KIM BONG HAN, D. Sc. (BIOLOGY)

ON THE KYUNGRAK SYSTEM

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Publisher's Note

In modern biology the problem of the unity of the organism and the environment, problem of the regulating mechanism which ensures a complete co-ordination of the function and activity of each component of the organism, and problem of the biochemical basis of the activity of living substance, constitute the most fundamental problems.

Biologists and medical scientists of the world have set up a number of well-substantiated theories and attained valuable achievements in the course of their research into these problems.

But the modern biology and medical science still have many problems to solve — the functions and role of nucleic acids in metabolism, the essence of hereditary phenomena, the growth and development of such diseases as tumor and their cure, etc.

This is connected with the fact that the modern biological theories still fail to give a full elucidation to the mechanism that ensures the unity of the activities of the organism.

Such limitations of the existing theories have long since placed it on the order of the day for biology and medical science to probe further into the secrets of the living substance, to find out a new course of development for themselves.

The Korean biologists and medical scientists found a clue to the solution of this problem in Kyungrak, which makes up the core of Dongeuihak, the traditional Korean medicine, one of the brilliant scientific heritages handed down by their ancestors.

Professor Kim Bong Han and his associates discovered the substance of Kyungrak, a new anatomico-histological system in the living body. It is an integrated system entirely different either from the nervous system or blood and lymphatic vessels. The results of their research were made public in August 1961, which created a sensation in the world of biology and medicine as the discovery of another secret of the living body.

Since then their research work made further progress, blazing the trail along an untrodden track to divulge the secrets of the organism.

The Kyungrak research collective clarified the histological microscopic composition of a structure (Bonghan corpuscle) found in the Kyunghyul position and a tubular structure (Bonghan duct) which connects the Bonghan corpuscles; they also disclosed their distribution and discovered new facts.

The Bonghan corpuscles, according to the results of their researches, have their own specific histological structure, and are distributed not only in the superficial layer of the skin but in the profund subcutaneous tissues, in the blood and lymphatic vessels and around the internal organs as well.

Bonghan ducts which link the Bonghan corpuscles are distributed round the artery, vein and lymphatic vessel, and even within them in an isolated manner, as well as in the superficial layer of the body.

The collective of Kyungrak researchers confirmed, through bioelectrical experiments, that the Kyungrak system has specific bioelectrical features. It was also proved that the Bonghan corpuscle is an excitable tissue which reacts differently to various external and internal stimuli and is correlated with certain internal organs.

The researchers delved into the chemical composition of the contents (Bonghan liquor) of the Bonghan duct by biochemical and histo-chemical methods, and established the fact that there was liquor circulating along a definite course in the Bonghan duct, a liquor containing nucleic acids, especially a large amount of desoxyribonucleic acid (DNA).

This has made it necessary to reconsider the accepted conception that DNA exists only in the nucleus and that ribonucleic acid only in the nucleolus and cytoplasm.

Today the substance of Kyungrak in all its aspects has been brought to light as a system covering the whole body, regulating and coordinating the biological processes that lie at the bottom of the vital activity.

This is indeed an epoch-making discovery and a big step forward in the development of biology and medical science. It is a product of bold scientific research free from existing formulas and theories, a fruit of enormous scientific stamina coupled with a high level of technique, and an embodiment of correct methods of analysis and synthesis applied from the viewpoint of unity between forms and functions.

In the long years of research work by Professor Kim Bong Han and his associates, there cropped up many difficulties and they had to grapple with countless complex problems. But they never yielded.

Comrade Kim Il Sung and the Central Committee of the Workers' Party of Korea always showed deep concern for their research work, inspiring them with courage all the time. This enabled them boldly to explore an untrodden path of scientific investigation and bear the brilliant fruits.

With the great achievements of the research in the Kyungrak system, it has now become necessary to re-examine the prevailing theories that give one-sided explanation to the fundamental problems of the phenomena of life including the regulating mechanism of the living body, not knowing that the Kyungrak system is an objective being.

The new achievements have opened up broad prospects of solution of such fundamental problems arising in modern biology and medical science as differentiation of the cells, metabolism, heredity, the reactivity of the organism, the causes and development of diseases, etc., thus paving the way for the solution of problems of better health and longer life of man.

This great discovery by the scientists of our country signifies a revolutionary event ushering in a new stage in the development of modern biology and medical science. We are convinced that the discovery will go down in history as a monument of science.

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Kim Bong Han, D. Sc. (Biology)

Part I

MORPHOLOGICAL STUDY OF THE KYUNGRAK SYSTEM

Our discovery of the substance of Kyungrak has raised a new question of principle before modern biology.

Having discovered the Kyungrak system as a new anatomico-histological system distinct from the vascular and nervous systems, our research staff set it as the first and foremost task in its further research systematically to elucidate the general morphological features of the Kyungrak system.

We have conducted morphological study of the Kyungrak system through experiments on human bodies and animals applying various anatomico-histological research methods. As a result, we have discovered a number of new structures.

Chapter I

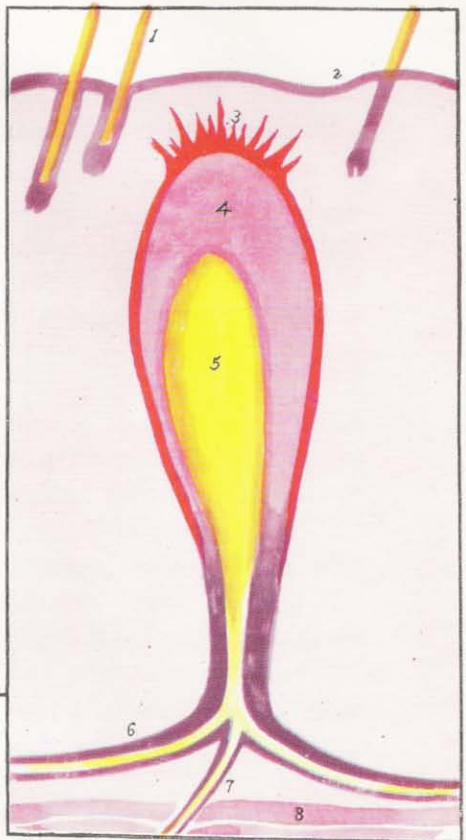
MORPHOLOGY OF THE BONGHAN CORPUSCLE

1. ANATOMICAL OBSERVATIONS ON THE BONGHAN CORPUSCLE

After discovering the Bonghan corpuscles (Corpusculum Bonghan, structures found in the Kyunghyul positions) distributed in the skin, we have found them also deep in the organism. This confirmed that the Bonghan corpuscles are classified into the superficial Bonghan corpuscles and the profund Bonghan corpuscles according to their location, forms and structure.

Fig. 1. Model of Superficial Bonghan corpuscle

1.) Hair
2.) Epidermis
3.) Radiating smooth muscle fibre
4.) Outer layer
5.) Inner substance
6.) Superficial Bonghan duct
7.) Profund Bonghan duct
8.) Skeletal muscle



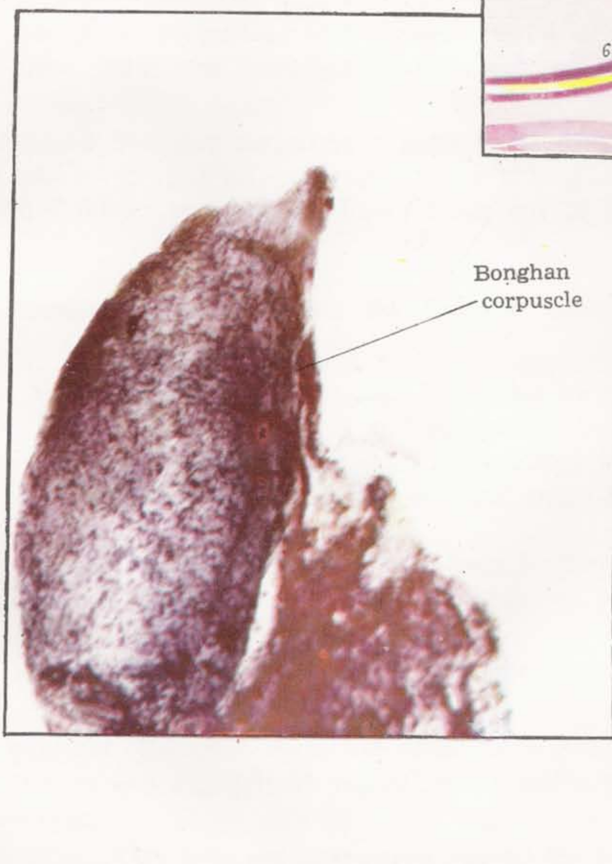


Fig. 2. Superficial Bonghan corpuscle (16×16)

A. Anatomical Observations on the Superficial Bonghan Corpuscle

By the vivi-staining method and by the unique external appearance of the Kyunghyul position we could unmistakably single out the Bonghan corpuscles and basically clarify their morphological features. The surface of the Kyunghyul position in the living body is more lustrous than in the non-Kyunghyul position and has a light yellowish colour and the appearance of softness *(Fig. 1)*.

The Bonghan corpuscle located in the reticular layer of the skin in the Kyunghyul position is an oval structure with a long diameter of 1.0-3.0 mm and a short diameter of 0.5-1.0 mm, and its long axis stands vertical to the surface of the skin *(Fig. 2)*.

The bottom-most part of the Bonghan corpuscle is connected with the bundle of blood vessels and Bonghan ducts.

Comparatively large blood vessels run around the Bonghan corpuscle, their branches touching it.

The Bonghan corpuscle and tissues around it are loosely linked with each other, and there is comparatively much tissue fluid in the connective tissues.

The exposed Bonghan corpuscle is more transparent than the tissues around it and is of light yellow colour. When it is dissected, semi-transparent, semi-fluid, tacky Bonghan liquor flows out of it.

B. Anatomical Observations on the Profund Bonghan Corpuscle

It has been established that profund Bonghan corpuscles are located deep in the subcutaneous tissues, in and around the blood and lymphatic vessels and around the internal organs and that they are connected with the superficial Bonghan corpuscles and internal organs by the Bonghan ducts.

The profund Bonghan corpuscle is a long fusiform one (cucumber-shape) with blunt ends or an oval form. It measures 3.0-7.0 mm in long diameter and 0.5-1.0 mm in short diameter.

Both ends of the Bonghan corpuscle are connected with the Bonghan duct.

The profund Bonghan corpuscle looks more compact than the surrounding tissues and has a light yellow colour and a comparatively distinctive features.

Hosts of capillary nets are interwoven around the Bonghan corpuscle.

2. HISTOLOGICAL STRUCTURE OF THE BONGHAN CORPUSCLE

The Bonghan corpuscle is not only an anatomical structure with a distinct boundary but has a very special histological structure hitherto unknown.

The superficial and profund Bonghan corpuscles are similar to each other in that both are linked with the Bonghan ducts and are formed of specific cells, but they have a number of different points in structure.

A. Histological Structure of the Superficial Bonghan Corpuscle

The superficial Bonghan corpuscle comprises the outer layer made up of smooth muscle and the inner substance made up of special cellular elements and many capillary nets *(Fig. 3)*.

The outer layer made up of thick smooth muscle layer can be subdivided into outer circulating layer and inner longitudinal layer according to the direction the muscle fibre runs *(Fig. 4)*.

At the top of the superficial Bonghan corpuscle, the smooth muscle fibres spread out in the connective tissues around them, towards the layer of the epidermis *(Fig. 5)*.

The outer circulating layer is a thin smooth muscle fibre layer surrounding the Bonghan corpuscle. It can be distinctly observed in the fresh specimen that exposes the Bonghan corpuscle *(Fig. 2)*.

The smooth muscle fibres in the outer circulating layer are loosely linked up with the connective tissues around them.

The inner longitudinal layer is a thick smooth muscle layer, its fibres running parallel with the long axis of the Bonghan corpuscle.

Of these fibres the muscle fibres abutting on the inner substance run obliquely up to the region bordering on the inner substance and there they all end together. Therefore their border is distinct.

The thickness of the inner longitudinal layer is not uniform; one part is thicker than the other *(Fig. 6)*.

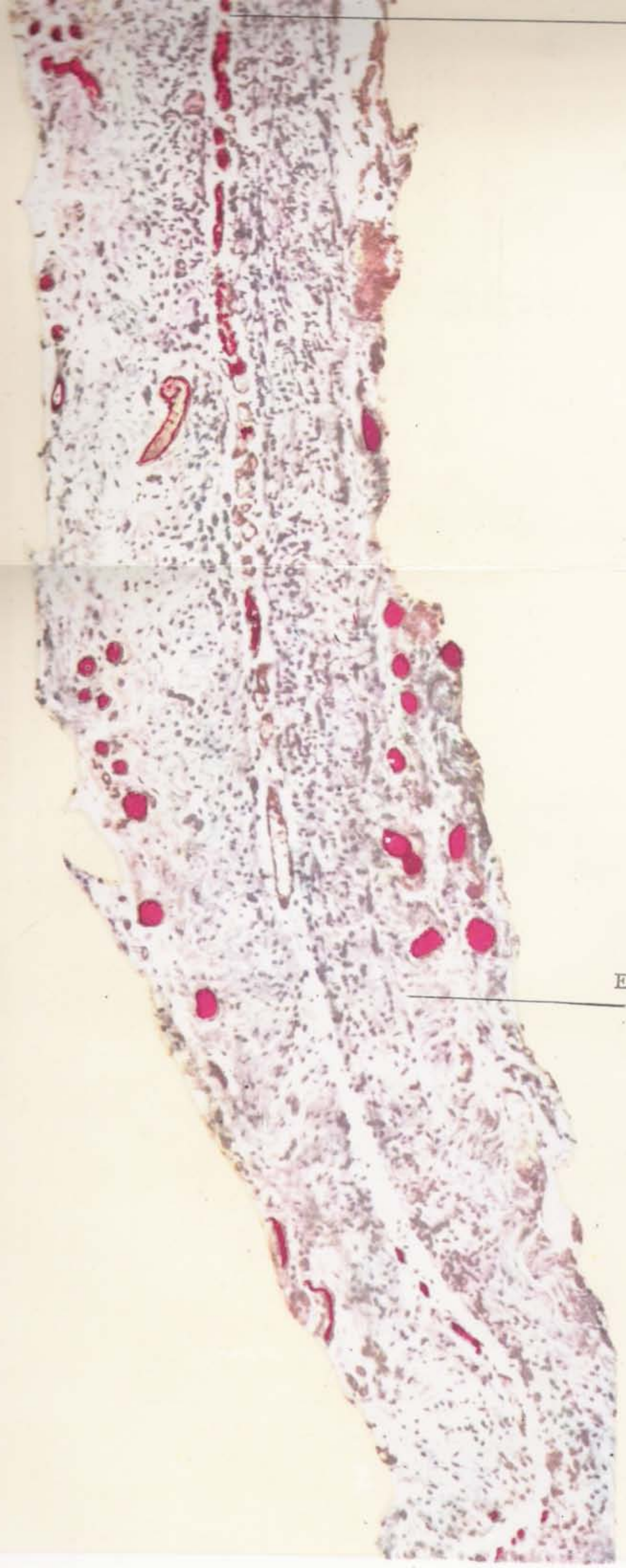
We observed a peculiar phenomenon when we applied a needle to the centre of the superficial Bonghan corpuscle from the surface of the skin. The needle slowly makes a conical movement, subtly trembling, and at times it moves vertically to the surface of the skin.

This serves to show the characteristic feature of the movement of the Bonghan corpuscle. This phenomenon is named "Kim Se Wook phenomenon" (Phenomenon Kim Se Uc) after its discoverer.

The outer layer becomes gradually thinner as it reaches the bottom of the Bonghan corpuscle; the space between the muscle fibres grows


Radiating smooth muscle fibre
Outer circulating layer
Inner longitudinal layer
Inner substance
Bonghan duct-blood vessel bundle


Epidermis
Radiating



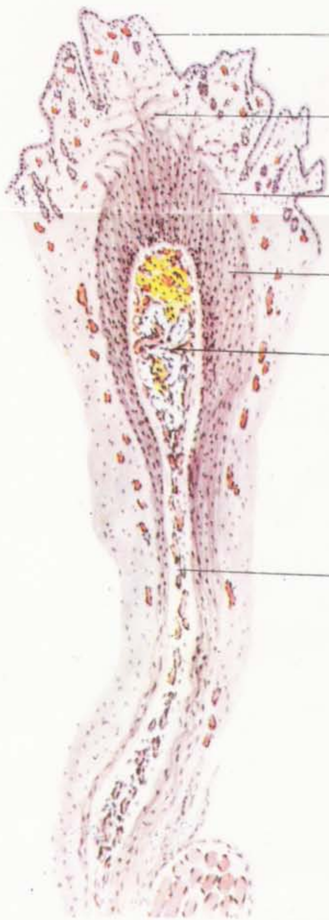


Fig. 3. Longitudinal section of superficial Bonghan corpuscle (16×6.3)

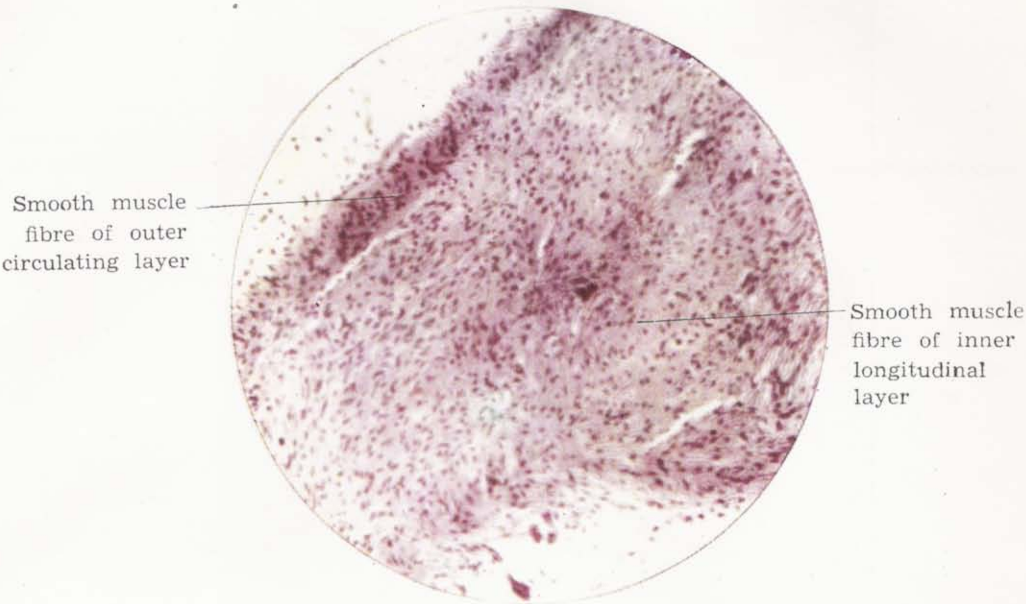


Fig. 4. Outer layer of superficial Bonghan corpuscle (longitudinal section) (16×16)

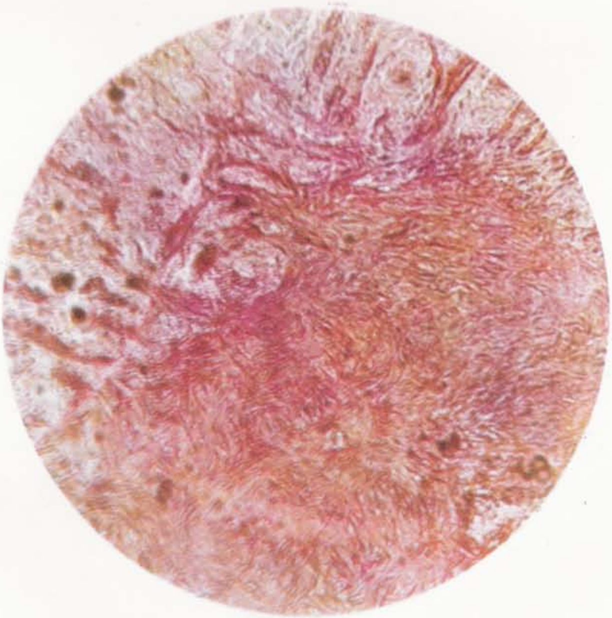


Fig. 5. Radiating smooth muscle fibre (cross section) on the upper part of superficial Bonghan corpuscle (16×16)

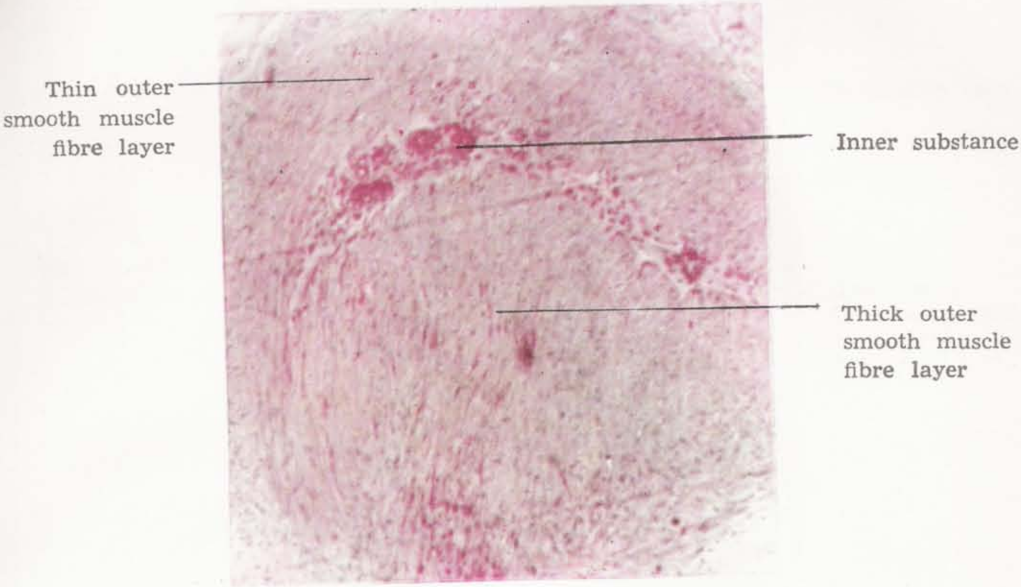


Fig. 6. Cross section of superficial Bonghan corpuscle (16×6.3)

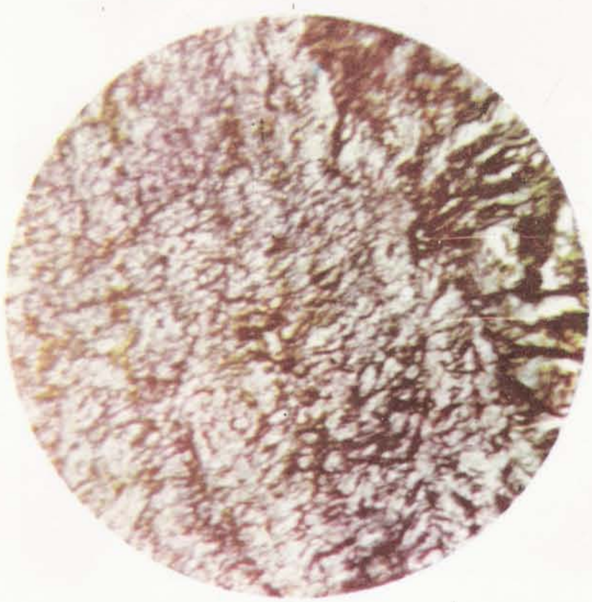


Fig. 7. Argyrophile fibre inside the superficial Bonghan corpuscle (16×16)

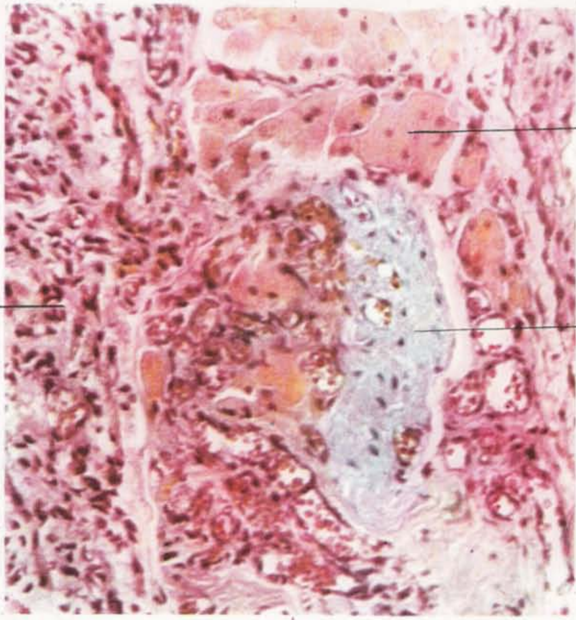


Fig. 8. Inner substance of superficial Bonghan corpuscle (16×16)

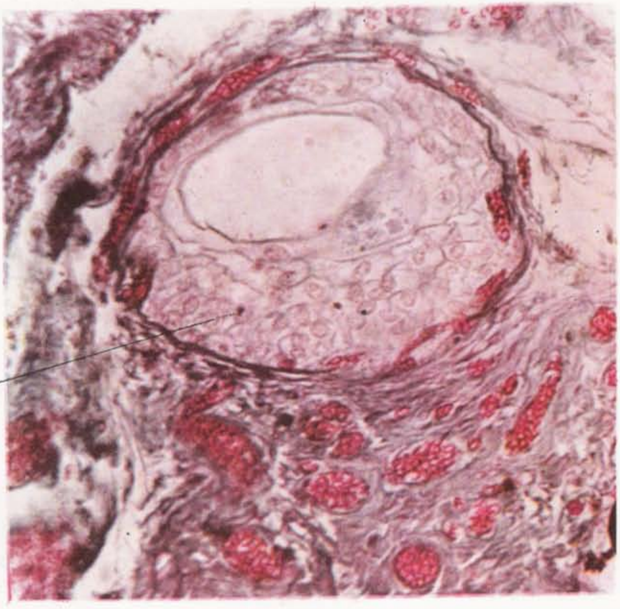


Fig. 9. Follicular structure of the inner substance of superficial Bonghan corpuscle (16×16)

wider; and between the muscle fibres there is an abundance of fibrous connective tissues rich in elastic fibres. At the bottom of the Bonghan corpuscle these connective tissues girdle the bundle of blood vessels and Bönghan ductules that are linked up with the Bonghan corpuscle.

Argyrophile fibres and capillary vessels are distributed between the smooth muscle fibres of the outer layer *(Fig. 7)*.

These capillary vessels are linked up with the blood vessels of the inner substance and with the blood vessels inside the connective tissues around the Bonghan corpuscle.

In some of the Bonghan corpuscles, one can observe, those comparatively thick blood vessels coming from the inner substance in the upper part pass through the outer layer and flow into the capillary vessels in the group of cells under the epidermis.

The inner substance of the Bonghan corpuscle comprises different kinds of cellular groups, fibrous connective tissues which abound in argyrophile fibres surrounding the cellular groups and well-developed capillary nets.

In all parts of the inner substance, one can observe, chromaffin cells are distributed in rows, around the blood vessel, in small groups or scattered. The size of the chromaffin cell is about 15-25 microns in diameter, its shape being round or oval.

In the centre of the cell is a round nucleus 5-10 microns in diameter, full of chromatin.

The cytoplasm is evenly filled with granules stained yellowish brown by bichromate. Of these cells some have distinct borders and others have indistinct border.

The inner substance has structures distinct from the connective tissues around it and from the chromaffin cells.

These structures have fibrous structures resembling collagenous and elastic fibres and there appear between them small granules that are sometimes basophilic and at other times acidophilic.

In these structures nuclei of different forms are found scattered in large numbers at times and in a very small number at another time *(Fig. 8)*.

In the central and lower parts of the inner substance we observe a follicular structure consisting of characteristic epithelial cells and around it groups of characteristic cells of the smooth-muscle shape.

There are 1-3 follicular structures in a Bonghan corpuscle.

The wall of the follicular structure is made up of layers of epithelial cells of flat, cuboidal or rhombic shape *(Fig. 9)*.

A cell is about 12-20 microns in diameter; its nucleus is round and 5-10 microns in diameter.

The outer part of the follicular structure is thinly enveloped in the connective tissue fibres and there are many capillary vessels around the structure.

Capillary vessels are distributed in the layer of the cells of the follicular structure. Basophilic granules of indefinite forms are often to be found in the cavity of the follicular structure, but no cellular element is to be found.

Peculiar cells of the smooth-muscle shape are observed around the follicular structure. They are of the spindle shape, and their cytoplasm can be deeply stained. They form long lines or small groups.

Between the cells of the smooth-muscle shape there is space, and structures resembling an inter-cell bridge are to be found there *(Fig. 10)*. Nucleus of the cell is small and round, and the chromatin can be deeply stained.

There are dense capillary nets in the inner substance. Particularly in the lower part of it we find many capillaries with wide lumen and in many cases the blood vessels are found full of blood *(Fig. 11)*.

In some of the Bonghan corpuscles we observe the blood vessel in the upper part of the inner substance pass through the outer layer in the direction of the skin. The blood vessel inside the inner substance runs along the bundles of Bonghan ducts and blood vessels hanging on the bottom of the Bonghan corpuscle to join the blood vessels outside the Bonghan corpuscle.

The Bonghan duct and neural element can also be observed inside the inner substance.

There is a small semi-globular mass of cells between the upper part of some superficial Bonghan corpuscles and epidermis and their convex faces look to the Bonghan corpuscle *(Fig. 12)*.

The semi-globular mass of cells is covered with the connective tissue membrane and its border with the epidermis is distinctly discernible. And there are many capillary vessels in the connective tissue membrane.

The border between the cells of this group is distinct; they are about 15-20 microns in diametre; the cytoplasm is bright; the nucleus is round or oval and 8-12 microns in diameter.

The nuclear membrane is clearly observed, the chromatin is comparatively scanty and a small nucleolus is to be seen.

Sometimes pseudo-eosinophilic leucocytes and small cells with curved nuclei make their appearance between cells.

The capillary nets running between cells are connected with the blood vessel coming from the upper part of the superficial Bonghan corpuscle.

Fig. 10. Cells of smooth muscle shape of the inner substance of superficial Bonghan corpuscle (16×16)

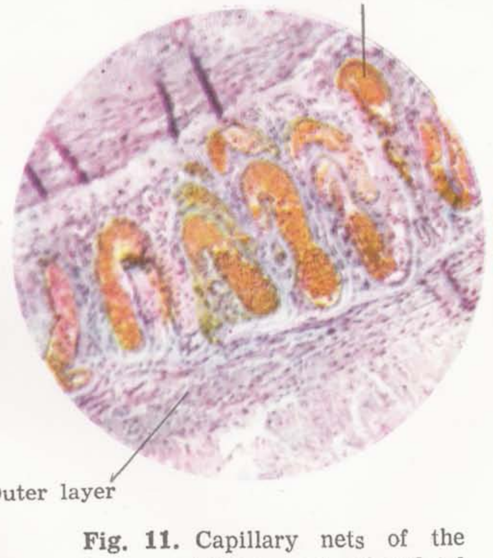


Fig. 11. Capillary nets of the inner substance of superficial Bonghan corpuscle (16×16)

Fig. 12. Semi-globular group of cells (16×40)

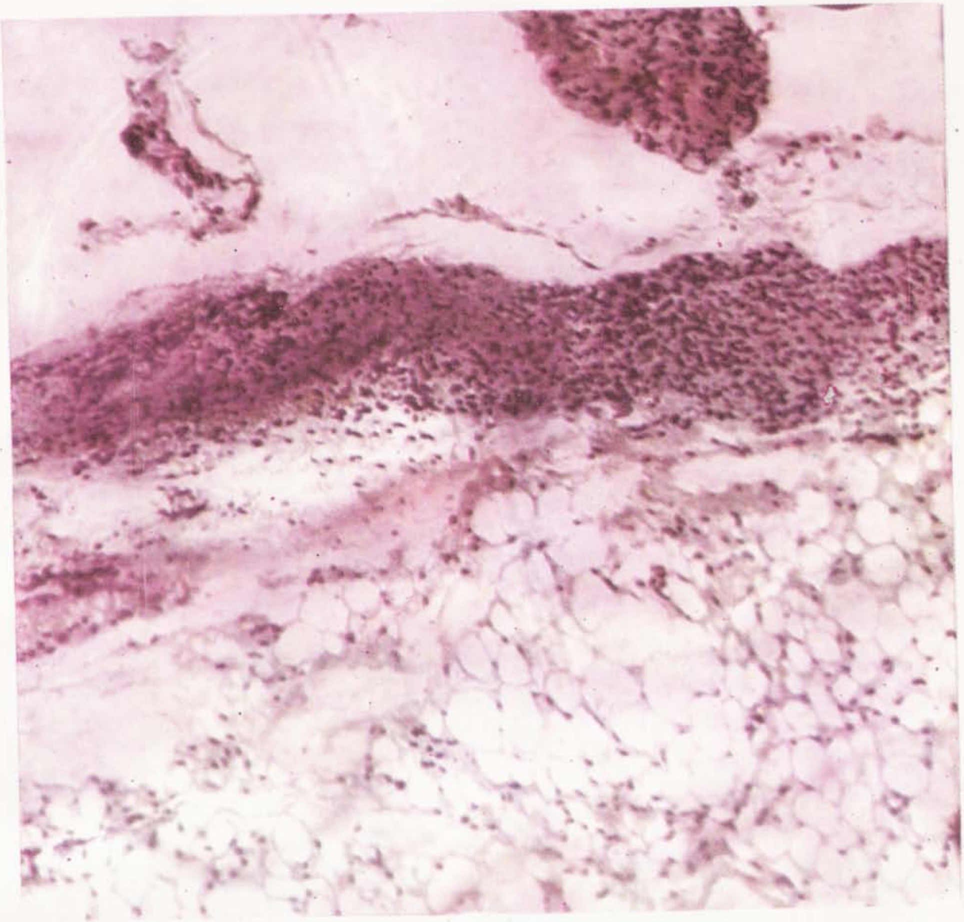


Fig. 13. Profund Bonghan corpuscle (16×6.3)

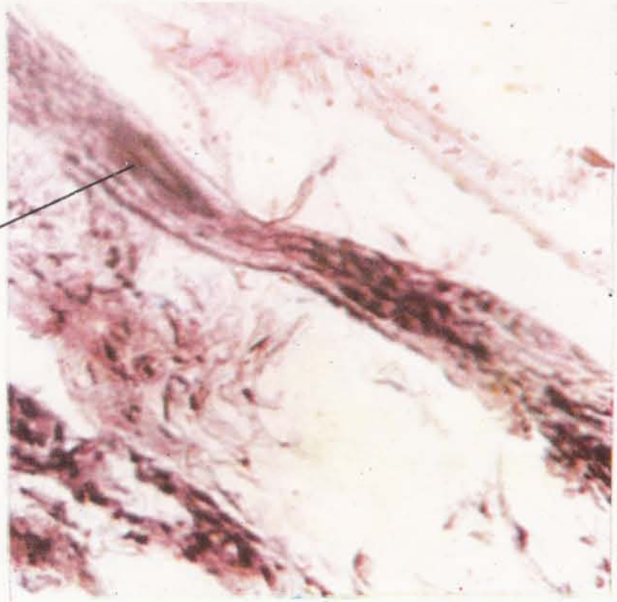


Fig. 14. Profund Bonghan corpuscle (16×16)

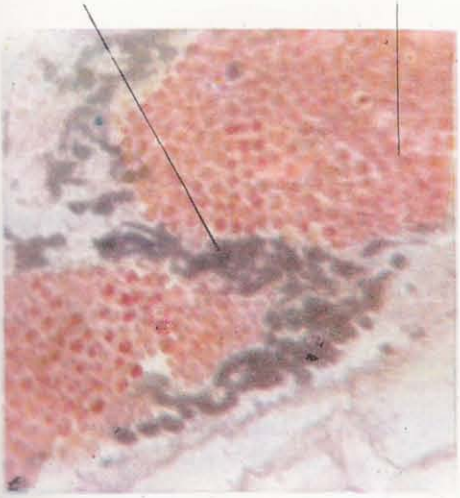


Fig. 15. Profund Bonghan corpuscle (16×40)

Fig. 16. Profund Bonghan corpuscle (16×40)

It has been proved that the histological structure of the Bonghan corpuscle has nothing in common with the already discovered structures existing in the skin and that it is a new histological structure.

The Bonghan corpuscle is of a peculiar structure clearly distinguishable from the Vater Paccini corpuscle, from the Feuer-Glosser cutaneous glomerules and from the Pinkus hair disk. When we bisect the superficial Bonghan corpuscle in its fresh condition, stain it with acridine-orange and observe it under a luminescent microscope, we find its outer layer tinged with yellowish brown and its inner substance emitting brilliant blue green fluorescence.

B. Histological Structure of the Profund Bonghan Corpuscle

The profund Bonghan corpuscle we have newly discovered is different from the superficial Bonghan corpuscle. It has no outer layer of smooth muscle; it comprises cells of different forms and sizes and basophilic substances.

Cells in the Bonghan corpuscle are arranged in a definite order. At one end of the Bonghan corpuscle are gathered mostly big cells with pale cytoplasm, distinct borders and a pale round nucleus. Cells of this type make up more than 50 per cent of the profund Bonghan corpuscles and without distinct borders they gradually pass on to a group of cells whose nucleus is bigger or smaller than the lymphocyte *(Fig. 13)*.

The chromatin of the nucleus of these cells can be deeply stained, the inner structure of the nucleus is not distinct and its cytoplasm is very small in quantity.

This group of cells is followed gradually by basophilic substances of different shape—granular, rod and thread—big and small.

These basophilic substances which are originally distributed in an irregular manner, take elongated zig-zag shape, scores of microns in length, at the region where Bonghan duct begins. Their arrangement coincides with the course of Bonghan duct *(Fig. 14)*.

We observe well-developed capillary nets in this region of the Bonghan corpuscle where there are many basophilic substances *(Fig. 15)*.

In the profund Bonghan corpuscle one can observe chromaffin cells existing in groups or scattered among other cells *(Fig. 16)*.

The existence of the chromaffin cells in the profund Bonghan corpuscle might present the need of distinguishing them from the paraganglia. But the composition and forms of cells and distribution of the blood vessel in the Bonghan corpuscle show that they are distinct from the paraganglia.

Chapter II

MORPHOLOGY OF THE BONGHAN DUCT

1. ANATOMICAL OBSERVATIONS ON THE BONGHAN DUCT

The Bonghan duct (Ductus Bonghan, a tubular structure linked with the Bonghan corpuscle) is observed in the vital specimen as a semi-transparent and somewhat yellowish thread-shaped structure surrounded with connective tissues, and it contains densely distributed capillary vessels.

Bonghan ducts are linked either with one end of the Bonghan corpuscle (superficial Bonghan corpuscle), or with both ends (profund Bonghan corpuscle), and are distributed in the superficial and profund layers of the body.

The Bonghan ducts in the superficial layer which connect the superficial Bonghan corpuscles, are distributed in the whole body in a definite system, running in the derma. Therefore, we call them "superficial Bonghan ducts."

The Bonghan ducts, however, are not only found in the superficial layer of the body, but are also widely distributed in its profund layer; and it has been newly observed topographically that the Bonghan ducts, running in general along the vessels in all parts of the body—the head, neck, chest, abdomen, limbs, etc.—branch off to all internal organs including the brain.

In this way, the superficial Bonghan duct, which starts from the superficial Bonghan corpuscle enters the body cavity, running through the skin and the muscle layer along the blood vessel, and there, joining with the profund Bonghan duct or profund Bonghan corpuscle, branches off to the relevant organs along the blood vessel.

For instance, it is observed that the Bonghan duct starting from the Bonghan corpuscle at the Joksamri puncture links itself with the profund Bonghan corpuscle after running along the ischiadic nerves and blood vessel bundles, and is distributed in the intestines.

These superficial and profund Bonghan ducts, running outside the vessels generally, keep a definite connection, and are distributed in the corresponding Bonghan corpuscles and organs. So we call them as a whole "extravascular Bonghan ducts."

Moreover, we have also discovered the existence of a structure inside

Fig. 17. Intravascular Bonghan duct (16×16)

Fig. 18. Intravascular Bonghan duct (16×40)

the vessel, a fact which no one has ever conceived of.

We have established through various experiments that the new structure is the same as the extravascular Bonghan duct in respect both of form and construction.

These structures exist not only in the artery and vein, but also in the heart, in the thoracic duct and lymphatic vessels without exception and they are found in the blood and lymph in all vessels in a state of isolation, not adhering to the vessel wall *(Fig. 17)*.

We decided to call this structure "intravascular Bonghan duct" or "Bak Jung Sik-Bonghan duct" (Ductus Bonghan-Pac Dieng Sic) after the name of its discoverer.

The intravascular Bonghan duct running inside the vessel branches off at the diverging point of the vessel and not only enters into the brain and other internal organs but also links the superficial and profund Bonghan corpuscles with the corresponding internal organs.

The superficial Bonghan duct is linked with the lower end of the superficial Bonghan corpuscle in a unipolar or pseudo-unipolar form, and the profund Bonghan duct is linked in a bipolar form with both ends of the profund Bonghan corpuscle existing in all regions. Semi-fluid and sticky liquid of somewhat yellowish colour is observed flowing in the Bonghan duct.

This liquid is named "Bonghan liquor" (Liquor Bonghan).

2. HISTOLOGICAL STRUCTURE OF THE BONGHAN DUCT

It is established that the extravascular Bonghan duct and intravascular Bonghan duct are of the same histological structure and have a series of features entirely distinct from the histological structure of the blood vessel, nerve, and lymphatic vessel so far known to us.

Each Bonghan duct is formed of a bundle of several Bonghan ductules. The Bonghan ductule has a unique striated structure and its wall is made of very thin endothelial cells.

The diameter of the Bonghan ductule, though it varies according to its functions and the quantity of its content, ranges from 10 microns, when it is thin, to 30-50 microns, when it is thick, in the routine fixed specimen.

When injected with a certain staining solution, the diameter of the Bonghan ductule becomes more enlarged than in its normal state *(Fig. 18)*.

The border of endothelial cells forming the wall of Bonghan ductule, unlike those of the lymphatic and blood vessels, is difficult to discern in the histological specimen, but there appear many long rod-shaped, narrow nuclei of 12-20 microns *(Fig. 19)*.

This nucleus can be stained heavily, and its nucleolus is to be seen with difficulty.

Large and small basophilic granules in the Bonghan ductule are observed in the histological specimen, which are more densely distributed around the circumference of the Bonghan ductule than in its interior.

The form and size of this granule vary, depending on the location of the Bonghan duct and the method of making the histological specimen.

The contents of the Bonghan duct present themselves in the form of droplet of various sizes when put to special staining, and are observed to be full of small granules when injected with a certain staining solution.

When these contents are stained with acridine-orange and observed under a luminescent microscope, they are seen, as in the case of the inner substance of the superficial Bonghan corpuscle, producing a bright, unique fluorescence of deep green or yellowish green colour *(see part III)*.

Such phenomenon of producing fluorescence suggests that the contents of the Bonghan corpuscle and the Bonghan duct are of special nature.

When observed under a phase-contrast microscope, the wall of the Bonghan duct is very thin; its rod-shaped endothelial nucleus is clearly distinguished by its dark shadow and the lines of each Bonghan ductule in the Bonghan duct are distinct *(Fig. 20)*.

On the vivi-stained specimen unique striated structures with different striae from those of the skeletal muscle, are clearly observed in the Bonghan ductules which also contain granules.

The basic histological structure of the Bonghan duct itself mentioned above is the same both in the extravascular Bonghan duct and in the intravascular Bonghan duct. But their surrounding tissues are different from each other.

This intravascular Bonghan duct is found inside the blood and lymphatic vessels and in the flow of the blood and lymph, and has no surrounding connective tissues.

But the extravascular Bonghan duct is covered with fibrous connective tissues which contain many capillary vessels densely distributed in them.

Fibrous connective tissues made of numerous elastic fibres are also observed surrounding the circumference of the Bonghan duct at the connecting point of the Bonghan duct and the Bonghan corpuscle.

Fig. 19. Extravascular Bonghan duct (16×40)

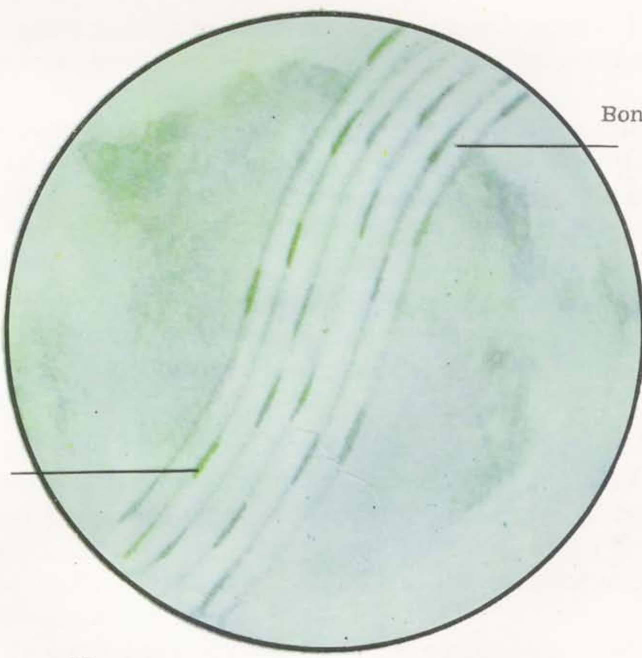


Fig. 20 Phase-contrast microscopic observations of Bonghan duct

SUMMARY

The new facts we have found in the course of studying the morphological features of the Bonghan corpuscle and the Bonghan duct, the major component elements of the Kyungrak system, will help eliminate the limitation in the established anatomico-histological conception in biology and raise new questions in the basic theory of biology.

Kyunghyul which was vaguely considered to be a position where nerves and blood vessels branch off to the skin, has come to hold a firm place as a new morphological unit with its specific anatomical and histological structure.

It was found, in particular, that the Bonghan corpuscles which had been so far considered to exist only in the skin, are also distributed deep in the living organism (deep in the skin and around the blood vessels and internal organs) in a definite law-governed order, forming a unified system with the Bonghan corpuscles in the superficial layer.

As for the Bonghan corpuscles, there are superficial Bonghan corpuscles in the skin and profund Bonghan corpuscles distributed deep in the organism.

The profund Bonghan corpuscle with no outer smooth-muscle layer differs from the superficial Bonghan corpuscle in that they have different cellular elements.

The unique movement observed in the superficial Bonghan corpuscle, when a small needle is applied to it, can be well explained by the histological structure of the Bonghan corpuscle made of thick outer smooth muscle layer, and it well coincides with the practice of acupuncture treatment of a long tradition.

Up to now biology has not known any other structure existing in the blood and lymphatic vessels than the blood and lymph.

But we have found for the first time that the Bonghan ducts run inside the blood and lymphatic vessels.

The data obtained from our experiments prove that there are two kinds of Bonghan ducts—extravascular and intravascular—and that the extravascular Bonghan ducts are classified into the superficial Bonghan ducts linking the superficial Bonghan corpuscles and the profund Bonghan ducts linking the profund Bonghan corpuscles, the internal organs and the superficial Bonghan corpuscles.

Thus, we think we have basically clarified the whole picture of the Kyungrak system, a new anatomical and histological system which, independent of the vascular and nervous systems, unifies and integrates the Bonghan corpuscles and Bonghan ducts.

A systematic observation of the course of the Bonghan ducts in the artery, vein and lymphatic vessels and in the heart, as well as experiments in injecting a staining solution into the Bonghan corpuscle and Bonghan duct served to prove that the Kyungrak system functions as a unique circulating system.

Particularly, the facts that the contents both of the superficial Bonghan corpuscle and the Bonghan duct produce specific fluorescence due to acridine-orange and that a special basophilic substance exists in the profund Bonghan corpuscle prove, along with the histo-chemical observations to be mentioned below, that there exists desoxyribonucleic acid (DNA) in the Bonghan duct.

This suggests that the activity of the Kyungrak system will exert a great influence on the material metabolism and physiological and pathological process of the organism.

Part II

EXPERIMENTAL-PHYSIOLOGICAL STUDY OF THE KYUNGRAK SYSTEM

The facts that the Kyungrak system is one of the duct systems distributed in the whole of the living body and that the Bonghan duct comprises a bundle of ductules and runs not only outside the vessels but also inside the blood and lymphatic vessels are indicative of the distinctive features of the functions of the Kyungrak system.

In view of the biochemical features of the Bonghan liquor flowing in the Bonghan duct, it is presumed that the Bonghan liquor formed in the Bonghan corpuscle is supplied to all cells and tissues in the course of circulating through the whole body. Therefore it is necessary to fully elucidate the question of the circulation of the Bonghan liquor.

At the same time, the study of the excitability and conductivity of the Kyungrak system is not only vital for the clarification of its general physiological features but also of great importance in the study of its circulating functions.

We have applied the dye injection method and the method of using radioactive tracers in the study of the circulation of the Bonghan liquor and the electro-physiological method in the research into the excitability and conductivity of the Kyungrak system.

Chapter I

STUDY OF THE CIRCULATION OF THE BONGHAN LIQUOR

We made a study of the process of circulation in the Kyungrak system with the aid of the method of radioactive tracers.

Here we adopted dosimetry of radioactivity and radioautography.

1. CIRCULATION OF THE BONGHAN LIQUOR IN THE SUPERFICIAL BONGHAN DUCT

A. Experiments by Dosimetry of Radioactivity

To observe the circulation of the Bonghan liquor in the superficial Bonghan duct, we injected P^{32} ($K_2HP^{32}O_4$ or $Na_2HP^{32}O_4$ to the amount of 5-50-100 microcurie) into the Bonghan corpuscle in the skin of the inner side of the femur and the abdominal wall of a rabbit and, after the lapse of a certain time (30 minutes to 6 hours) we cut off a definite amount of the skin and surrounding tissues on the line along which runs the Bonghan duct containing the Bonghan corpuscles, and determined its radioactivity with the dosimeter.

Fig. 21 shows the result of dosimetry 3 hours after P^{32} was injected into a Bonghan corpuscle in the inner side of the femur skin of a rabbit.

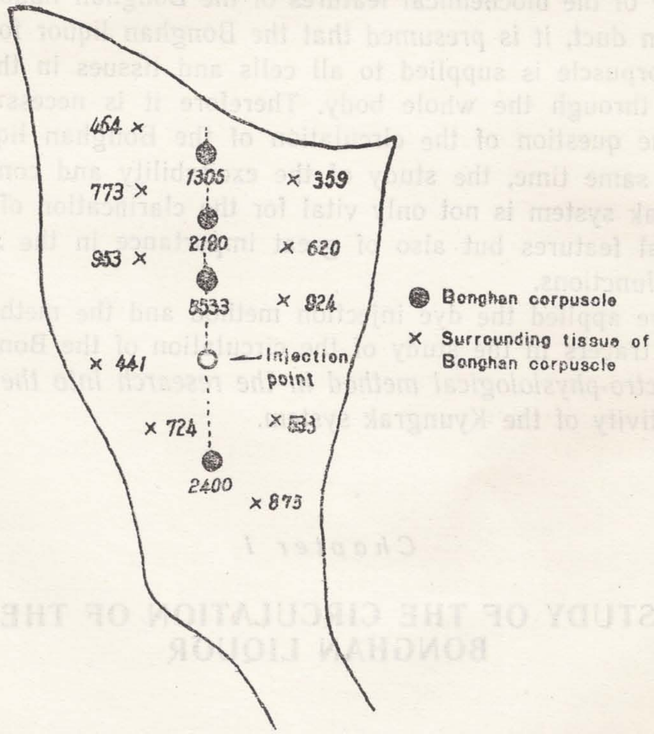


Fig. 21. Distribution of P^{32} (50 μC) after its injection into the Bonghan corpuscle in the inner-side skin of the femur.

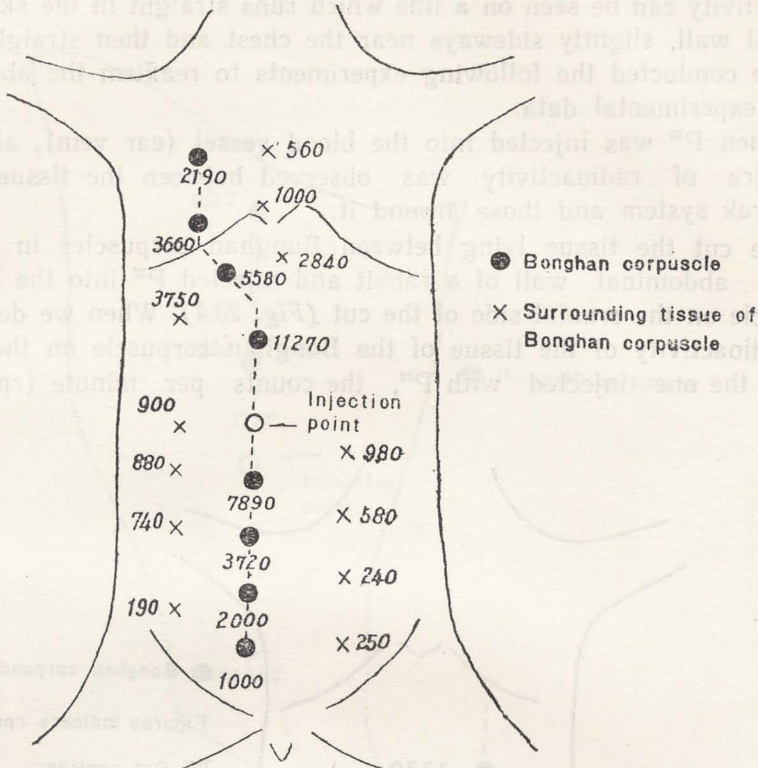


Fig. 22. Distribution of P^{32} (100 μC) after its injection into the Bonghan corpuscle in the abdominal skin.

According to this experiment, radioactivity of the tissues on the Bonghan duct having the Bonghan corpuscle injected with P^{32} is far higher than that of the surrounding tissues, and positions with such higher radioactivities are observed on a nearly straight line.

Radioactivity is comparatively high also in the tissues around the above-said Kyungrak system with higher radioactivity. This is explained by the fact that when P^{32} is injected into the Bonghan corpuscle, part of it tends to flow into the blood and lymphatic vessels within the corpuscle and another part of it might spread out of the Bonghan duct to the surroundings.

When P^{32} is injected into the Bonghan corpuscle in the skin of abdominal wall of a rabbit, positions indicating higher radioactivity can be seen on a line parallel with linea alba, as in the case of the femur (*Fig. 22*).

Noticeable in this experiment is the fact that positions with higher radioactivity can be seen on a line which runs straight in the skin of abdominal wall, slightly sideways near the chest and then straight again.

We conducted the following experiments to reaffirm the above-mentioned experimental data.

When P^{32} was injected into the blood vessel (ear vein), almost no difference of radioactivity was observed between the tissues of the Kyungrak system and those around it.

We cut the tissue lying between Bonghan corpuscles in the skin of the abdominal wall of a rabbit and injected P^{32} into the Bonghan corpuscle on the cranial side of the cut *(Fig. 23A)*. When we determined the radioactivity of the tissue of the Bonghan corpuscle on the cranial side of the one injected with P^{32}, the counts per minute (cpm) were

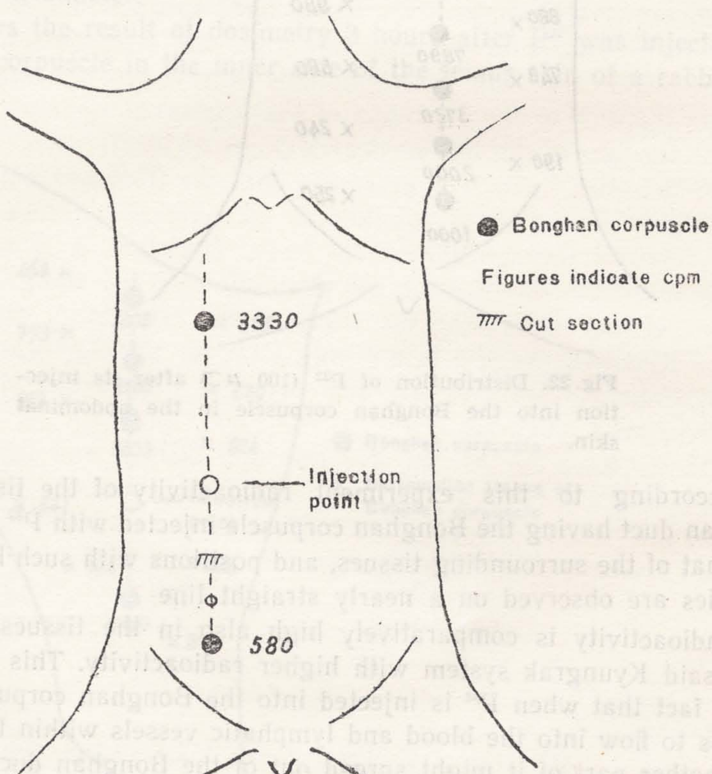


Fig. 23 A

Fig. 23 A-B. Distribution of P^{32} injected after the cut of the tissue between Bonghan corpuscles.

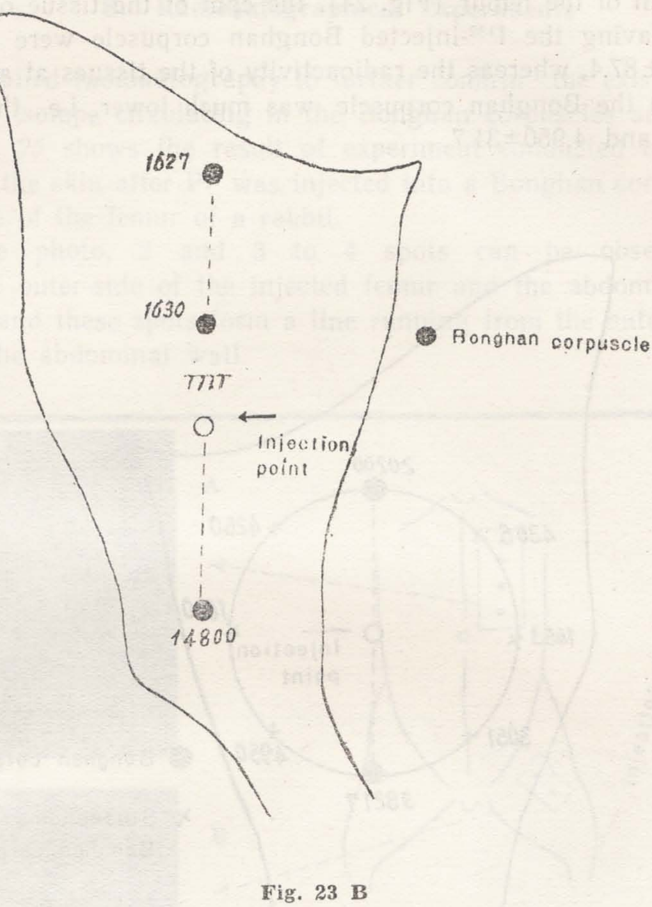


Fig. 23 B

3,330±26.4, whereas the cpm of the Bonghan corpuscle on the caudal side of the cut were no more than 580±11.1.

When we cut the tissues between the Bonghan corpuscles in the inner-side skin of the femur of a rabbit and injected P^{32} into the Bonghan corpuscle on the distal side of the cut *(Fig. 23B)*, the cpm in the Bonghan corpuscle on the distal side of the cut were 14,800±40.6, whereas the cpm of the Bonghan corpuscle on the proximal side of the cut were no more than 1,630±13.8.

These experimental data point to the existence of the Bonghan duct, a structure in which certain substance can circulate, between Bonghan corpuscles.

In view of the fact that when P^{32} is infused into a Bonghan corpuscle, it is liable to diffuse in the tissues surrounding it, we determined radioactivity in the skin around the Bonghan corpuscle injected with P^{32}.

According to the experiments on the Bonghan corpuscle in the inner side skin of the femur (Fig. 24), the cpm of the tissue on the Bonghan duct having the P^{32}-injected Bonghan corpuscle were $20{,}200 \pm 63.6$ and $38{,}217 \pm 87.4$, whereas the radioactivity of the tissues at a certain distance from the Bonghan corpuscle was much lower, i.e., the cpm were $1{,}453 \pm 17.4$ and $4{,}950 \pm 31.7$.

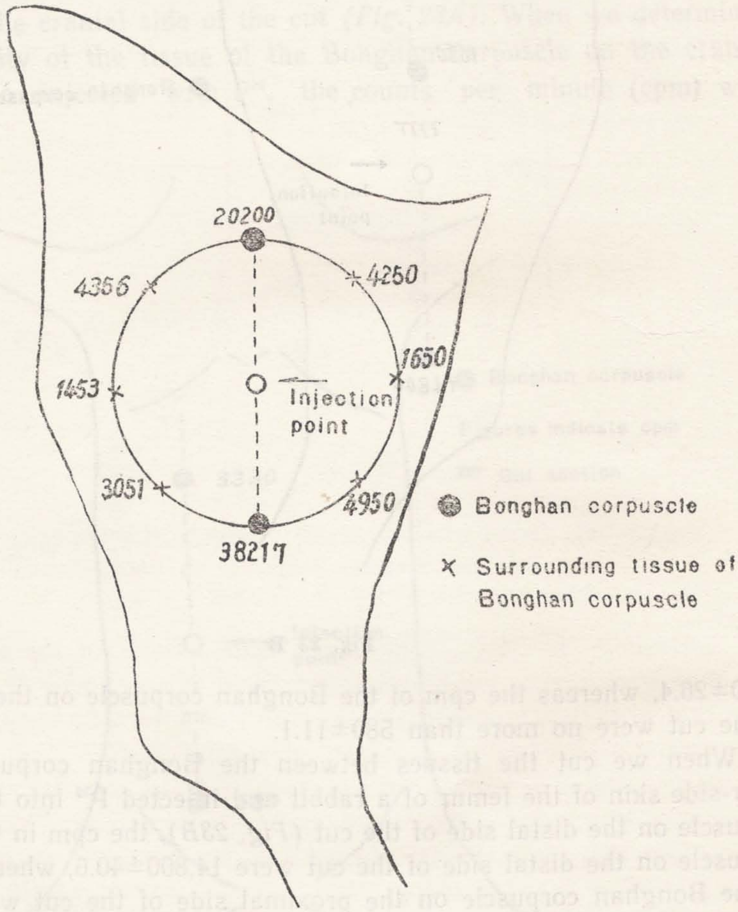


Fig. 24. Radioactivity of the surrounding tissues after injection of P^{32} (100 μC) into a Bonghan corpuscle.

This experimental result proves that a large amount of the injected P^{32} migrate along the Bonghan duct.

B. Radioautographical Experiments

We applied radioautography to further confirm the existence of the radioactive isotope circulating in the Bonghan corpuscles and Bonghan ducts. *Fig. 25* shows the result of experiment conducted by radioautography on the skin after P^{32} was injected into a Bonghan corpuscle in the lateral side of the femur of a rabbit.

In the photo, 2 and 3 to 4 spots can be observed on the skin of the outer side of the injected femur and the abdominal wall respectively and these spots form a line running from the outer side of the femur to the abdominal wall.

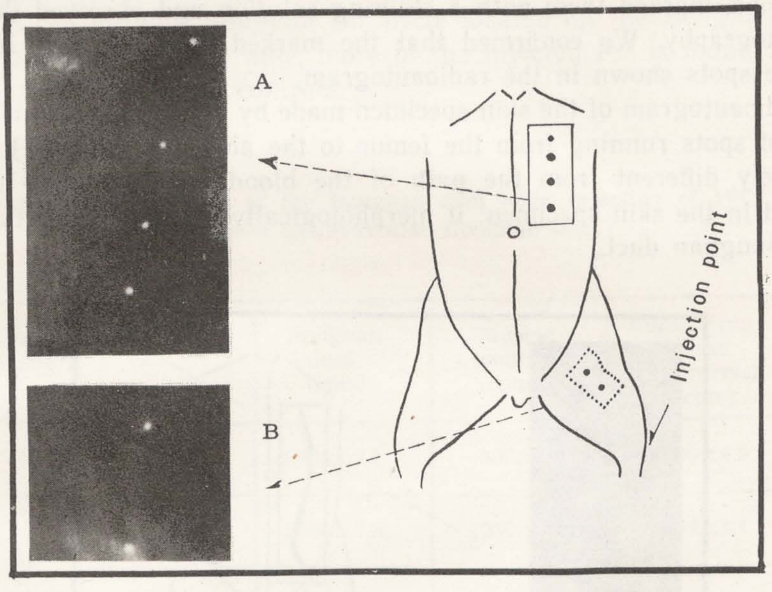


Fig. 25. Radioautogram after the injection of P^{32} into a Bonghan corpuscle in the lateral-side skin of the femur of a rabbit.

A photo taken after the injection of P^{32} into the Bonghan corpuscle in the skin of the abdominal wall also shows negative spots forming a row *(Fig. 26)*.

The positions of the negative spots seen in the above radioautogram coincide with the positions of higher radioactivity spotted by dosimetry.

To confirm the coincidence of the positions of spots with the positions of the Bonghan corpuscles, we located several Bonghan corpuscles on a single Bonghan duct in the order of their position with the aid of a

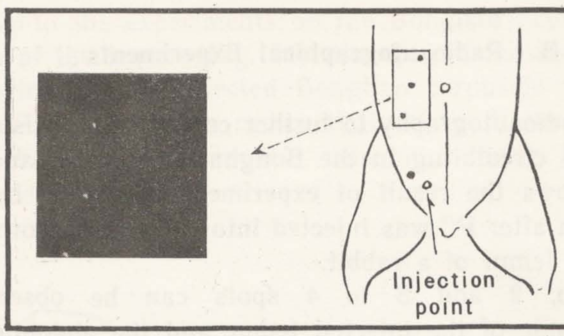


Fig. 26. Radioautogram of the abdominal skin after the injection of P^{32} into a Bonghan corpuscle.

microscope, marked them with a staining solution and observed them by radioautography. We confirmed that the marked positions well coincide with the spots shown in the radioautogram.

Radioautogram of the skin specimen made by a different method shows a row of spots running from the femur to the abdomen *(Fig. 27)*. It is completely different from the path of the blood and lymphatic vessels observed in the skin specimen; it morphologically coincides with the path of the Bonghan duct.

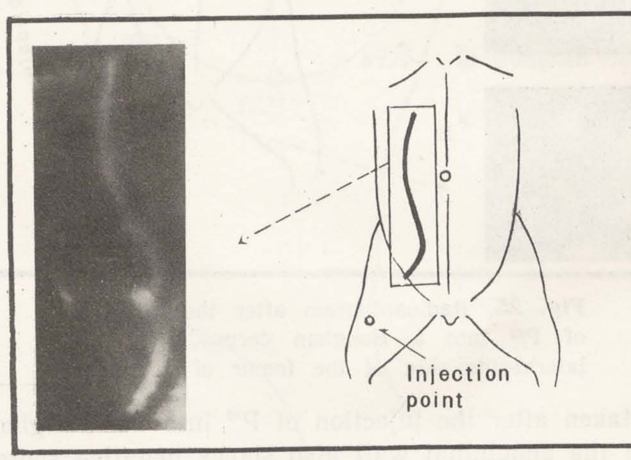


Fig. 27. Radioautogram after the injection of P^{32} into a Bonghan corpuscle on the inner-side skin of a rabbit femur.

On the basis of the above-mentioned experimental data, we can consider that the positions of spots seen in the radioautogram coincide with the positions of the Bonghan corpuscles and that they, linked with each other by the Bonghan duct, form a course of circulation.

2. CIRCULATION OF THE BONGHAN LIQUOR IN THE PROFUND BONGHAN DUCT

To observe circulation of the Bonghan liquor in the profund Bonghan duct, we injected P^{32} into the profund Bonghan corpuscle on the extravascular Bonghan duct running between the circumference of the aorta in the abdominal cavity and the profund cervical region, and cut off a mass of tissues containing the Bonghan corpuscle, Bonghan duct and other surrounding tissues in the cervical region (muscle and connective tissues) 1 hour and 2 hours after injection respectively, and compared their radioactivity.

According to the experiment (Table 1) for determining radioactivity at the position of the Bonghan duct in the cervical region after injection of P^{32} into the profund Bonghan corpuscle located on the Bonghan duct on the abdominal aorta side, more of the injected P^{32} is found in the Bonghan duct than in the controls.

Table 1: Radioactivity of the Bonghan duct after injection of P^{32} into the profund extravascular Bonghan duct

Time after injection	Tissues / Experiments	Bonghan duct (cpm)	Muscle (controls) (cpm)	Connective tissue (controls) (cpm)
1 hour	1	1,250±7.1	505±4.8	520±4.9
	2	1,280±7.3	360±4.0	384±4.1
	3	624±5.9	12±3.6	0
	4	1,904±9.3	584±5.2	336±3.9
2 hours	1	408±4.4	112±2.7	104±2.3
	2	752±5.7	256±3.6	244±3.5
	3	2,247±9.9	848±6.6	40±3.3
	4	436±5.2	0	0

When the Bonghan duct is cut, such phenomenon cannot be observed (Table 2). The radioactivity of the Bonghan duct on the cranial side of the cut is not so high as in the above experimental results.

Table 2: Radioactivity of the Bonghan duct after the Bonghan duct is cut and P^{32} injected into the profund Bonghan corpuscle

Time after injection	Tissues / Experiments	Bonghan duct (cpm)	Muscle (controls) (cpm)	Connective tissue (controls) (cpm)
1 hour	1	468±5.4	338±4.9	3,112±11.6
	2	380±5.5	237±4.5	480±6.3
	3	740±7.0	450±5.8	0
2 hours	1	436±5.2	1,728±10.7	1,256±9.2
	2	730±6.1	730±2.7	310±4.1
	3	428±5.0	400±4.8	360±4.1

In the above experiments the controls also show a certain niveau of radioactivity. We consider this to be the result of the fact that when P^{32} is injected into the Bonghan duct, part of it is absorbed into the blood in the surrounding tissues and spreads throughout the body. The results of these experiments are indicative of the circulation of the Bonghan liquor in the profund Bonghan duct, too.

Contrary to the experiments done, when we inject P^{32} into the cervical part of the above-mentioned Bonghan duct and determine radioactivity in the abdominal part of the Bonghan duct, the movement of P^{32} in the Bonghan duct is hardly noticeable (Table 3).

Table 3: Radioactivity of the Bonghan duct on the abdominal side after injection of P^{32} into the cervical part of the Bonghan duct

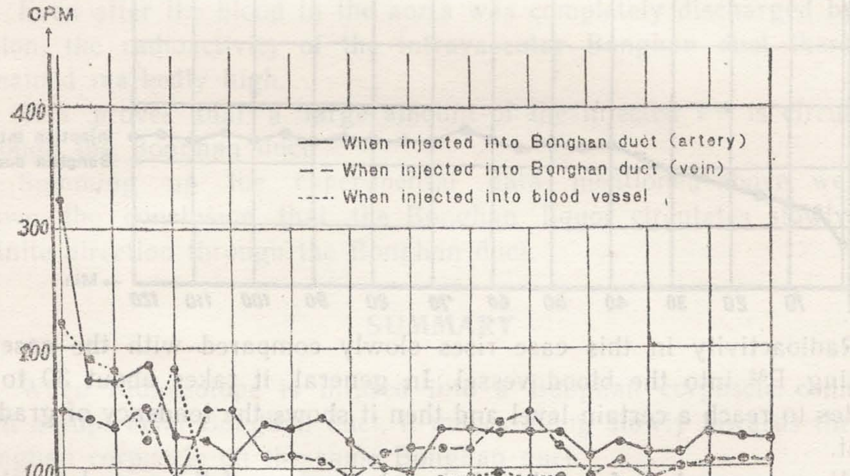
Tissues / Experiments	Bonghan duct (cpm)	Muscle (controls) (cpm)	Connective tissue (controls) (cpm)
1	280±6.0	40±3.4	320±6.3
2	130±2.7	148±4.0	162±4.1
3	310±4.7	304±4.7	328±4.8

This proves the one-sided direction of circulation of P^{32} in the Bonghan duct.

Next, in order to elucidate the circulation of the Bonghan liquor in the intravascular Bonghan duct, we injected P^{32} into the Bonghan duct inside the vein of an internal organ in the abdominal cavity and traced it circulating into the Bonghan duct in the femoral artery through the intravascular Bonghan duct of major circulation.

As P^{32} injected into the Bonghan corpuscle and Bonghan duct in the abdominal cavity might spread to the tissues surrounding the injected position and be absorbed by the blood, as in the case of injection into the superficial Bonghan corpuscle, we determined and compared, to begin with, the radioactivity of the blood when P^{32} is injected into the blood vessel (ear vein) with that when it is injected into the Bonghan duct *(Fig. 28)*.

Fig. 28. Change of blood radioactivity after the injection into the blood vessel and the Bonghan duct.

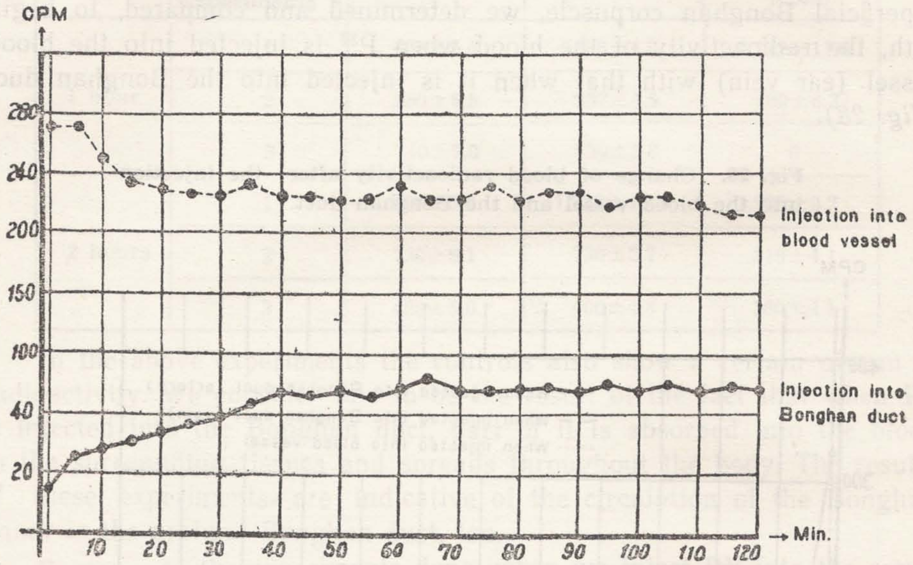


As can be seen in Fig. 28, when P^{32} is injected into the blood vessel, the radioactivity of the blood sharply rises 1 minute after the injection and then gradually subsides in the following 5 minutes. Such changes of the blood radioactivity can be observed also when P^{32} is injected into the Bonghan duct.

When we determine the radioactivity on the femoral artery after injection of P^{32} into the blood vessel (ear vein), the radioactivity, like the changes of the blood radioactivity observed in the above-mentioned experiments, generally reaches the maximum during the period from 1 to 5 minutes and then subsides a little, and then no remarkable change is observed for a definite period of time.

But a different phenomenon is observed in the data on the determination of radioactivity on the femoral artery after P^{32} is injected into the Bonghan duct *(Fig. 29)*.

Fig. 29. Changes of radioactivity determined on the femoral artery after injection of P^{32} into the blood vessel and the Bonghan duct.



Radioactivity in this case rises slowly compared with the case of injecting P^{32} into the blood vessel. In general, it takes about 30 to 50 minutes to reach a certain level and then it shows the tendency of gradual ascent.

We may conclude from this that such changes of the cpm determined on the femoral artery have little connection with the P^{32} included in the blood of the femoral artery, but are related to the P^{32} circulating through the Bonghan duct running in the blood vessel.

It is presumed that radioactivity in the region of the femoral artery gradually rises because the injected P^{32} flows into the Bonghan duct and circulates slowly through it.

To establish the circulation of the Bonghan liquor in the intravascular Bonghan duct more firmly, we determined directly the radioactivity of the intravascular Bonghan duct after injection of P^{32} into the profund Bonghan corpuscle.

The radioactivity of the Bonghan duct taken out of the descending aorta 30 minutes after injection of P^{32} into the Bonghan duct in the vein of the internal organ in the lower part of the abdomen is more than 100 times higher than the radioactivity of the blood of the descending aorta at that moment, and two hours later it is still nearly 95 times higher (Table 4).

Table 4: Radioactivity of the intravascular Bonghan duct after injection of P^{32} into the profund Bonghan corpuscle.

Radioactivity of tissues / Time after injection	Bonghan duct	Blood
30 minutes	1,538,550±1,240.3	15,420±124.2
2 hours	1,376,140±1,173.0	14,500±120.4

(Figures indicate cpm/1 ml)

Even after the blood in the aorta was completely discharged by perfusion, the radioactivity of the intravascular Bonghan duct there still remained markedly high.

This proves that a large amount of the injected P^{32} is circulating through the Bonghan duct.

Summing up the experimental data mentioned above, we have drawn the conclusion that the Bonghan liquor circulates slowly in a definite direction through the Bonghan duct.

SUMMARY

When radioisotope is infused into a Bonghan corpuscle connected with a superficial Bonghan duct, it moves along slowly towards the next Bonghan corpuscle on the same Bonghan duct.

When radioautography is carried out in the skin following the infusion of radioisotope into the Bonghan corpuscle, spots can be observed on the film in a row at the position of the Bonghan corpuscle and, also, a line of shadow can be observed along the course of the Bonghan duct.

This line of shadow is different from the blood vessel, lymphatic vessel and nerve courses. The radioisotope infused into the profund Bonghan corpuscle and profund Bonghan duct circulates in a certain direction along the Bonghan duct. When a staining solution is infused into the Bonghan duct, too, one can see it moving along in the duct as in the above-mentioned case. The results of these experiments testify to the circulation of the Bonghan liquor.

Chapter II

BIOELECTRICAL STUDY OF THE KYUNGRAK SYSTEM

Because of the morphological features of the Bonghan corpuscle which has a smooth-muscle layer and secreting cells, it was presumed that the corpuscle performed a series of movements as well as secretion and, on this basis, an electrophysiological analysis was made of the excitation process under the physiological conditions and under various stimuli.

It was of essential significance to elucidate whether this excitability, as in the case of nerve, is conducted along the Bonghan duct. Accordingly, tests have been made of the conductivity between the Bonghan corpuscles and between the internal organs and the Bonghan corpuscles.

1. BIOELECTRICAL CHANGES IN THE BONGHAN CORPUSCLE

We have already confirmed, through our studies of the substance of Kyungrak, the fact that the Kyungrak system has definite bioelectrical features, and published the results of our studies in our first paper (August 18, 1961).

We cut off a small piece of skin from a rabbit and put it in a damp camera maintained at a temperature of 39° C, and then inserted an electrode directly into a Bonghan corpuscle in it and induced its bioelectrical change by using a low-frequency or a direct-current amplifier and an electronic recording device. Induction by this method shows a peculiar change of electric potential in the Bonghan corpuscle. These bioelectrical changes in the Bonghan corpuscle proceed much slower than in the nervous and skeletal-muscle tissues, and there appear 6-12 waves in a minute. The basic form of the changes of electric potential is similar to the sine curve and its cycle is 3-6 seconds.

3 to 7 of these changes of electric potential make a wave group, and they appear periodically at intervals of 15-30 seconds, or appear separately without forming any wave group or continuously without intervals.

The amplitude of each wave is 0.1 mv on an average.

Also, in the Bonghan corpuscle these changes of electric potential appear in cycles of 7-10 seconds, two or three of these changes taking place concurrently *(Fig. 30)*. There also take place big changes of electric potential which have a long cycle of 20-25 seconds.

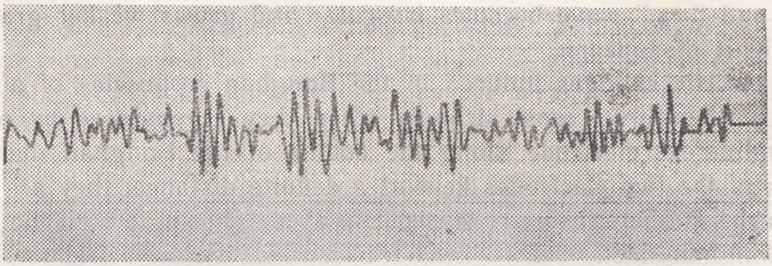


Fig. 30

It is decided that these three changes of electric potential be called respectively "ㄱ" (geu) wave, "ㄴ" (neu) wave and "ㄷ" (deu) wave of the Kyungrak electrogram.

These changes of electric potential take place in different rates, depending on the varieties of the Bonghan corpuscles and their state prior to induction. There are instances in which "ㄱ" wave prevails and "ㄷ" wave almost fails to appear or appears very weakly. On the contrary, there are instances of "ㄱ" wave appearing rather weakly while "ㄷ" wave prevails *(Fig. 31)*.

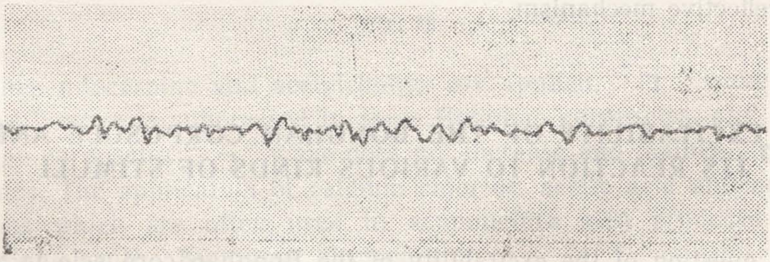


Fig. 31

These electric changes which take place in separated Bonghan corpuscles disappear when the temperature of the environment is dropped to below 27° C.

But when the temperature is raised again to 39° C immediately, the electric changes which have vanished appear again.

The same electric changes as taking place in separated Bonghan corpuscles can be induced in the Bonghan corpuscles of a living body, too; they can also be observed in the Bonghan corpuscles of an animal immediately after it has been killed, but they grow weaker gradually, sometimes lasting for about 30 minutes, after the animal's death.

In the electric changes appearing after death "ㄷ" wave often prevails and "ㄱ" wave becomes irregular and grows weaker gradually till finally it disappears.

The electric changes induced in the Bonghan corpuscles of a living body show themselves most strongly when they are induced by putting in the indifferent electrode along the course of the Bonghan duct with the poles of the two electrodes kept at a definite distance; they are weakest when the indifferent electrode is put in at a right angle with the course of the Bonghan duct.

And the electric changes in the Bonghan corpuscles of a living body vary even in the same animal, depending on various Bonghan corpuscles, and even in the same Bonghan corpuscle they are different according to the time of induction, state of the animal, etc.

These results furnish proof that unique electric changes which have so far been unknown take place in the Bonghan corpuscle.

Likewise, in the Bonghan corpuscle separated from the body of a rabbit and therefore having no connections with its central nervous system, bioelectrical changes take place for a certain length of time when appropriate temperature and humidity are preserved. This attests to the fallacy of the views which explain the electric changes of certain parts (positions of Kyunghyul) of the skin from the viewpoint of the neural reflective mechanism.

2. EXCITABILITY OF THE BONGHAN CORPUSCLE AND ITS REACTION TO VARIOUS KINDS OF STIMULI

The question of the excitability of the Bonghan corpuscle is a basic question in elucidating the physiological functions of the Kyungrak system.

We, therefore, examined the excitability of the Bonghan corpuscle by giving it various stimuli, using electric changes, the principal signs of excitability, as indices.

We conducted experiments to examine the bioelectrical changes in the Bonghan corpuscle by applying chemicals which promote the contractile action of the smooth muscle in view of the fact that the superficial layer of the Bonghan corpuscles is composed of smooth muscles.

While inducing electric changes by inserting an electrode into the Bonghan corpuscle of a small piece of skin placed in a damp camera maintained at a temperature of 39° C, we dripped pilocarpine solution or acetylcholine on it and observed its changes.

Immediately after the application of the chemicals, the bioelectrical activity of the Bonghan corpuscle grew feeble, and then at once began to grow vigorous and became still stronger in about 30 minutes.

In some cases the electric changes are weak at first but the effect appears 20-30 minutes after the application of acetylcholine *(Fig. 32).*

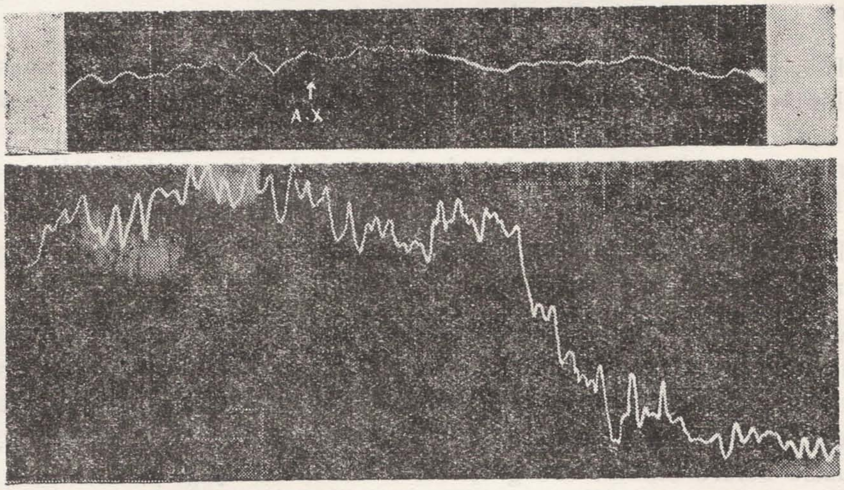


Fig. 32

When pilocarpine and acetylcholine are applied, "ㄱ" wave prevails and "ㄷ" wave is suppressed in some Bonghan corpuscles, and in other Bonghan corpuscles "ㄱ" wave does not increase and mainly "ㄷ" wave fluctuates. The application of calcium chloride, acetic acid and novocaine solutions which are often used in acupuncture also produces various fluctuations on the Kyungrak electrogram.

The length of time between the application of chemicals and appearance of fluctuations on the Kyungrak electrogram and the state of reaction differ according to the variety and concentration of the chemicals and to the state of the Bonghan corpuscle prior to the application of chemicals.

These facts indicate that the Bonghan corpuscle is an excitable tissue reacting differently to external factors and that it reacts likewise to the chemicals which act on the choline reaction system.

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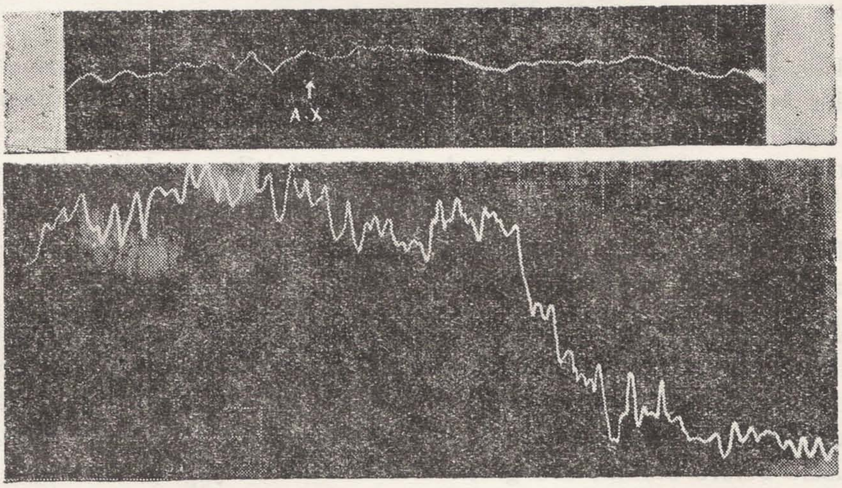

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These facts indicate that the Bonghan corpuscle is an excitable tissue reacting differently to external factors and that it reacts likewise to the chemicals which act on the choline reaction system.

On the basis of the anatomico-histological features that the Bonghan corpuscles are linked with definite internal organs by Bonghan ducts, we made experiments to examine the mutual relations between the Bonghan corpuscles and the activity of internal organs.

When we stimulate the colon of a rabbit with a hot or cool saline solution while inducing electric changes of the Bonghan corpuscle on the lateral side of the crus, the activities of the colon are either promoted or enfeebled, and the electrogram of the Bonghan corpuscle shows changes accordingly.

But a stimulus to the small intestines has no big influence on the electric changes of this Bonghan corpuscle.

This fact, together with the experimental result that the movement of colon is promoted when the Bonghan corpuscle on the lateral side of the crus is stimulated with a needle, proves that the Bonghan corpuscles and internal organs are interlinked and act on each other and that the activity of definite internal organs is reflected on the Kyungrak electrogram.

Then, we conducted stimulation experiments to see how the Bonghan corpuscle reacted to various external stimuli of different intensity.

We gave a Bonghan corpuscle stimuli of different intensity with needle, moxacautery and chemicals and observed the electric changes induced therefrom. And we have found out that there exist certain relations between the scope of the electric changes taking place in the Bonghan corpuscle before stimuli are given and the intensity of the stimuli.

When a strong stimulus is given to the Bonghan corpuscle in case the electric change is weak before the stimulus is given, the electric change is intensified. But if a strong stimulus is given when the electric change is already strong, it produces no effect at all or weaken the electric change *(Figs. 33-34)*.

When the electric change of the Bonghan corpuscle has become weak by strong stimulation, it cannot be made strong even by giving stronger stimuli repeatedly *(Fig. 35)*.

In this case, however, if a proper, weak stimulus is given, the electric change will pick up.

These results prove that there are complicated mutual relations between the activity of the Bonghan corpuscle and the intensity of stimulus, that the effect is most conspicuous when a stimulus of a proper intensity is administered to the functions of the given Bonghan corpuscle, and that repeated strong stimuli do not produce a strong effect.

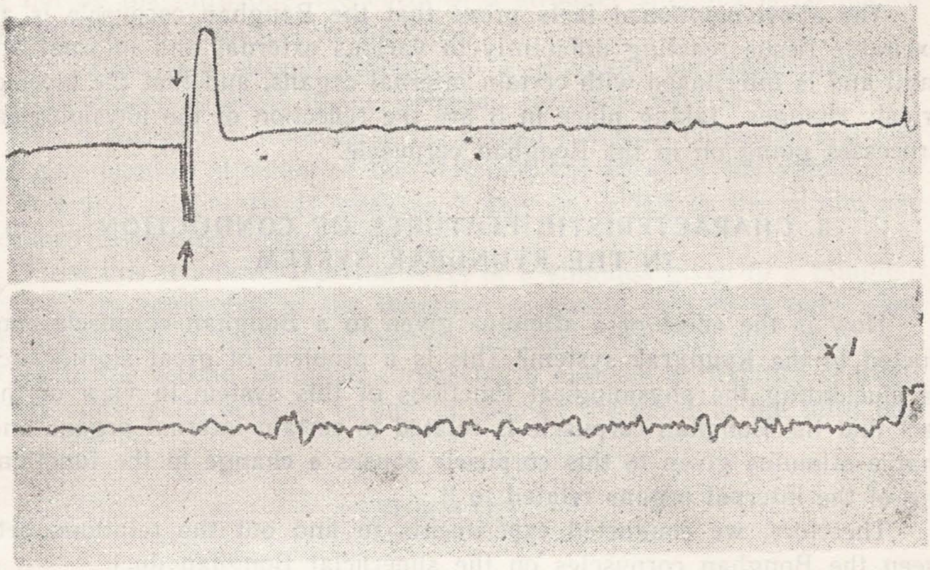


Fig. 33

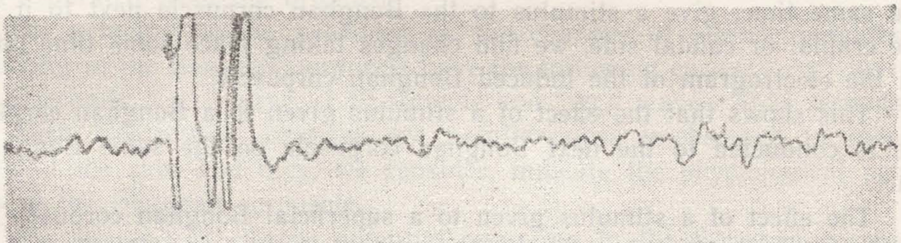


Fig. 34

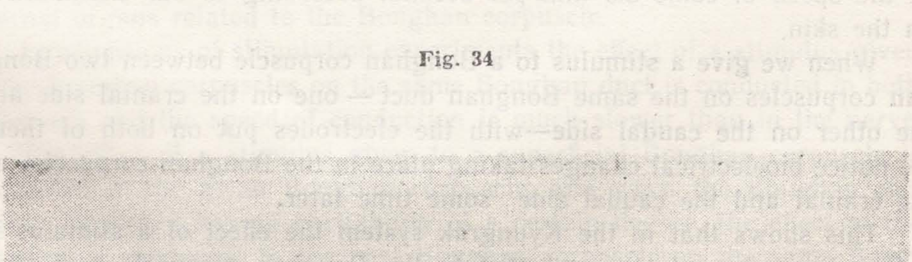


Fig. 35

The above-mentioned facts prove that the Bonghan corpuscle is an excitable tissue reacting differently to various external and internal stimuli and is interlinked with certain internal organs, and that the bioelectrical changes taking place in it are the reflection of the physiological processes going on in the Bonghan corpuscle.

3. CHARACTERISTIC FEATURES OF CONDUCTION IN THE KYUNGRAK SYSTEM

How is the effect of a stimulus given to a Bonghan corpuscle conducted in the Kyungrak system? This is a problem of great significance in elucidating the physiological functions of this system in view of the fact that the Bonghan corpuscle is related to certain internal organs and that a stimulus given to this corpuscle causes a change in the functioning of the internal organs related to it.

Therefore, we conducted experiments to find out the relations between the Bonghan corpuscles on the superficial Bonghan duct.

When we induce bioelectrical changes of one of the Bonghan corpuscles belonging to the same Bonghan duct in the skin of a rabbit and, at the same time, give a stimulus to the Bonghan corpuscle next to it on the cranial or caudal side, we find changes taking place some time later on the electrogram of the induced Bonghan corpuscle.

This shows that the effect of a stimulus given to a Bonghan corpuscle is conducted to the next Bonghan corpuscle on the same Bonghan duct.

The effect of a stimulus given to a superficial Bonghan corpuscle is conducted to the Bonghan corpuscle next to it on the same Bonghan duct at the speed of some 3.0 mm per second, according to our examination on the skin.

When we give a stimulus to a Bonghan corpuscle between two Bonghan corpuscles on the same Bonghan duct — one on the cranial side and the other on the caudal side—with the electrodes put on both of them, we notice bioelectrical changes taking place in the Bonghan corpuscles on the cranial and the caudal side some time later.

This shows that in the Kyungrak system the effect of a stimulus to a Bonghan corpuscle is conducted to the Bonghan corpuscle next to it much slower than in the nerve and that the effect is conducted in both directions in conditions of stimulation experiments.

Now let us see how the effect of a stimulus given to a Bonghan corpuscle in the superficial Bonghan duct is conducted to other Bonghan corpuscles on the same Bonghan duct. Whereas the effect of a weak stimulus is felt only by the Bonghan corpuscle next to the stimulated one and not by the third one, the effect of a stronger stimulus is conducted from the second corpuscle to the third.

An excessively strong stimulus to a Bonghan corpuscle, however, fails to conduct its effect to the Bonghan corpuscle next to it.

When you give a stimulus to the second Bonghan corpuscle first and then give another stimulus to the first one, the effect of the stimulus to the first one, comparatively weak as it may be, is felt by the second one and then conducted to the third.

From this it follows that the effect of a stimulus given to a Bonghan corpuscle is conducted to the Bonghan corpuscle next to it only when the stimulation it feels is of certain intensity and that the effect conducted to the second Bonghan corpuscle, in case its excitability is weak, merely adds to its activity, failing to conduct the effect to the third one.

SUMMARY

We have recorded bioelectrical changes taking place in the Bonghan corpuscle by inserting an electrode into the Bonghan corpuscle in the skin separated from the organism.

The principal waves produced by the changes of electric potential occurring in the Bonghan corpuscle have the following cycles: "ㄱ" wave—3-6 seconds, "ㄴ" wave—7-10 seconds and "ㄷ" wave—20-25 seconds.

Such bioelectrical changes are peculiar ones unobserved in other parts of the skin and they, we consider, indicate the physiological process of the Bonghan corpuscle.

The changes of electric potential occurring in the Bonghan corpuscle reflect the functioning of the living body and the functioning of the internal organs related to the Bonghan corpuscle.

In conditions of stimulation experiments the effect of a stimulus given to the Bonghan corpuscles on the same Bonghan duct is conducted in both directions and the speed of conduction is much slower than in the nerve.

The effect of a stimulus given to a superficial Bonghan corpuscle is multiplied in the given Bonghan corpuscle, and when the Bonghan corpuscle concerned has an excitability of a certain degree, the effect of the stimulus is conducted to the next Bonghan corpuscle on the same Bonghan duct.

It is believed on the basis of the above-mentioned facts that the Bonghan corpuscle is a new excitable tissue which differently reacts to different factors and the effect of a stimulus given to a Bonghan corpuscle is conducted to the Bonghan corpuscle next to it through the same Bonghan duct.

Part III

BIOCHEMICAL AND HISTO-CHEMICAL STUDY OF THE KYUNGRAK SYSTEM

As the anatomico-histological characteristics of the Bonghan corpuscle and the Bonghan duct are elucidated gradually as a result of the accelerated morphological study of the Kyungrak system, a ripe possibility has been provided for studying and explicating the structure and functions of this newly-found anatomico-histological system.

Taking up the biochemical study of the Kyungrak system, the first question to be solved must be that of explicating the chemical composition of this tissue.

Histological observations have already established that the Bonghan liquor running in the Bonghan duct and the Bonghan corpuscle contain a large amount of basophilic substance.

It is, therefore, recognized to be of great significance for elucidating the functions of the Kyungrak system to study the chemical nature of this substance before anything else.

We have directed our attention above all to the study of nucleic acids of this tissue system when we took up the biochemical study of the Kyungrak system.

We determined the nucleic acid contents in the Bonghan corpuscle and Bonghan duct, and, at the same time, employed the histo-chemical method in our study to clarify the localization of the nucleic acids.

1. BIOCHEMICAL STUDY OF THE BONGHAN CORPUSCLE AND BONGHAN DUCT

Superficial Bonghan corpuscles and intravascular Bonghan ducts were collected and homogenized as materials for analysis. Determination of phosphorus was carried out according to Fiske-Subbarrow and separation of phosphorus of nucleic acids according to Shmidt-Thanhauser.

The content of phosphorus of various forms in the Bonghan duct is shown in Table 5.

Table 5: Content of phosphorus of various forms in Bonghan duct

Kind of phosphorus	Content (mg %)
Total P	450.0-520.0
Inorganic P	5.0-7.2
Protein P	16.0-17.5
Phosphatide P	28.0-31.2
P of ATP	3.2-4.3
P of nucleic acids	370.0-440.0
P of DNA	184.0-250.0
P of RNA	152.0-198.0

As is shown in Table 5, the amount of nucleic acid phosphorus is largest among various forms of phosphorus found in the Bonghan duct. Besides, we carried out the direct determination of the nucleic acids by ultraviolet absorption.

The determination showed that the DNA content in the Bonghan corpuscle was about 2,000 mg % and RNA 330 mg %.

As to the content of nucleic acids in the Bonghan duct, nearly 2,300 mg % (1,200-3,700 mg %) DNA and about 1,600 mg % (900-1,700 mg %) RNA were found.

These figures and Table 6 reveal that Bonghan corpuscles and Bonghan ducts are extraordinarily abundant in nucleic acids when compared to other tissues.

Table 6: DNA content in rabbit tissues

Tissue	Content of DNA (mg %)
Bonghan corpuscle	2,000
Bonghan duct	2,300
Liver	153
Spleen	700
Kidney	119
Blood	35

2. HISTO-CHEMICAL OBSERVATIONS ON THE BONGHAN CORPUSCLE AND BONGHAN DUCT

Nucleic acid identification reactions were carried out on the separated Bonghan corpuscles and Bonghan ducts. Granules of positive Feulgen reaction were found immensely crowded in the special histological structures which include the fibrous structures in the Bonghan corpuscles. Similar granules were also found around the special histological structures *(Fig. 36)*.

Many Feulgen reaction positive granules, varying in form and size, are also found in the intravascular Bonghan duct.

These granules are obviously distinguishable morphologically from the nuclei of the endothelial cell of Bonghan duct, and distributed in an entirely different manner from the arrangement of the nuclei.

These granules are either crowded densely or scattered in the Bonghan duct.

Besides them, the leucocytes around the Bonghan duct alone show positive Feulgen reaction; they can, however, easily be recognized because of their morphological features *(Fig. 37)*.

As was the case with the intravascular Bonghan duct, in the extravascular Bonghan duct, too, many Feulgen reaction positive granules are found, their number being greater in general than in the intravascular Bonghan duct.

Granules in the Bonghan corpuscle and Bonghan duct show positive Brachet- and Unna-Pappenheim reactions as well.

We then cut a Bonghan duct, and the flowing contents from the section were smeared on the objective glass and Feulgen test was done. We observed the same reaction positive granules as in the case of microscopic section. But the result of Feulgen reaction was negative when the test was done after the depletion of DNA by trichloracetic acid.

These results confirm that the basophilic substance found in the contents of the Bonghan duct is rich in DNA, and that these contents are flowing in the Bonghan duct.

3. OBSERVATIONS OF THE BONGHAN CORPUSCLE AND BONGHAN DUCT UNDER LUMINESCENT MICROSCOPE

Bonghan corpuscles and Bonghan ducts were taken out and stained with the 1,000-fold diluted solution of acridine orange, and examined under a luminescent microscope. The inner substance of the Bonghan cor-

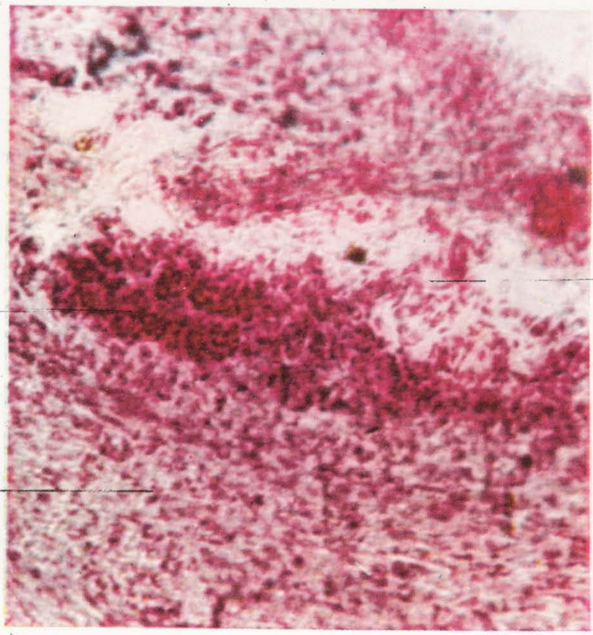
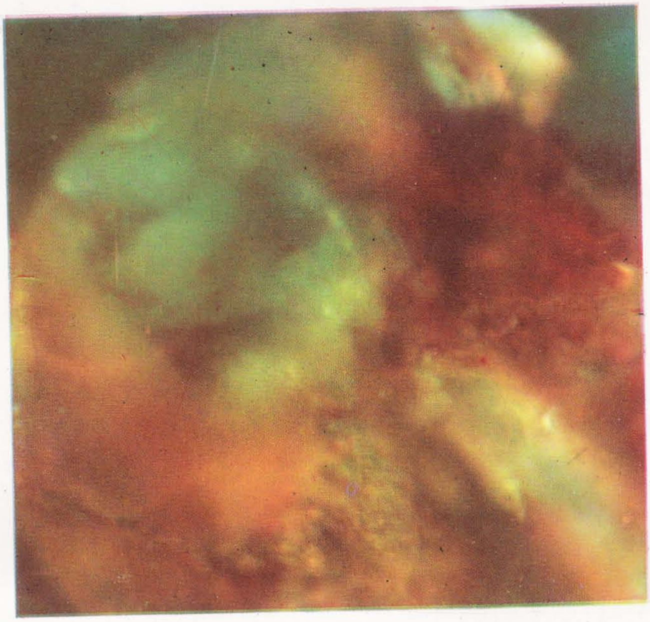


Fig. 36. Inner substance inside the Bonghan corpuscle (Feulgen reaction) (16×16)

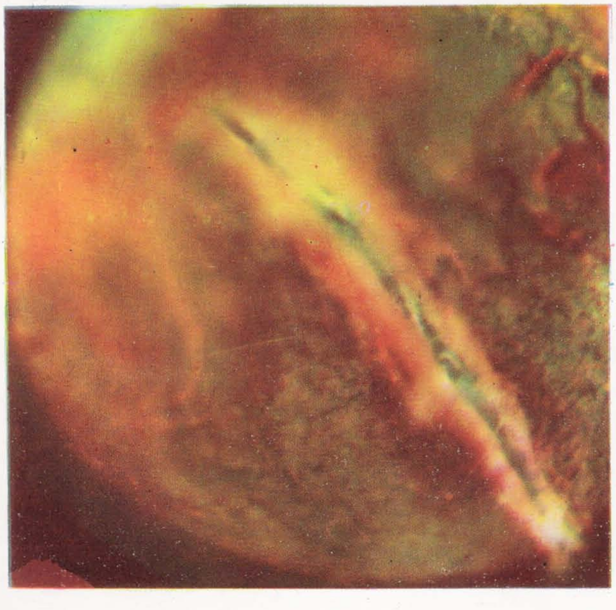
Fig. 37. Intravascular Bonghan duct (Feulgen reaction) (16×16)



(A)

Fig. 38 A-B. Luminescent microscopic observations of Bonghan corpuscle (by acridine-orange) (5×40)

(B)



puscle and the Bonghan duct linked to it selectively fluoresced brilliantly in blue green or yellowish green.

This has convinced us that an enormous amount of DNA is contained in the inner substance of the Bonghan corpuscle and in the Bonghan duct *(Fig. 38 A-B)*.

SUMMARY

To sum up the experimental data mentioned above, we notice above all the fact that the Bonghan corpuscle and the Bonghan duct contain more nucleic acids, especially DNA, than any other tissues and a considerable amount of RNA as well.

The contents of the Bonghan duct are sharply distinguished from the blood and lymph in respect to the DNA contents, although they move through the Bonghan ducts inside the lymphatic and blood vessels.

This furnishes a firm proof that the Kyungrak system is an independent system entirely distinct from the blood vessel system or the lymphatic system.

Quite unlike the general concept hitherto in rage about the distribution of DNA, a good deal of DNA is found in the homogeneous Bonghan liquor, which has no cellular element, and flows in the body. This fact opens a new prospect for the study of the functions of nucleic acids and its metabolism.

On the basis of the observations mentioned above, we consider that the functions of the Kyungrak system are closely related with the nucleic acids, with DNA in particular.

CONCLUSION

1. The Bonghan corpuscle and the Bonghan duct contain a large amount of nucleic acids, particularly DNA, as well as no small amount of RNA.

DNA and RNA are contained in the Bonghan liquor and flow through the Bonghan duct.

2. DNA exists in a unique manner in the homogeneous Bonghan liquor independently from cytoplasm and nucleus.

GENERAL CONCLUSION

All the results of a series of above-mentioned experiments on the Kyungrak system show that the Kyungrak system is another, independent functional-morphological system.

I.

The Kyungrak System Consists of the Bonghan Corpuscles and the Bonghan Ducts Linking Them

The Bonghan corpuscles exist not only in the skin but are widely distributed in the profunda of the organism as well.

This coincides also with the experiences gained in the clinical acupuncture.

In structure, however, the Bonghan corpuscle in the skin (superficial Bonghan corpuscle) is different from the profund Bonghan corpuscle deep in the body.

The superficial Bonghan corpuscle consists of the outer layer of smooth muscles and the inner substance made of various cells.

It is considered that this muscle layer is important in sending secretion to the Bonghan duct.

It is also considered that there are various kinds of cells in the inner substance and they perform the secretory function.

The results of histo-chemical and biochemical study prove that the inner substance has an abundance of nucleic acids, particularly DNA.

In the profund Bonghan corpuscle specific cells are arranged in a definite order and materials, which are basophilic like the nucleus and varied in form, some rod-shaped and others thread-shaped, are irregularly located.

These materials are arranged in the same direction as the path of the Bonghan duct and their DNA reaction proves positive histo-chemically. This is related to the fact that DNA of high concentration is contained in the Bonghan duct. The above-mentioned profund Bonghan corpuscle has no outer muscle layer.

The structure of the Bonghan corpuscle is completely different from the other structures hitherto known.

II.

The Bonghan Duct Has Two Forms of Existence

One of the forms of its existence is that it runs inside the blood vessel or the lymphatic vessel and the other is that it runs outside the vessel.

The intravascular Bonghan duct and the extravascular Bonghan duct take different directions from each other, but there is no difference between them in structure.

The Bonghan duct comprises bundles of the Bonghan ductules.

The Bonghan ductule is very soft and has a thin wall, which consists of endothelial cells of a single layer. It is difficult to discern clearly the internal structure of the nucleus of the endothelial cell by applying the usual staining method. It is of a peculiar rod shape.

The contents of the Bonghan ductule often appear in the shape of granule when they are stained by a routine method. And it has been established by cytochemical reaction that it contains DNA.

The contents of the Bonghan duct are entirely different from those of the blood and lymphatic vessels. When stained with acridine-orange, the Bonghan duct brightly fluoresces in yellowish green.

This also clearly distinguishes the Bonghan duct from other tissues.

Examination under a phase-contrast microscope of the Bonghan duct in the fresh specimen reveals that it has nuclei of a peculiar form and arrangement.

The superficial Bonghan ducts among the extravascular Bonghan ducts are connected with the superficial Bonghan corpuscles, while the profund Bonghan ducts link together the intravascular Bonghan ducts, the profund Bonghan corpuscles and organs.

III.

Bonghan Liquor Circulates in the Kyungrak System

This has been substantiated by the method of dye injection into the Bonghan corpuscle and the Bonghan duct and by the use of radioactive tracers.

The speed of its circulation is slower than that of the blood, and is much slower in the extravascular Bonghan duct.

Circulation in the intravascular Bonghan duct is considered to be maintained by the heart beat as is the case with the blood and lymph circulation. In other words, the circulation of the Bonghan liquor is, it is considered, caused by the differences of pressure created around it, since the Bonghan duct lies in the blood current.

It is therefore established that the Bonghan liquor inside the Bonghan duct flows in one direction, in the same direction as the blood circulation.

The contractile action of the smooth muscles of the outer layer of the Bonghan corpuscle is believed to be playing a definite role in the circulation of the Bonghan liquor in the system of extravascular Bonghan ducts.

The Kim Se Wook phenomenon (Phenomenon Kim Se Uc) to be observed when a needle is applied to a Bonghan corpuscle shows the peculiar movement of the Bonghan corpuscle.

IV.

The Bonghan Corpuscle Has Unique Bioelectrical Activity

A series of similar changes of electric potential are observed in the Bonghan corpuscle even when various electrodes and induction systems are applied to it. These changes of electric potential are connected with the action of the living body, particularly with the action of the Kyungrak system.

The electrogram of Kyungrak directly induced from the Bonghan corpuscle are different from the various electric changes so far induced from the skin.

It is presumed that "ㄱ" and "ㄴ" waves on the electrogram of Kyungrak are directly connected with the action of the muscle layer of the Bonghan corpuscle and "ㄷ" wave with the secretory action of the cells of the Bonghan corpuscle.

The effect of a stimulus given to a Bonghan corpuscle is conveyed to the next Bonghan corpuscles through the same Bonghan duct.

It is confirmed through various functional experiments that the electrogram of Kyungrak also reflects the general functioning of the organism.

V.

A Large Quantity of Nucleic Acids, DNA in Particular, is Contained in the Bonghan Corpuscle and Bonghan Duct

DNA in the Bonghan duct exists in a peculiar way, outside the nucleus in the homogeneous Bonghan liquor.

This is established not only by the results of biochemical experiments but also by Feulgen reaction and other histo-chemical methods and by the luminescent microscopic examination.

In view of this, we consider that the action of the Kyungrak system is closely connected with nucleic acids.

And the specific form of the existence of nucleic acids in the Kyungrak system also requires the study of the functions and metabolism of nucleic acids from a new viewpoint.

Our new research achievements made public, we believe, have made a certain contribution to the comprehensive elucidation of the Kyungrak system, raised a series of important questions of principle in the field of modern biology and medicine and opened up a new vista in this field.

Publishing the results of our researches today, we extend our heartfelt gratitude with deep emotion to the Central Committee of the Workers' Party of Korea and to Comrade Kim Il Sung, our respected and beloved leader, who have always directed profound solicitude and concern to our scientific research work.

We would like also to express our deep thanks to many scientists and friends at home and abroad who have actively supported and encouraged us in our research work.

THE KYUNGRAK RESEARCH INSTITUTE

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