromaffine cells. Even in such a case there were no sign of general as well as local sign of sympathicotonia.

It is very interesting that a tumor having proliferated sympathetic nerve cells can not produce any sympathetic effects on the body, whereas the one having proliferated chromaffine cells and SCHWANN's cells can produce sympathetic action, i. e., a marked hypertension.

SUMMARY

Using modified Bielschowsky's silver impregnation, the author studied the normal adrenal gland of dogs and two adrenal tumors, i. e., aldosteronism and pheochromocytoma.

Summarizing the results, the following conclusions are obtained.

1) In the capsule of adrenal gland, three kinds of nerve bundles, and a plexus are observed.
2) Thick nerve fibers in the small sized nerve bundle are supposed to be the sensory nerve and simetime end in a KRAUSE's corpsucle.
3) In the reticular zone a nerve plexuses are observed. The nerve fibers of this plexus are commposed of the thick nerve fibers in median sized nerve bundles. They have communications with the cortex as well as the medulla.
4) In the interacinous connective tissues of glomerular zone, there appears fine or large networks with SCHWANN's nuclei and the interstitial cells.
5) In glomerular zone, the thick nerve probably sensory in nature, fibers with few SCHWANN's nuclei duplicate repeatedly on the way and gradually come to very fine fibrils and end freely just beneath the glandular cell or enter into the intercellular spaces.
6) An adrenocortical adenoma in a typical case of aldosteronism has only a few fine autonomic nerve fibers with SCHWANN's nuclei around the adenomatous cell groups. The nervous control of this tumor is considered

to be poor.

7) A pheochromocytoma in a case with hypertension has proliferated SCHWANN's cells, SCHWANN's syncytia and accessory cells. The nerve cell elements, i. e. the nerve cells and the nerve fibers, are rather poorly developed in tumor. This tumor is, possibly, be under a poor control of the nervous system.

To Assist. Prof. Dr. Ch. Kimura, I offer my sincere gratitude for suggesting and first interesting me in this problem. This study has been done under his kind guidance and helpful advice.

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和文抄録

正常副腎，アルドステロン症及び褐色細胞腫の副腎神経組織学的研究

京都大学医学部外科学教室第2講座（指導：青柳安誠教授）

青　木　　崇

Bielschowsky 氏鍍銀法（鈴木氏変法）を用い，Weddell 氏によつて紹介された，拡散因子を応用して成犬の副腎の神経組織学的研究行い，更に併せて，手術的に剔除したアルドステロン症及び褐色細胞腫の2つの副腎腫瘍の神経組織学的研究を行つた，

そして得た結果は次のようである．

1）副腎被膜には神経叢及び3種類の神経線維束を認めた．

2）太い神経線維は，知覚神経と考えられ，時に Krause 氏小体に終つている．

3）副腎皮質中の網状帯に神経叢を認めた．この神経叢は，太い神経線維で形成されていると考えられ，更にこの神経叢は，副腎の皮質と髄質とに連絡している．

4）副腎皮質の球状帯の細胞群の間にある結合組織には，Schwann 氏核及び間質細胞を含む網様構造が見出された．

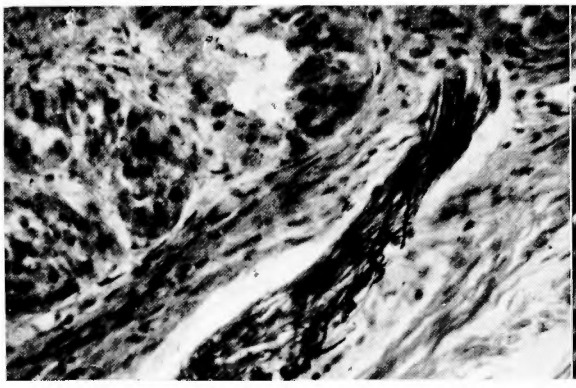
5）球状帯に於ける太い神経は，知覚性と考えられるもので，この神経線維には Schwann 氏核は見られず，分岐を繰返えして，終には繊細な神経線維になり，游離終末として，腺細胞の極めて近くに終る．時には細胞に入ることもある．

6）典型的な，アルドステロン症の副腎皮質腺腫は，腺腫細胞群の周囲に，僅かな Schwann 氏核を有する自律神経を持つている．この腫瘍の神経支配は，貧弱であると考えられる．

7）高血圧症を示す褐色細胞腫には，Schwann's cell, Schwann's Syncytium 及び accessory cell が，非常に増殖している．

神経細胞要素，即ち神経細胞及び神経線維は，この腫瘍に於てはむしろ貧弱である．この腫瘍は多分神経組織系の支配は少ないものであろう．

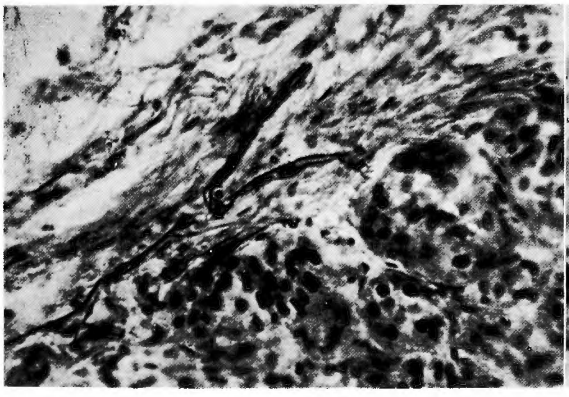
(I) Normal adrenal gland



i) Capsule of adrenal gland

Fig. 1 Thick nerve bundle consisting of thin nerve fibers in the capsule. ×200.

Fig. 2 Median sized nerve bundle of comparatively thick nerve fibers. Capsule. ×400.



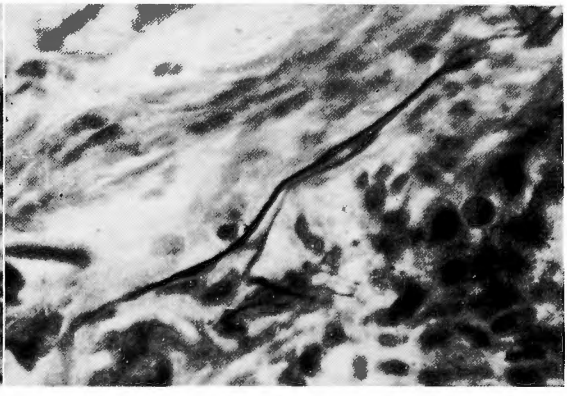
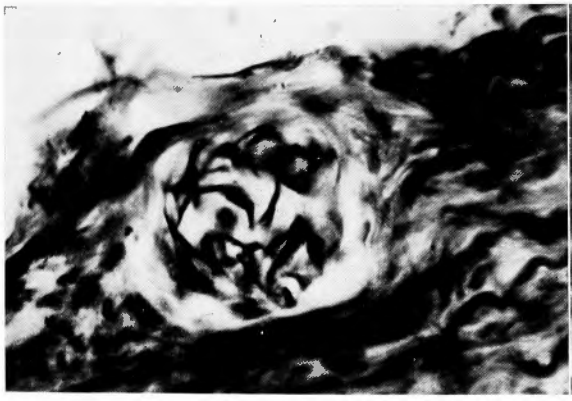


Fig. 3 Small sized nerve bundle of thick nerve fibers in the capsule. ×200.

Fig. 4 Enlarging ×400 of Fig. 3.



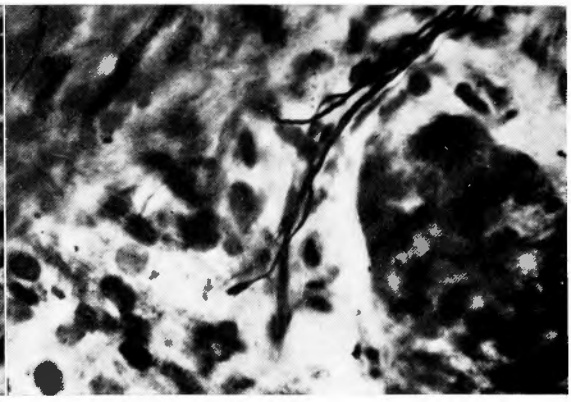
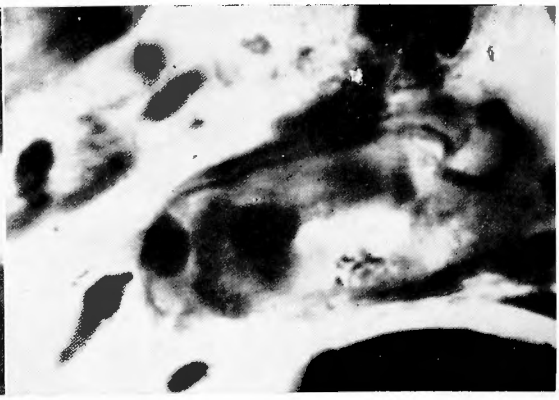


Fig. 5 KRAUSE's sensory receptor in the capsule. ×400.

Fig. 6 Thick nerve fibers in the subcapsular connective tissues. ×400.



ii) Glomerular zone

Fig. 7 Thick nerve fiber ramifying from median sized nerve bundle in the subcapsular part. ×1000.

Fig. 8 Thick nerve fiber in Fig. 7 coming around the cell groups of glomerular zone, and forming a loop. ×1000.

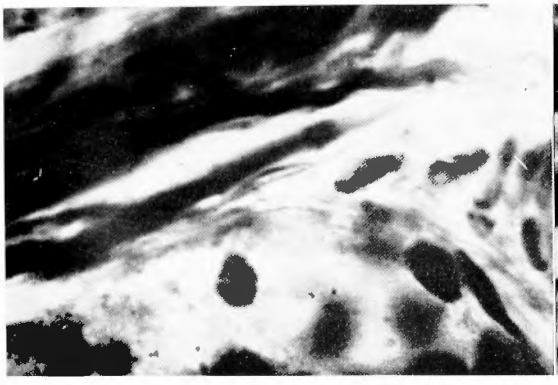
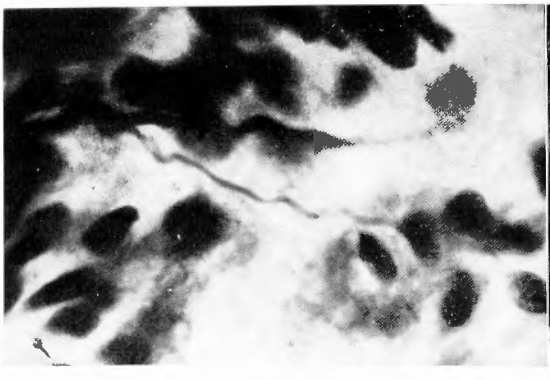


Fig. 9 Neurofibril with SCHWANN's nuclei around the glomerular cell groups. ×1000.

Fig. 10 Thick nerve fibers between the glomerular cell groups running along the connective tissues. ×400.



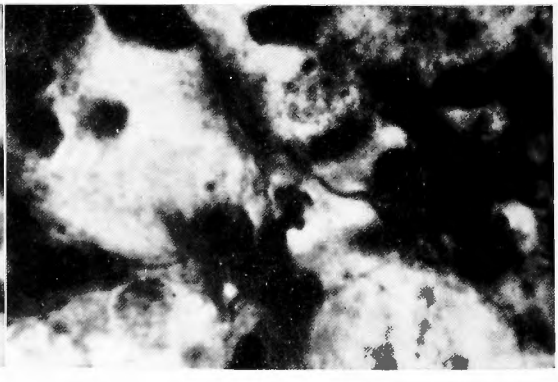


Fig. 11 Thick nerve fibers with duplication in the glomerular cell group ×1000.

Fig. 12 The nerve termination ending on the cell surface. ×1000.

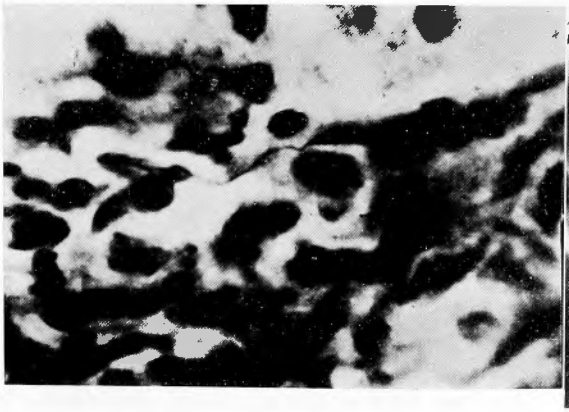
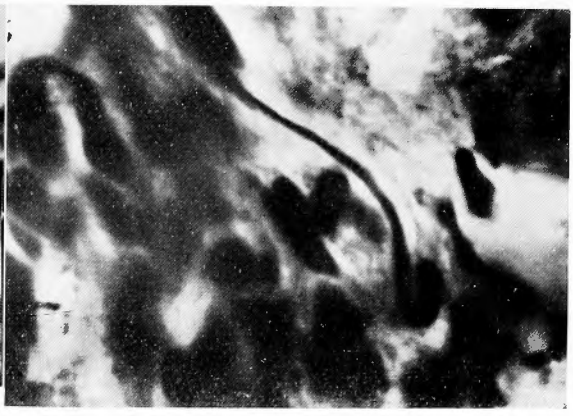


Fig. 13 Neurofibril with SCHWANN's nuclei in connective tissues between the glomerular cell acini. ×750.



Fjg. 14 Median sized nerve fiber with a tongue-like expansion. ×1000.

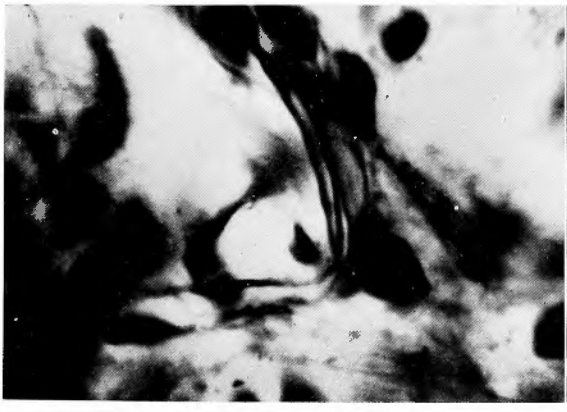


Fig. 15 Median sized nerve fibers and a small network composed of fine neurofibrils connected with each other. And small nerve cell or interstitial cell. ×1000.

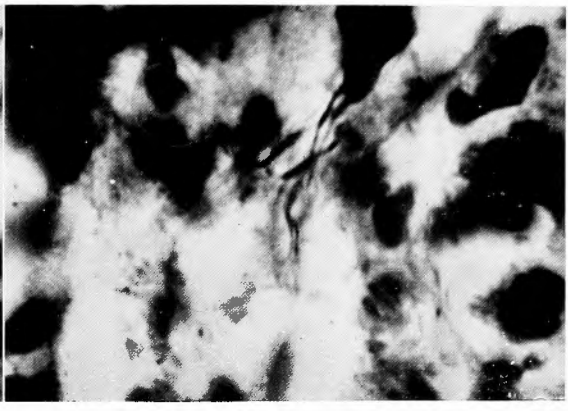
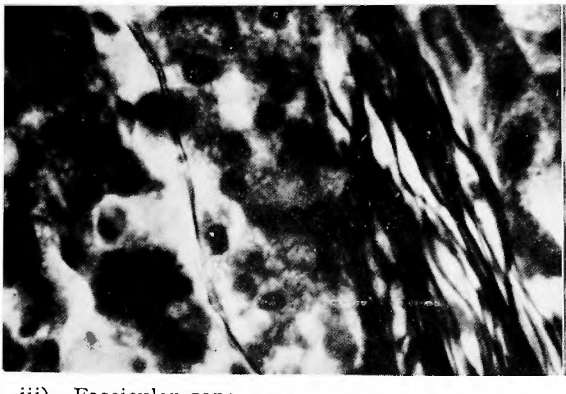


Fig. 16 A large sized cell in the connective tissues having nerve fibers and processes ; Being supposed to be a nerve fiber or interstitial cell. ×1000.



iii) Fasciculer zone

Fig. 17 Nerve fibers and bundles along the fascicular cell-column. ×400.

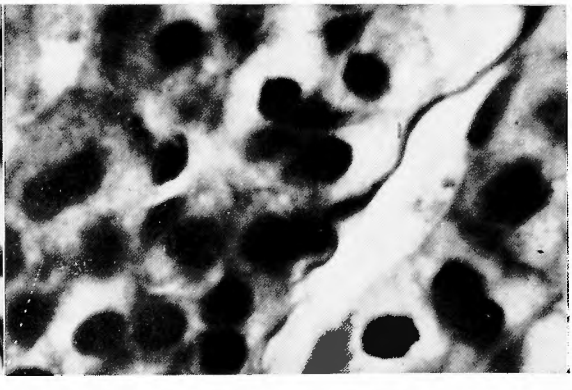


Fig. 18 Fine nerve fiber along the intercolumnar spaces with a endothel cell. ×1000.

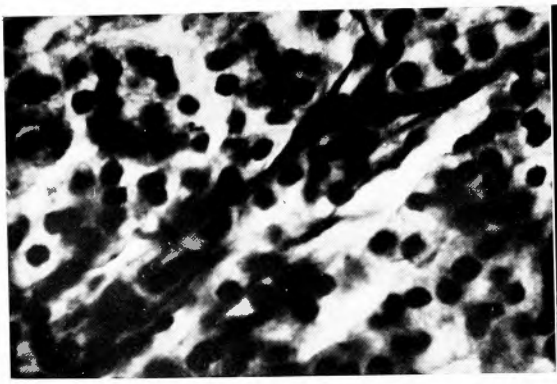


Fig. 19 Nerve bundle (or wide nerve fibers), with branches going along the cell-column in oblique direction. ×400.

Fig. 20 Wide nerve fibers with a loop-like winding. ×1000.

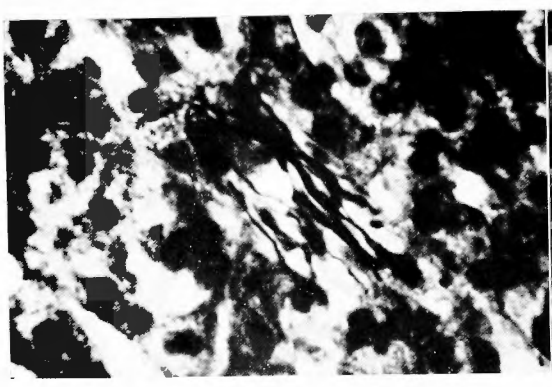
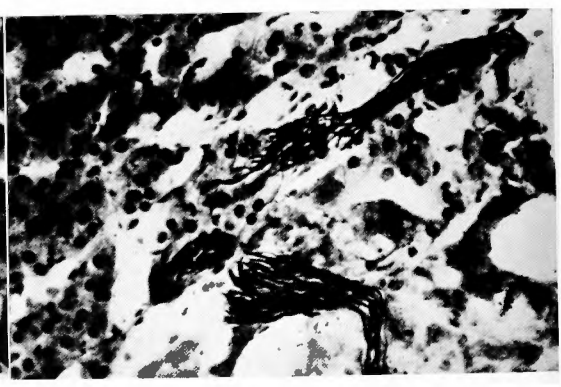


Fig. 21 Large network of thick and fine nerve fibers in the fascicular zone in oblique section. ×400.



iv) Reticular zone

Fig. 22 In the corticomedullar border nerve bundle in particular form, i. e. once swelling up and loosening, and again making dense bundle. ×200.

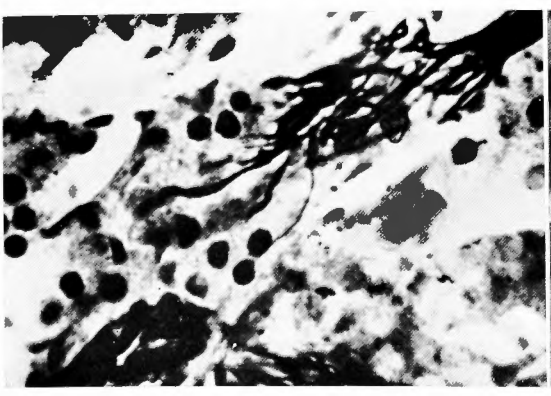


Fig. 23 Enlargement (×400) of Fig, 22.

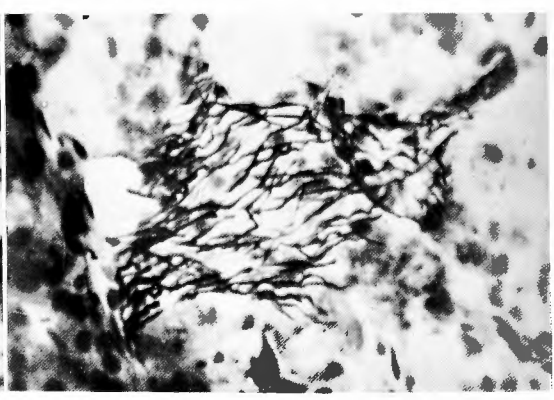


Fig. 24 A particular form of nerve bundle (reel-like) in the medulla near the border. ×400.

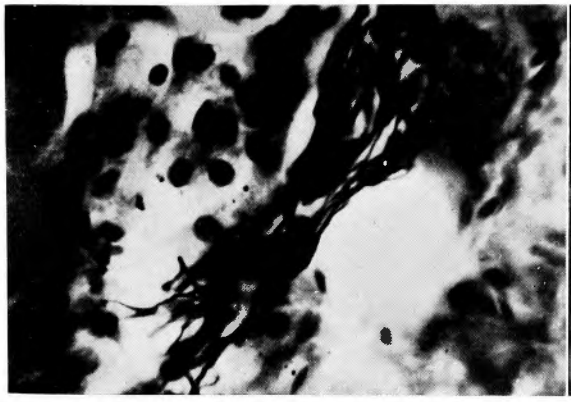


Fig. 25 Nerve bundle of thick nerve fibers forming a plexus in the reticular zone near the border and containing there SCHWANN's nuclei or interstitial cells. ×400.

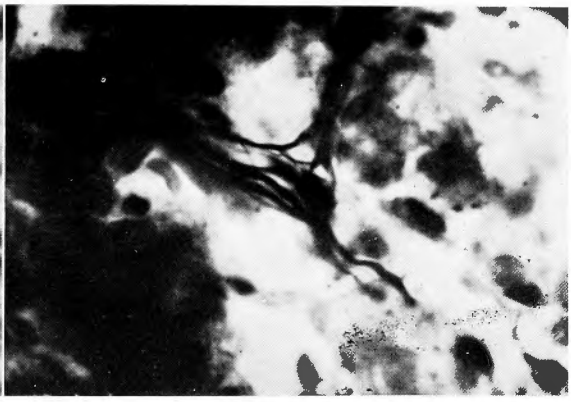


Fig. 26 Thick and fine nerve fibers forming a network at the corticomedullar border. ×400.

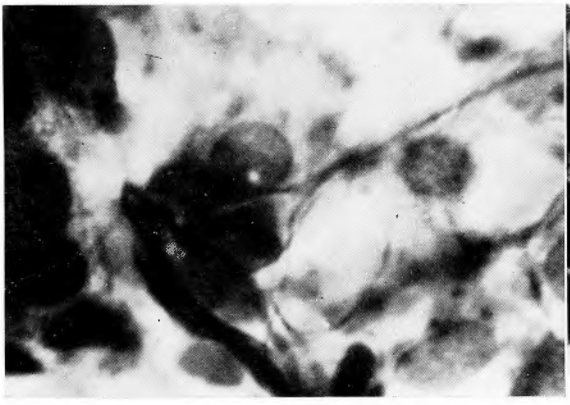


Fig. 27 Thick and fine nerve fibers coming into beneath the glandular cells in the medulla at the border. ×1000.

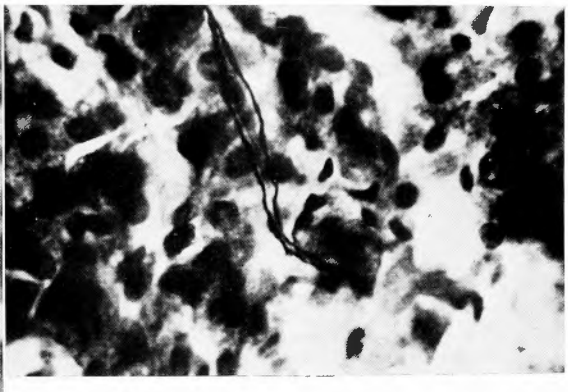


Fig. 28 Small sized nerve bundle of thick nerve fibers in the reticular zone. ×400.

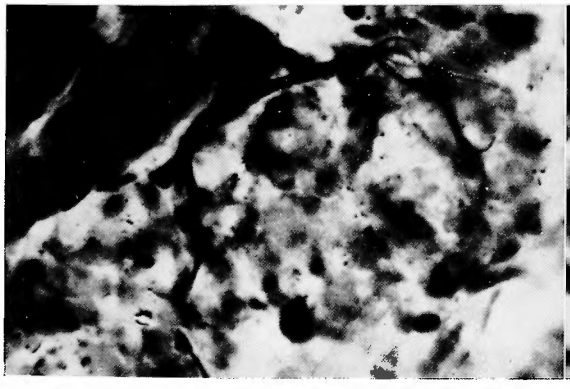


Fig. 29 At the the corticomedullar border the thick nerve fiber repeatedly ramifying into the fine nerve fibers. ×1000.

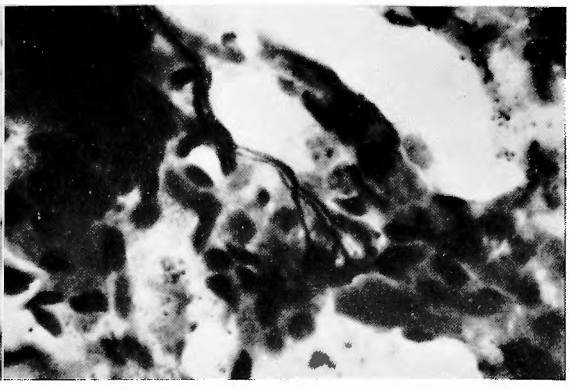


Fig. 30 Nerve fibers arising from the nerve cell in the medulla, making a nerve bundle and then passing through the corticomedullar border. ×400.

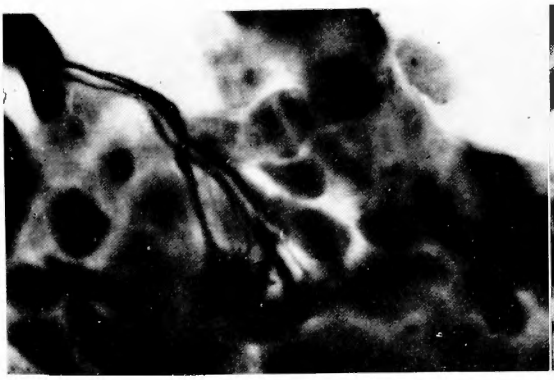


Fig. 31 Enlargement (×1000) of Fig. 30.

Fig. 32 Nerve plexus in the cortico-medullar border. ×1000.

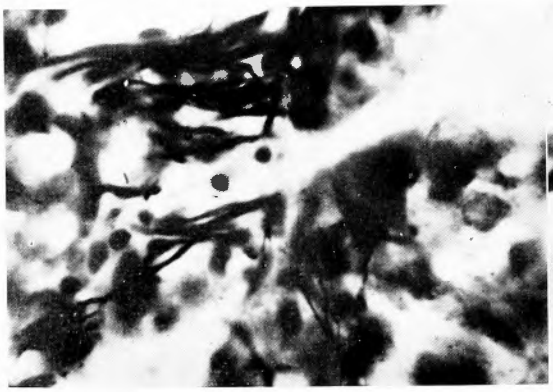


Fig. 33 Nerve plexus of thick nerve fibers in reticular zone and nerve cell with fine nerve fibers communicating each other. ×400.

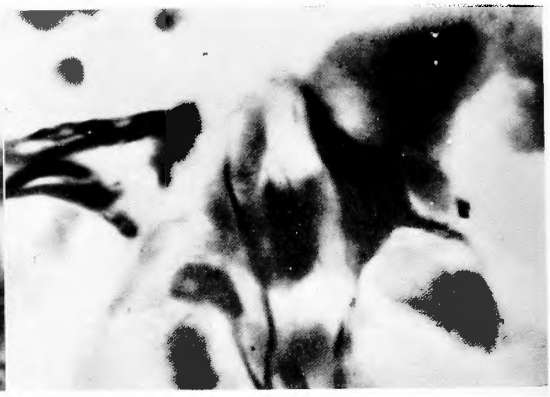


Fig. 34 Enlargement (×1000) of Fig. 34.

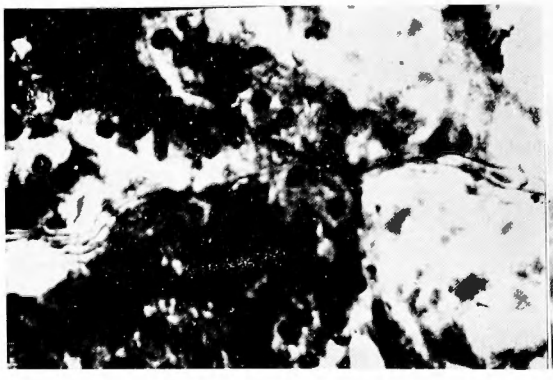


Fig. 35 Median sized nerve fibers forming a thin and loose nerve bundle and connecting the cortex and the medulla. ×300.

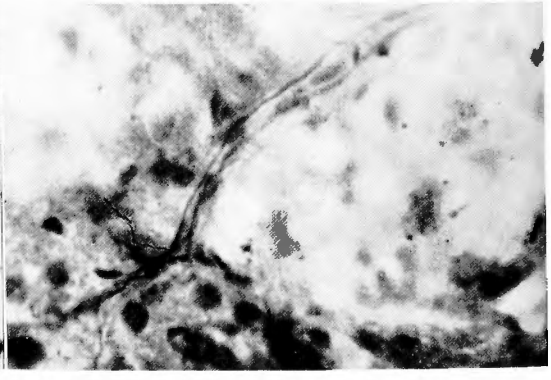
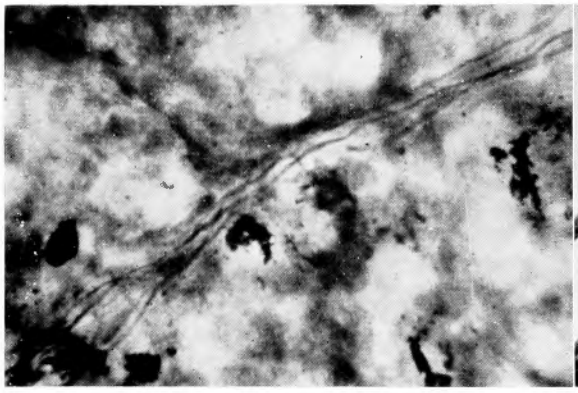


Fig. 36 Enlargement of Fig. 35. ×400.



v) Medulla

Fig. 37 The same bundle as in Figs. 35, 36 spreading out in the medulla. ×400.

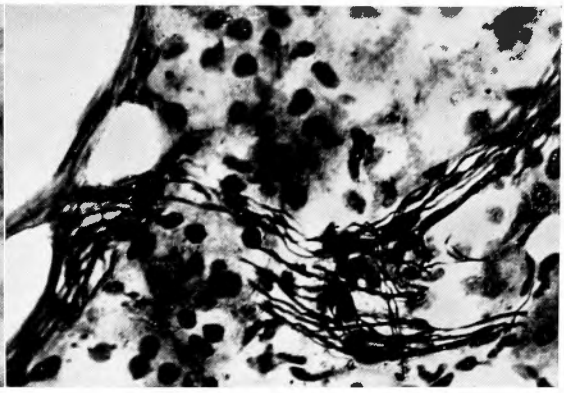
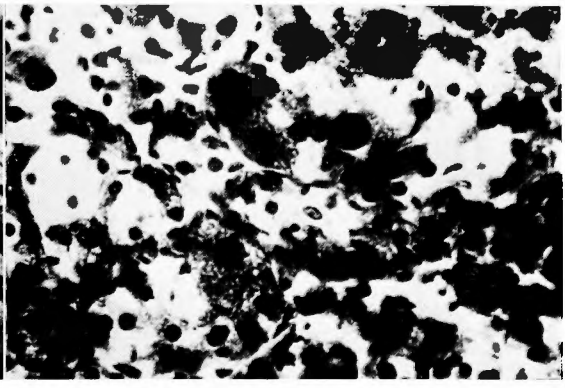


Fig. 38 After passing the border the thick nerve bundle spreading out in various forms. ×400.

Fig. 39 The same bundle as shown in Fig. 38. coming to the cells beneath the sinus. ×400.



Ⅱ) Aldosteronism

Fig. 40 Irregular cell arrangement in adrenocortical adenoma of aldosteronism. ×200.

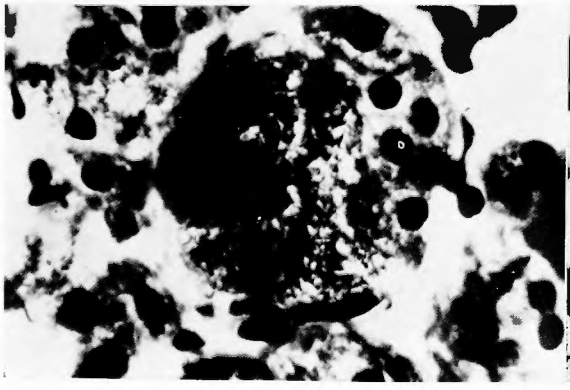


Fig. 41 Huge sized tumor cell. ×400.

Fig. 42 Neurofibrils with SCHWANN's nuclei around the tumor cell group. ×400.

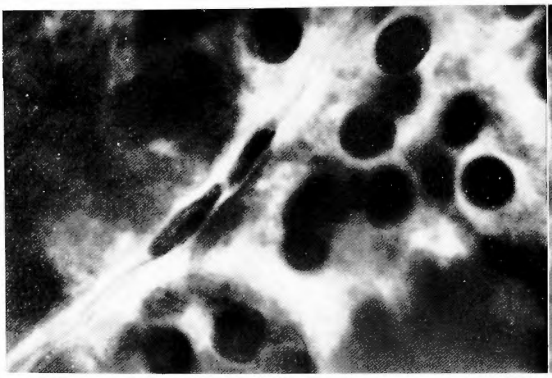


Fig. 43 Neurofibrils with SCHWANN's nuclei around the tumor cell group. ×1000.

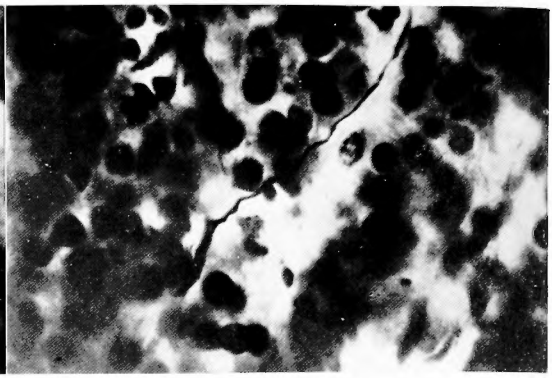


Fig. 44 Thick nerve fiber in the fascicular cell-arrangement. ×400.

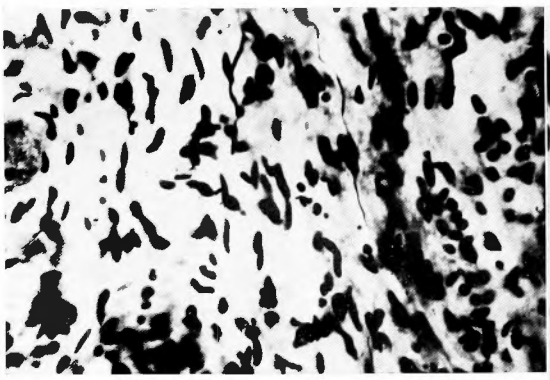


Fig. 45 Nerve fiber with SCHWANN's nuclei or interstitial cell in the connective tissues. ×200.

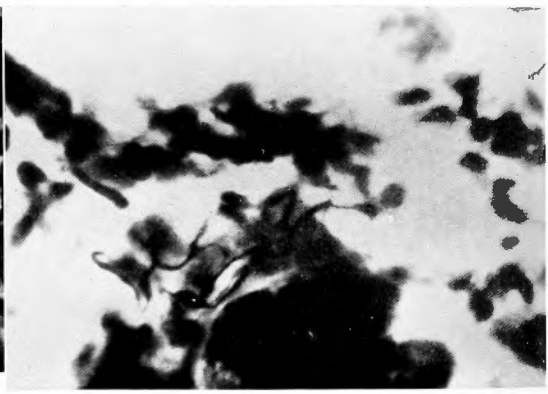


Fig. 46 Tangled thick nerve fiber forming a apperance of an arabesque in the area near the medulla. ×400.

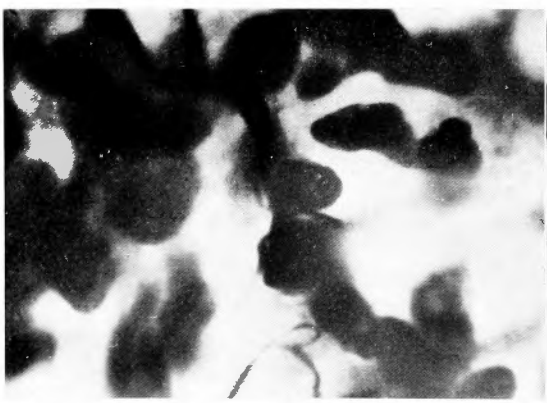


Fig. 47 In the same area as in Fig. 46. the thick and fine nerve fibers. ×1000.

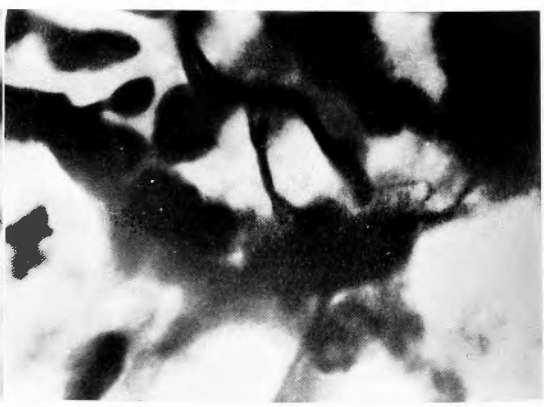
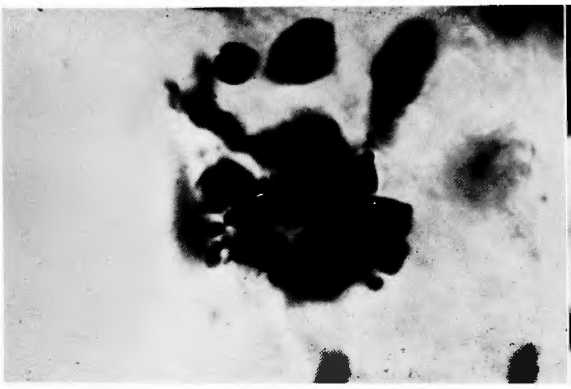
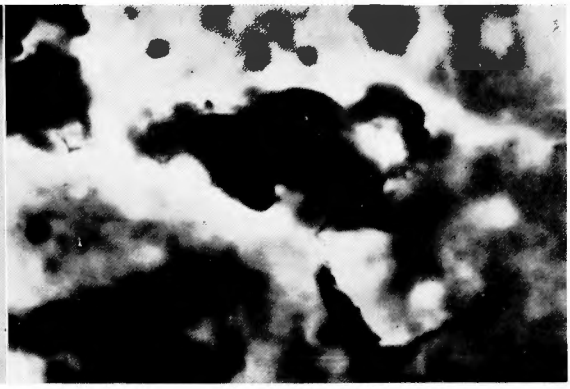


Fig. 48 Nerve cell with processes and neve fibers in the same area as shown in Fig. 47. ×1000.

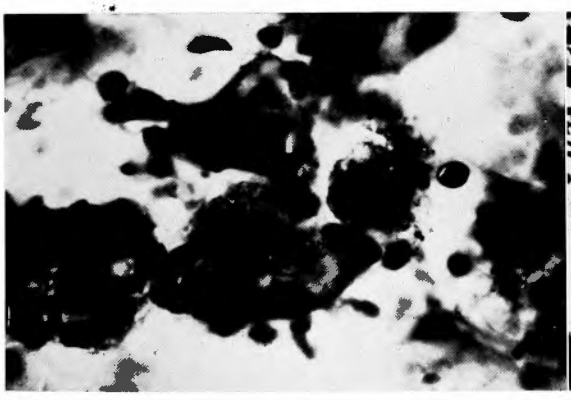




Ⅲ) Pheochromocytoma

Fig. 49 Fig. 49. 50. 51. Nerve cells with large accessory cells. ×1000.

Fig. 50



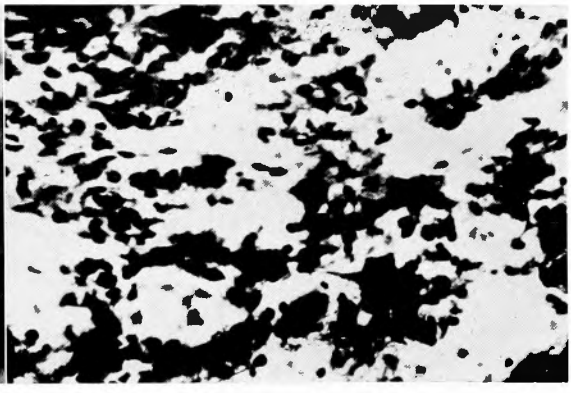


Fig. 51

Fig. 52 Dark stainable (argylophile) cells and SCHWANN's syncytia surrounding the extremely developed venous sinus. ×200.

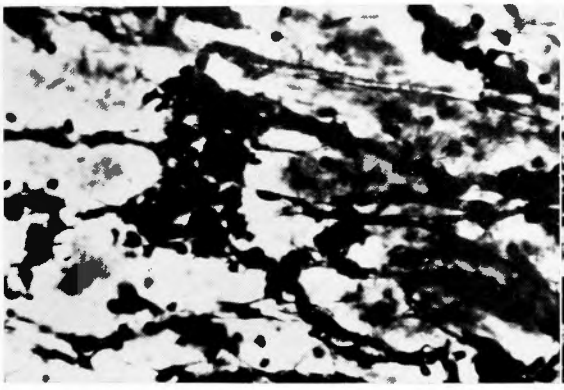


Fig. 53 The same as Fig. 52.

Fig. 54 The same as Fig. 52.

Fig. 55 Extremely proliferated argylophile cords : SCHWANN's cell syncytia. ×200.

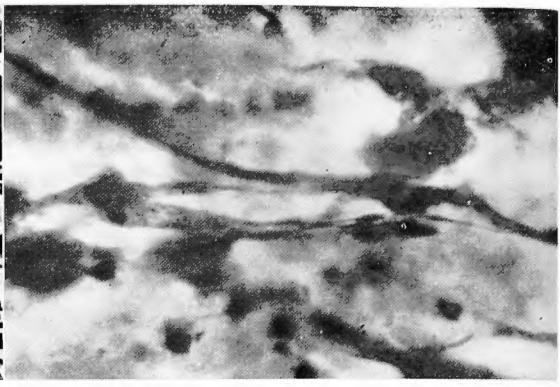


Fig. 56 The same as Fig. 55. ×1000.

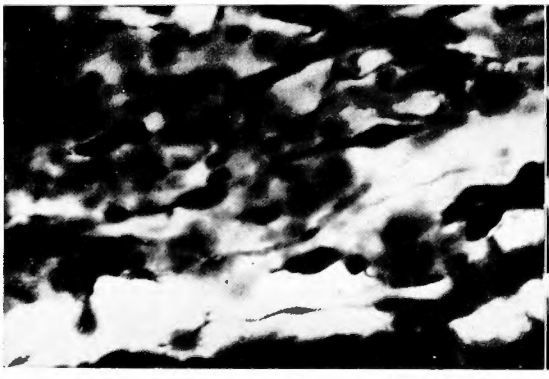


Fig. 57 The same as Fig. 55. ×400.

Fig. 58 Argylophile cords and nerve cell. ×400.

Fig. 59 Extremely proliferated accessory cells and SCHWANN's cell syncytia. ×1000.

Fig. 60 Developed SCHWANN's syncytia without nerve fibers. ×1000.

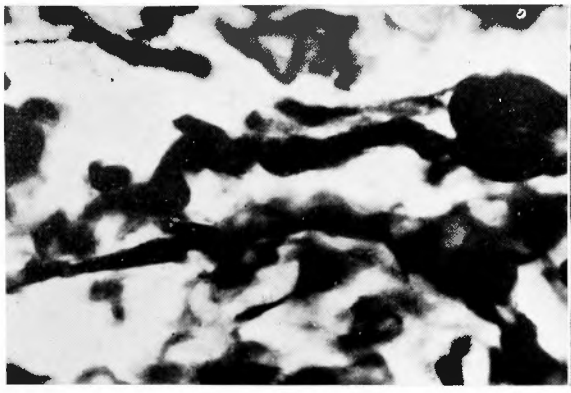


Fig. 61 Proliferated interstitial cells with argylophile cords. ×1000.

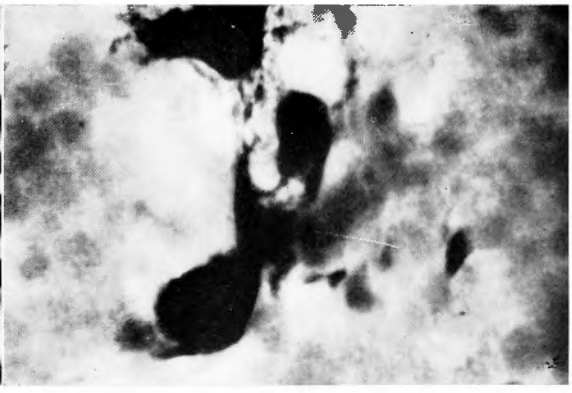


Fig. 62 Developed accessory cells and SCHWANN's cell syncytia. ×1000.

Fig. 63 The same as Fig. 62.

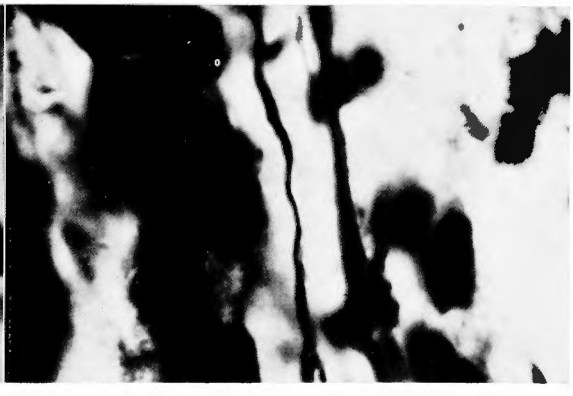


Fig. 64 Nerve fibers running paralleled with argylophile cords. ×1000.

Fig. 65 The same as Fig. 65.

Fig. 66 Proliferated accessory cell and SCHWANN's syncytia. ×1000.

Fig. 67 Various formed dysharmonic nerve cells. ×1000.

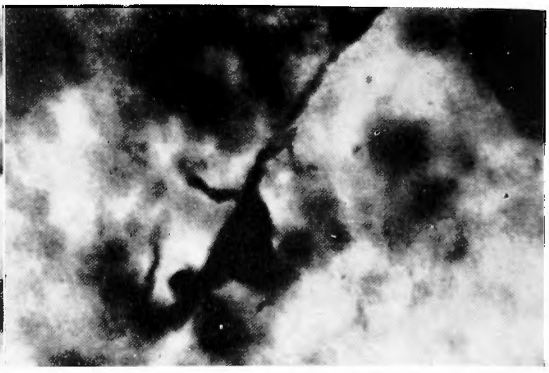


Fig. 68 The same as Fig. 67.

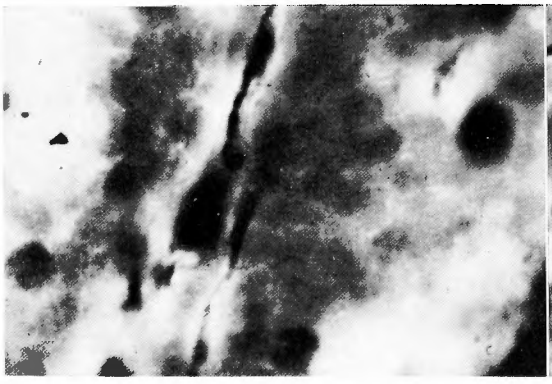


Fig. 69 The same as Fig. 67.

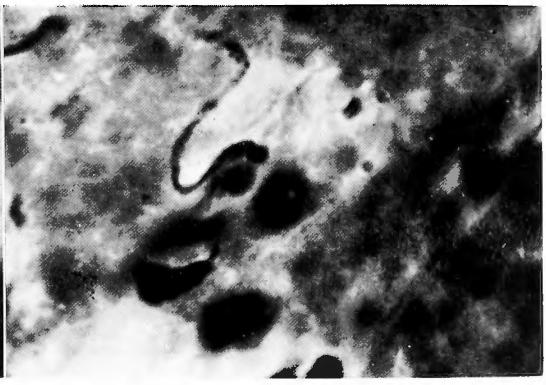


Fig. 70 The same as Fig. 67.

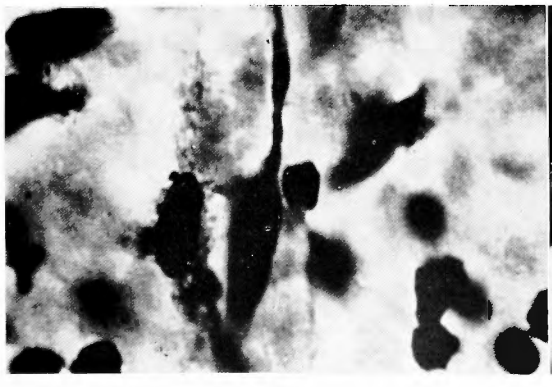


Fig. 71 The same as Fig. 67.

Fig. 72 The same as Fig. 67.