THE MOVEMENTS OF THE IRIS.

ROBT. J. LEE.

Presented to

John Croft Esqre. FRCS &c.

by the Author.

June 6. 1868.

AN EXPLANATION

OF

THE MOVEMENTS OF THE IRIS

BY

ROBERT JAMES LEE

M.B. Cantab. M.R.C.P.

'Omnibus esse igitur totas dicemus in illis
Particulis animas'

LONDON

RICHARD BENTLEY, NEW BURLINGTON STREET

PUBLISHER IN ORDINARY TO HER MAJESTY

1867

THE GANGLIA AND NERVES
OF
THE IRIS.

In Physiology, as in every other branch of natural philosophy, changes in the doctrines of those who pursue it have not always been evidence of advancement of knowledge.

In examining the opinions held by those of past time on points now clear to us, by the revelation of new facts, we are sometimes surprised at their apparent correctness, and imagine that those who held them possessed as complete a knowledge as ourselves. Yet the true method of studying the progress of a science is not by attempting to determine the accurate value of theoretical opinions, but by tracing the gradual establishment of undoubted facts.

That theories should precede the explanation of natural phenomena has been thought necessary for the advancement of truth. Nevertheless, no progress is made unless founded on facts, and limited by the direct conclusions drawn from them. As often as men have reasoned beyond facts or indulged in theories, the only benefit they have conferred upon science is that they have excited others with a greater regard for truth to investigate their errors, appealing to nature, and separating the false from the true.

These remarks are an excuse for not detailing the opinions of ancient writers upon the source of voluntary and involuntary movement in animal bodies.

Though several invisible agencies, producing many natural phenomena, have been discovered and demonstrated by their effects, and we have learned to comprehend the existence of forces of vast power and extent of influence, and have been allowed to advance beyond the simple limits to which our senses restrain us to the certain belief in their reality; yet none of these—gravitation, electricity, magnetism, or any other that time shall reveal—will equal in interest the vital force.

Of the history, it is sufficient to say that the brain and spinal cord were not proved to be the true source of voluntary motion till many years after the time of Aristotle.

The great importance of this discovery by Erasistratus and Herophilus it is difficult at the present day fully to appreciate, and to regard with proper esteem the memory of those two anatomists, who had succeeded in solving a problem which had surpassed the power of Aristotle.

By this discovery the principle was established that the nervous system was the origin of all motion.

About 400 years after this period, Galen extended the principle by another discovery, which must be regarded as the most remarkable ever made in any science. It was the demonstration of the existence in the animal body of another system of nerves, with which those wonderful structures the ganglia are connected, and in which they perform peculiar and extraordinary functions.

What is meant by a ganglion, or what are the ganglia, are questions which have constantly been asked.

> Some creatures do move a good while after their head is cut off, as birds; some a very little, as men and all beasts; some move though cut in several pieces, as snakes, eels, worms, flies, etc.

Bacon explains these facts as follows:—

> As for worms and flies and eels, the spirits are diffused almost all over, and therefore they move in their several pieces.

If the word 'ganglia' be substituted for 'spirits,' the general reader may form some idea of the property they possess.

The ceremonies of religion in ancient times afforded opportunities of observing a spectacle which produces, the first time it is witnessed, a feeling of indescribable astonishment.

On every occasion that Galen saw the heart of an animal removed from its body while living, or soon after death, and gazed on the extraordinary movements it displays, he had reason for believing and affirming that it did not depend upon the brain and spinal cord for the power it possesses.

Galen was little acquainted with the importance of his discovery of the ganglia, and with the extent of its application; nor was it till many centuries after his time, when Fallopius repeated the observations, and later still, when the nervous system of invertebrate animals became known to anatomists, that the functions of ganglia were better understood.

Now, though none were found to dispute the statement of Galen, that the motion of the heart was not produced by nervous influence, yet so mysterious were its movements that they excited the attention of all the most celebrated anatomists and physiologists after his time. It was the great problem to be solved. And a satisfactory solution was thought to have been found in the hypothetical existence of another power or property as mysterious as that possessed by the nervous system itself—to which Haller gave the name 'irritability' or 'vis insita.'

This attempt to explain phenomena, previously unaccountable by any known cause, may have been suggested by the example of Newton, in his assumption and proof of the existence of a force in nature which holds by attraction every particle of matter, bodies infinitely small and of vastest magnitude; through distances far and near exerting its power with less or greater effect, subject to simple and invariable laws, which have found more and more support in extension, and have remained unshaken by any opposing exception.

However, so numerous were the objections to the supposition of Haller, and so impossible was it to reduce its actions to any general law, that only those who preferred any explanation to a confession of ignorance supported the theory. Such confusion existed between the various opinions of physiologists on the question of the cause of the movement of vital organs in the human body which are independent of the brain, and so much labour had been bestowed upon it, that it is not a matter of surprise that anyone venturing to assert boldly that he had discovered the 'vera causa' would be received with favour and credibility; especially when he ascribed those movements to a simple and ancient principle, and showed that the organs were possessed of a nervous system of such a character and so extensive, as to afford an explanation of all the phenomena they displayed.

It is not a matter of wonder that the discovery of the source of the action of the most powerful muscular organ in the living body, the uterus, should have been doubted or disbelieved; for it was not the discovery of structures never before imagined to exist, but it was a contradiction to the opinions of celebrated anatomists who had denied their existence. It could not be possible, it was thought, that so many should have failed, and that one at last should succeed.

Not many years elapsed after 'the ganglia and nerves of the uterus' had been demonstrated, before the same anatomist was led to extend his observations; and was rewarded by finding support to his opinions in the discovery of a great system of ganglia and nerves in the heart, which was also denied to possess them, and whose functions had excited greater attention than those of the uterus.

Now that the verdict of time has been given in favour of the truth of those observations, and that only a few remain, who either are unable to see their importance, or whose minds are held captive by the chains of long-accustomed opinion, we might enquire by what means previously unknown were these facts brought to light—whether it was the result of accident, of observation, or by the adoption of some hitherto unknown plan of investigation. It may be answered, briefly, that it was an accident which excited attention; it was true inductive reasoning which directed observation and enquiry; and it was ingenuity in adopting a method never before employed, which succeeded in overcoming the difficulties and accomplishing the result.

When the voluntary system of nerves is regarded, we see that the parts which compose it are arranged in a simple and symmetrical manner. A regular plan is observed in the origin, relation, and distribution of the nerves to different parts of the body, and the effects of injury or disease of the nervous system are known by constant and appreciable symptoms. In the sympathetic system, similar regularity and symmetry of parts is not observed. The reason of this is apparent, when it is seen that the position of the ganglia, which form the important feature of that system, is admirably adapted to that of the organs which they supply with nerves.

At the same time the ganglia themselves are best protected from injury in the situations they occupy.

The next point to which attention must be directed is the connection which exists between the spinal and sympathetic nerves. Those muscles which are entirely under control of the will have no connection, apparently, with the ganglia of the sympathetic system; but whenever there is movement, to any extent whatever, of an involuntary kind, there we find that the nerves of the part are connected with a ganglion at no great distance from it.

Those movements which are partly involuntary, of which the intercostal muscles and the diaphragm offer the best examples, receive branches from the ganglia in the thorax and from the solar plexus respectively. The pneumogastric nerve, upon which depend all the movements of deglutition and those muscular actions employed in the production of sound by the adjustment of the vocal chords, actions only partially dependent on the voluntary nerves, has numerous connections with the ganglia of the sympathetic. The glands in all parts of the body, the liver, spleen, pancreas, and others, are to a great degree independent of the brain and spinal cord, and derive their nerves almost entirely from the sympathetic system.

There is another fact worthy of attention. If we examine the nerves of the heart we find that they proceed from a large ganglionic plexus situated between the aorta and the pulmonary artery. This plexus is formed by the union of nerves from the pneumogastric and from the ganglia of the sympathetic in the neck.

Many other examples might be adduced of a similar kind to show that such plexuses are intended to unite the cerebro-spinal and sympathetic systems.

There is one which furnishes the best example of this principle. The ophthalmic ganglion, which bears the same relation to the ciliary muscle and the iris as the cardiac plexus bears to the heart, is similarly connected with the cerebral and sympathetic systems through the branches it derives from the third and fifth pair of nerves, and from the cavernous plexus.

Some physiologists have imagined that these ganglia, of which we have explained the purpose to be the means of connecting the sympathetic and cerebro-spinal systems, are related to their respective organs in the same manner as the brain and spinal cord are related to the voluntary muscles; and they have applied the theory of reflex action to explain their functions. The conception of these ganglia as sources of the nervous power of the organs which they supply with nerves is one of those theories into which men of lively imagination are easily led. They think that they see a striking analogy between them and the brain. They conceive that the nerves which come from them are endowed with similar properties to those which leave the brain and spinal cord. They imagine that an organ owes all its power to those 'centres,' as they term them, and that instantaneous loss of power follows division of the nerves which pass to it from the ganglion.

The nerves from the spinal cord follow an uninterrupted course from commencement to termination. They have no connection with adjacent nervous filaments; and, what is important to remark, have no ganglia upon them after they leave the spinal canal. On the other hand, the nerves in organs such as the heart are of a totally different character: they do not divide and subdivide after leaving the ganglion from which they proceed, nor do they follow, like the spinal nerves, an uninterrupted course to their terminations, but numerous connections and many ganglia exist in various parts of the organ. It is the existence of these ganglia that explains the fact that, when the heart is removed from the body and from all connection with the cardiac plexus, it still possesses the power of contraction and dilatation it enjoyed before. Nay, more; it explains the reason why, when the heart is divided into segments, these will display the same movement as when united.

The same difficulty which was experienced in explaining the movements of the heart, has existed with regard to those of the iris; and various theories have been from time to time proposed to account for them.

The great similarity between the actions of the heart and iris is apparent to everyone: they both act to a great degree independently of the brain, and both display power of movement for some period after death. They both derive their nerves from a ganglion or plexus situated closely and externally to them, and they both possess in themselves, when removed from the body and from connection with the external ganglion, the same property they displayed before.

From the view which has been taken of the nervous system of the organs which display involuntary movement, there was evidently every reason to expect that ganglia would be found to exist in the structure of the iris similar to those in the heart and other organs.

Although attempts have been made to demonstrate ganglia in the iris of some of the lower animals—as white rabbits, &c.—up to this time it can be confidently asserted that no facts have been arrived at which prove the incorrectness of the explanation offered of its movements in the most recent works on the subject.

I shall proceed to show, in a brief and simple manner, that the strong analogy which exists between the movements of the heart and the iris is confirmed by the demonstration of similar nervous structures in the two organs.

On the 21st May, 1865, while dissecting the internal structures of the eye in water, and while attempting, without success, to trace the nerves as they pass into the iris, it occurred to me that by one method alone could this be effected—namely, that which had been adopted in dissecting the ganglia and nerves of the heart.

This method had never before been employed in such an investigation, and it was with great anxiety and interest that the first dissection was made.

The iris of a bullock, the same which had been examined in water, was allowed to remain in pure alcohol for two days. By these means the nerves become much whiter and firmer.

With the assistance of a magnifying glass, equal in power to the two-inch microscope piece, the iris being retained in alcohol, it was possible, with great care, to trace the nerves to the edge of the iris. The greatest difficulty met with was at that point where the ciliary nerves passed into the structure known as the ciliary ligament. A ciliary nerve, after passing through the sclerotic coat, preserved its dimensions until it entered an enlargement concealed in the ciliary muscle, for the so-called ligament is really of that nature; from which enlargement nervous filaments could be traced into the tissue of the iris. There was another fact of great importance to observe —namely, that one or more branches connected the enlargement upon one ciliary nerve with that of the nerves on either side of it.

It is necessary here to refer to the difference in the ciliary muscle in various classes of animals. It may be described as a ring of muscular tissue interposed between the sclerotic and choroid coats of the eye, surrounding the external margin of the iris, and lying below the margin of the sclerotic, where it unites with the cornea. The muscular fibres which compose it pass backwards from the inner surface of the sclerotic to be attached to the choroid beneath.

This muscle varies in size in different classes of animals. In the human species and in many of the larger quadrupeds, the bullock, the stag, horse, pig, and sheep, in which I have examined it, it is of very small size, and bears so strong a resemblance to ligamentous structure, and forms so firm an attachment between the choroid and sclerotic, that it has received the name of 'ciliary ligament.'

In the feline species the muscle is of very great breadth and thickness. The attachment of the sclerotic to the choroid in the eye of the cat is very easily destroyed, so that the muscle is intended for some additional and more important purpose than it performs in the case of the animals mentioned above. In the bird the ciliary muscle is of great breadth, and offers the best opportunity of examining its actions.

A portion of the ciliary muscle and iris is represented in Photograph II., from which it will be seen to be composed of numerous muscular fibres radiating from their attachment to the horny ring which forms part of the sclerotic in such a manner as to have the appearance of a broad band surrounding the iris. The muscular tissue in the recent state has a reddish white colour, but after immersion in alcohol it soon becomes perfectly white.

The great difficulty in demonstrating the nervous structures consists in following the nerves into the ciliary muscle, especially in those animals where its size is small and its structure dense and firm.

There is another source of difficulty—namely, that the connection of the muscle to the sclerotic is so strong that the nervous filaments are frequently broken in the process of separating that membrane.

In the present communication I shall attend more particularly to the nervous system of the ciliary muscle and iris of the bird—as the photographs which have been made by Mr. Highley to illustrate the subject afford great facility in understanding the arrangement of the structures. I hope to complete gradually in the same manner descriptions of the parts in the various animals which have been already examined.

In the first photograph, a view is given of the ciliary nerves of the eye of the pheasant, as seen after the ciliary muscle has been completely removed. The nerves pass through the sclerotic at one point, differing in this respect from their arrangement in the higher animals.

They pass forward, diverging from one another to the margin of the ciliary muscle, when they enter its structure, and are concealed by its fibres.

It is apparent that, between the point where the nerves pass through the sclerotic and the margin of the ciliary muscle, there is no indication of the ganglia and plexus revealed on its removal.

Photographs II. and III. are reduced by one-half from drawings of the structures, as seen through the one-inch object-glass of the microscope.

They are intended to show the appearances presented before and after removal of the ciliary muscle.

A few filaments proceed from ganglia upon the ciliary nerves, to pass into the iris. They will be seen to follow a long and somewhat irregular course. They are of large size, and, like the rest of the system, pass into ganglia at various points, from which smaller filaments proceed towards the inner margin of the iris.

The iris may appear to have but few ganglia, but on consideration it is evident that the position of those around its margin is admirably adapted to supply both the ciliary muscle and iris with nerves. In other organs it is found that the ganglia are situated in those parts which are least affected by the pressure of muscular contraction; for it would seem necessary to the proper performance of their functions that, like the brain and spinal cord, the small ganglia should be protected from any influence which might interfere with their action.

From a comparison of the differences in the ciliary system of nerves in various classes of animals, between the bird, in which the iris is most sensitive, and the fish, in which it is almost if not quite inactive, it may be concluded that, generally, the muscular activity of the iris varies directly with the number and size of the ganglia and nerves connected with it.

Many will be unwilling to allow the theories proposed by physiologists to be supplanted by such a simple explanation as is here offered of the movements of the iris. If they will liberate their minds from such influences, and consider the subject for themselves, I am convinced that they will allow no explanation to be satisfactory which does not take into account these nervous structures. It is not to be supposed that I consider the brain has no influence on the movements of the iris, or that the ciliary ganglion does not perform very important functions: but what I desire to prove is, simply, that a system of ganglia and nerves, never before demonstrated by anatomists, exists in the ciliary muscle and iris precisely similar to those shown to exist in the heart. If it be allowed that such structures have any influence on the movements of the heart, it must be allowed that they exert a similar influence on the movements of the iris.

In conclusion, the practical application of the subject may be briefly pointed out. Those who are engaged in the study of medicine and surgery are accustomed to observe the condition of the pupil in many diseases with great interest, and are enabled to form a correct opinion of the condition of the brain and nervous system from the appearance it presents.

It is reasonable to suppose that the various agents which affect the condition of the iris, exert the same influence upon the whole system of organs supplied with similar nervous structures. This consideration it is hoped may be the means of directing the attention of those engaged in the practice of medicine and surgery to a subject of such interest and importance.

SPOTTISWOODE AND CO., PRINTERS, NEW-STREET SQUARE, LONDON.

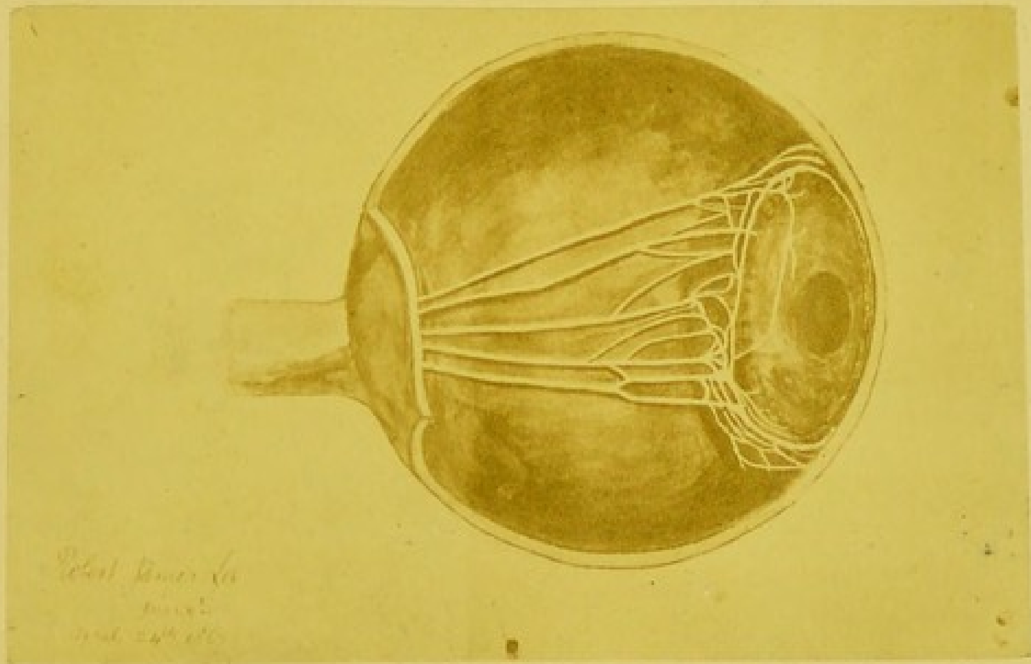

PLATE I.

Eye of the Pheasant, exhibiting the ciliary nerves.

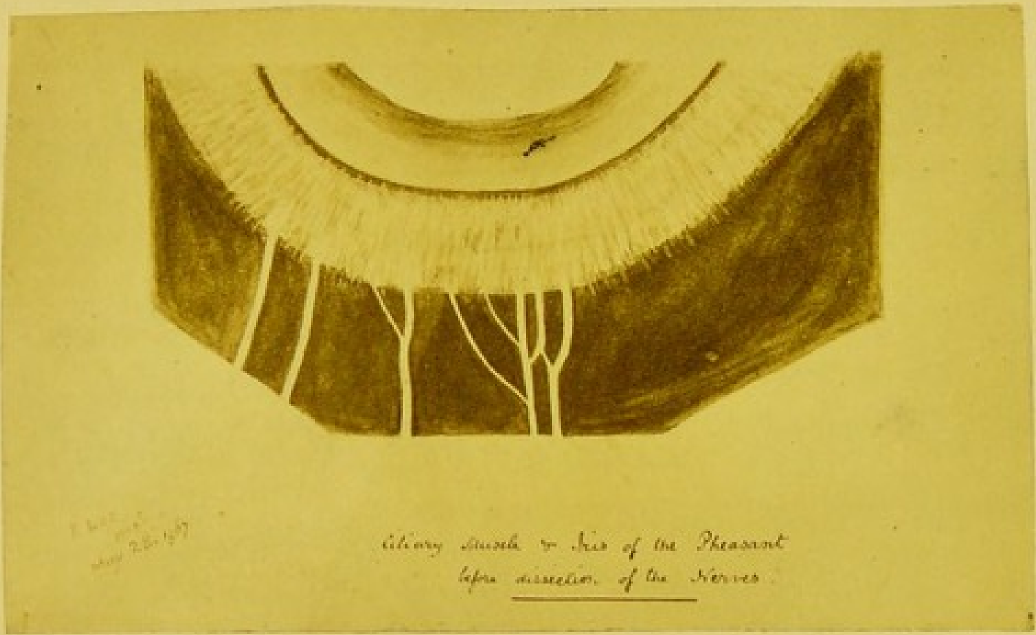

PLATE II.

The ciliary muscle, with the ciliary nerves of the eye of the Pheasant partly dissected.

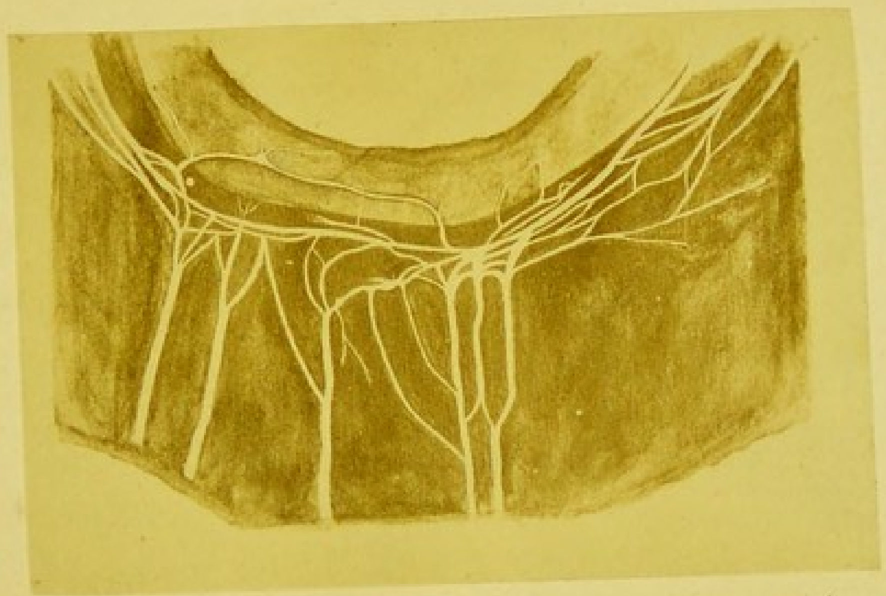

Plate III.

The nerves of the ciliary muscle and iris of the Pheasant.

5L