tendency of the symptoms is most plausibly explained by degeneration progressing toward the periphery and affecting finally the intrastomachal and intra-intestinal plexuses.

Vomiting was observed occasionally after removal of the stellate ganglion or of the lower part of the thoracic sympathetic or of the semilunar ganglion, but this symptom was very inconstant and transitory.

3. *Secretion of the Bile.* Munk observed that excitation of the splanchnic nerve in rabbits was followed first by an acceleration, then by a retardation of the flow of bile. He attributes this effect chiefly to vaso-motor influences and to stimulation of the muscles of the gall ducts. The latter effect was also noted by Doyon (quoted from Howell), who states that the corresponding nerve fibres reach the liver through the semilunar plexus.

Afanassiew noted that section of the nerves of the liver gave rise to polycholia: (*a*) increased secretion of bile; (*b*) dilatation of all the blood-vessels of the liver to a marked degree, and afterward dilatation of the lymphatic pathways; (*c*) excess of urobilin, its presence being caused partly by the polycholia and partly by compression of the fine gall ducts by the dilated blood and lymph vessels, the consequence being retention of bile; (*d*) absence of glycogen in the liver; (*e*) swelling of the liver cells, which take on an appearance similar to that observed after fibrin feeding.

Howell concludes that, as far as our knowledge goes, the physiological evidence is against the existence of true secretory nerves controlling the formation of bile. On the other hand, he says, there are some experiments (Morat and Dufour), though not absolutely conclusive, which indicate that glycogen formation within the liver cells is influenced by a special set of glyco-secretory fibres.

4. *Influence upon the Pancreatic Secretion.** According to the investigations of Pawlow and his students, stimulation of the vagus nerve or the sympathetic causes, after a considerable period of latency, a marked flow of pancreatic secretion. Howell says that, in harmony with the theory of trophic and secretory fibres, the experiment seems to indicate that trophic fibres are more abundant in the sympathetic, and, similarly, the secretory fibres proper in the pneumogastric.

(*e*) *Renal Secretion.*—Howell concludes that the majority of purely physiological experiments upon direct stimulation of the nerves going to the kidney are adverse to the theory of secretory fibres, the marked effects obtained in these experiments being entirely explicable by the changes produced in the blood supply of the organ. Hermann comes to similar conclusions.

The vascular nerve fibres of the kidney are supplied by the renal plexus, and are preponderatingly but not exclusively derived from the splanchnic nerves (Hermann). According to Bradford, the innervation of the vessels of the kidney is furnished by the anterior roots of the dorsal nerves from the fourth downward and of the lumbar nerves down to the third and fourth; most abundantly, however, by the eleventh, twelfth, and thirteenth dorsal. The existence of fibres passing within the splanchnic to the kidney, fibres which exert a tonic influence, cannot be proven (Hermann). According to Langley and Dickinson, the splanchnic vascular fibres of the kidney are interrupted by cells of the renal plexus.

Peyrani has found that section of the cervical sympathetic causes a lessening of the quantity of urea and urine to a minimum, while excitation of the peripheral (head) stump of this nerve causes increase both of urea and of urine. Kuelz could not confirm these results, and denies that the cervical sympathetic has any influence upon the above-mentioned secretions.

(*f*) *Glycosuria Produced by Influence of the Sympathetic.*—The subject of glycosuria is ranged in here for convenience' sake, although not properly belonging here.

Since Claude Bernard showed that irritation of the floor of the fourth ventricle, the so-called hepatic vaso-motor centre or area, causes glycosuria, physiological and pathological evidence has been accumulated to show that the production of grape sugar stands in causal relationship to the function of the sympathetic nervous system. Schiff demonstrated that section of the vaso-motor pathways in the spinal cord at any level down as far as the exit of the nerves for the liver, caused glycosuria. Pavey noted that destruction of the superior cervical ganglion caused glycosuria, and Eckhard observed that a similar condition resulted when the inferior cervical and first thoracic were destroyed. Trambusti showed experimentally that after extirpation of the cœliac plexus there was deposition of glycogen in the kidneys. Dr. J. Collins and the writer found much sugar in the urine in one cat four weeks after removal of the lower part of the thoracic sympathetic nerve on one side, in another cat four months after the same operation. Nearly every physiologist who has experimented on the abdominal sympathetic, and has afterward carefully observed the constitution of the urine, has found that lesion of this part of the sympathetic is accompanied usually by glycosuria (Klebs, Munk, Hensen); but in most if not all of these experiments only the immediate effects of lesions in the domain of the sympathetic were studied, while in the observations of Dr. Collins and the writer the remote effects of such lesions were the subject of inquiry.

The hypotheses that have been advanced to explain the occurrence of glycosuria with these experimental lesions of the sympathetic nervous system are numerous. The majority of writers seem to be of the opinion that the occurrence of grape sugar with such lesion is immediately conditioned by change in the tonus of the blood-vessels of the liver and in the quantity of blood passing through the liver.

From the large amount of sugar found four months after the lesion of the thoracic sympathetic, it is fair to conclude that the glycosuria caused by such lesions is not temporary but permanent, and seems, if we are allowed to judge anything from the observations of Dr. Collins and myself, limited to two cases only, to have a tendency to increase rather than to diminish.

We find, then, that nearly all secretory glands are under the influence of the sympathetic system. The facts indicate, as Claude Bernard showed for the submaxillary ganglion and gland, that there are independence and dependence of action of the peripheral (that is, sympathetic) secretory nerve apparatus from the central nervous system. The fibres of the latter (cerebro-spinal fibres, motor fibres of the first order—Kölliker; preganglionic fibres—Langley) exert a controlling influence upon the secretions, which influence is either stimulating or inhibitory, purely secretory or partly vascular, or solely vascular, as in the case of the kidney, for instance, in which organ the existence of purely secretory fibres could not be proven. For some glands (salivary, pancreas) the existence of true trophic nerves is possible, although rendered questionable by Matthews' conclusions, and it would seem that most of the trophic fibres are derived from the sympathetic cord.

II. Vascular Functions.—The investigations of Claude Bernard, Dastre and Morat, Ostroumoff, Gruetzner, Heidenhain, and others have demonstrated the existence of two kinds of vascular nerve fibres (fibres calorifiques of Claude Bernard). The excitation of one kind causes vaso-constriction—" vaso-motor or vaso-constrictor fibres"; while excitation of the other kind produces vaso-dilatation—" vaso-dilator or vaso-inhibitory fibres." The vaso-constrictor fibres usually predominate in number or strength, and are therefore more easily demonstrated than the vaso-dilators.

As to *sensory* vascular nerve supply, Spallita and Consiglio find that the entire vascular surface is provided with special sensibility, capable of producing notable modifications in the general distribution of the blood. It is the opinion of these investigators that the function of the vaso-sensitive nerves is to prevent a superabundance of blood in the peripheral parts of the circulatory

* See results of Matthews' experiments, p. 582.

system, an action analogous to that which Cyon admitted for the sensory nerves of the heart and of the liver.

The motor vascular fibres leave the spinal cord for the most part with the anterior roots, but a part of the vaso-dilator (vaso-inhibitory) fibres seem to be contained in the posterior roots (Stricker, Gaertner, Morat). In their further course the vascular fibres either join the great gangliated cord by means of communicant rami, which is the case for most if not all vascular fibres of the limbs (Claude Bernard, Ostroumoff, Heidenhain and Gruetzner, Langley), or they pass from the spinal nerve directly to one of the great prevertebral plexuses. We find thus, for instance, that part of the vascular fibres supplying the pelvic viscera are derived from the lumbar plexus and join the periphery by intermediation of the great gangliated cord, while the other part, arising from the sacral nerves, pass directly to the hypogastric plexus without connection with the gangliated cord (Langley).

Many of the vascular fibres enter the gangliated cord and become interrupted by cells of the ganglia of the latter. This is probably the case with most of the vaso-motor and vaso-inhibitory fibres for the limbs. Others again, those which are contained in the posterior roots, are said to be interrupted by cells of the spinal ganglia (Morat). Still others take an uninterrupted course through the sympathetic cords, using the latter only as a kind of commissure. This has been demonstrated to be so for the vascular fibres of the splanchnic nerve, which pass without interruption from the spinal cord either to the semilunar or to the superior mesenteric ganglion (Langley and Dickinson).

The presence of both vaso-constrictor and vaso-dilator fibres has been proven in almost every division of the sympathetic system.

Recently the section or resection of the cervical sympathetic unilaterally or bilaterally has given opportunity of studying the vascular functions of this part of the gangliated cord in man. Jonnesco, making his studies on fifteen epileptics thus operated, concludes that the cervical sympathetic contains vaso-constrictor fibres for the head, face, and heart, made evident by excitation with strong electric currents; that it contains, furthermore, vaso-dilator fibres for the inner parts of the cheeks and lips, for the gums, inner and lateral part of the tongue, and for the brain, brought out by the application of feeble currents.

In rabbits, Lafforgue had observed as the direct result of stimulation of the cervical sympathetic nerve (peripheral stump) a spasmodic ischæmia of the whole cerebrum, cerebellum, and oblongata.

A common central organ for the vaso-motor nerves is situated in the medulla oblongata, by stimulating which (the spinal cord and sympathetic being uninjured) contraction of all the small arteries, increase of the blood pressure in the arterial trunks, and turgescence of the heart (Ludwig and Thiry, quoted from Hermann), will be produced. It extends in rabbits from about 3 mm. above the calamus scriptorius to the upper portion of the fourth ventricle. It is bilateral, situated at some distance from the median line.

Reinhold, in several cases of vascular disturbances which by exclusion were interpreted as being of central origin, found multiple hemorrhages at the floor of the fourth ventricle.

The outflow from the spinal cord, of the vaso-motor fibres for the lungs (in the dog) takes place between the first and fifth dorsal nerves, with a maximum at the level of the third dorsal. Some of these fibres leave the thoracic sympathetic chain at the level of the stellate ganglion and pass through the ansa Vieussenii to the inferior cervical ganglion (Bradford, Dean, and François Frank).

III. Cardiac Functions.—The striking autonomy of the peripheral nerve apparatus of the heart is shown by the fact that the latter, when removed from the body or deprived of all the nerves passing to it, still continues to beat for some time, in cold-blooded animals even for days. Recently Engelmann has called attention to a still more marked autonomy of the heart's action, pointing out that in the fœtus pulsations of the heart begin at a period when the latter is still absolutely devoid of nerve cells (and consequently also of nerve fibres). In the human embryo the first beginnings of cardiac ganglia are not found before the end of the fourth or commencement of the fifth week (His), while Pflüger saw regular pulsations of the heart in a human embryo of hardly three weeks, which denotes the possibility of purely myogenic heart action entirely independent of any nervous influence. Yet its action is under the control of certain nerves, part of which have an accelerating and at the same time augmenting (intensifying) influence—augmentor nerves; while the others have an inhibitory effect by lessening the number of beats and the force of the contractions—inhibitory nerves of the heart. Most of the inhibitory nerves are contained in the pneumogastric nerve, which is the cardiac inhibitory nerve *par excellence.*

In the dog the augmentor fibres are said to leave the spinal cord by the anterior roots of the second and third and to some extent the first and fourth, possibly the fifth, thoracic nerves. They travel by the several rami communicantes to the stellate ganglion, and pass thence to the cardiac plexuses and to the heart by nerves from the ganglion itself or from the ansa Vieussenii, or from the so-called lower cervical ganglion. In the cat, and probably in mammals generally, the path of the augmentor impulses is very similar. They leave the spinal cord by the upper thoracic nerves and pass to the heart through the lower cervical and upper thoracic sympathetic ganglia (Langley, Foster).

Part of the augmentor fibres, however, are derived from the pneumogastric nerve (Hermann). Schiff, who goes so far as to claim that the pneumogastric alone contains augmentor fibres, says that when this nerve is completely degenerated no acceleration of the heart action can be obtained through any nerve. He concludes that the influence which the sympathetic ganglia have upon the acceleration of the heart's action is due to the action of the pneumogastric nerve connected with them.

IV. Respiratory Functions.—Graham finds that the splanchnic nerve exerts a reflex, inhibitory influence upon respiration. If the splanchnic nerve of the one (left) side is severed and the central stump excited by the faradic current, the respiration arrests itself in the state of expiration—diaphragm perfectly relaxed, abdominal muscles contracted. The tests succeed also when both pneumogastric nerves are severed at the neck.

Section of the oblongata above the region of the respiratory centre does not influence the result, which remains also unchanged when the spinal cord is severed between the eleventh and twelfth dorsal vertebræ, while the excitation of the splanchnic nerve loses its effect if the section is made between the fourth and fifth dorsal vertebræ. This shows that the fibres in question enter from the splanchnic nerve into the spinal cord above the eleventh or twelfth dorsal, and below the fourth or fifth dorsal vertebræ, and then ascend to the oblongata to influence the respiratory centre.

Guillebeau and Luchsinger confirm Graham's observation of the influence of faradic excitation of the splanchnic nerve upon respiration if the spinal cord is intact; but if the oblongata is severed from the cord, the effect of the faradization of the splanchnic nerve is contraction, not only of the abdominal muscles, but of the diaphragm. They contend that the spinal cord contains the primary centres for abdominal *pressure* (*Bauchpresse*), because after isolation from the oblongata the mechanics of the abdominal pressure can be brought into action reflexly by excitation of sensory nerves.

It may be of some interest briefly to mention here the remote effects of lesions of the sympathetic on respiration and on the respiratory tract in general, as observed by Dr. J. Collins and the writer after removal of the lower part of one thoracic sympathetic nerve in some cats and of one stellate ganglion in others. These effects, as a rule, made their appearance as late as weeks after the operation, and, in the case of lesion of the thoracic sympathetic, even four months after the injury inflicted. They consisted in either case in the occurrence of attacks of sneezing and of paroxysms of coughing and hiccough. Removal of the stellate ganglion caused, in addition, first a mucous, then a purulent secretion from the nasal mucous membrane, and in one case it produced a chronic purulent bronchial secretion with lobular infiltration of the lungs.

The respiratory symptoms were more grave in the case of removal of the stellate ganglion than in the case of resection of the thoracic sympathetic in its lower portion. To account for this we must not forget that in the cat the vagus nerve sends a powerful communicating branch to the stellate ganglion. This may also explain the presence of the catarrhal condition in case of removal of the stellate ganglion and its absence in the case of resection of the lower portion of the thoracic sympathetic. The cough and hiccough, however, could not be due to involvement of the pneumogastric alone, since they were observed also after resection of the lower part of the thoracic sympathetic, an operation which involved chiefly the splanchnic nerve. For the innervation of the pulmonary vessels, see page 585, end of section on vascular functions.

V. Involuntary and Automatic Movements.—Under this heading I class the movements caused by non-striated muscles. The heart muscle has a structure which forms a transition between the striated and non-striated muscles. Owing to the intimate connection which exists between the heart and the blood-vessels, it was found most convenient to discuss the sympathetic influence upon this organ directly after discussing the vascular functions.

It now remains to discuss the influence of the sympathetic system upon the movements of the stomach and intestines, the bladder, the uterus, the pupil, and on the erectors of the hair follicles (pilomotor nerves, Langley).

(*a*) *The Movements of the Stomach and Intestines.*—In this paragraph we may at the same time discuss the vascular influence upon the stomach and intestines. The nerves presiding over the secretions of these parts have been spoken of in a preceding chapter.

The movements of the stomach and smaller intestine are under the control chiefly of the pneumogastric and the splanchnic nerves, which nerves are to a large extent functionally antagonistic to each other (Pflüger, Mayer and Basch, van Braam-Houckgeest). The pneumogastric is chiefly a vaso-dilator nerve and excites the movements of the intestine and the stomach; the splanchnic inhibits the movements, and it is at the same time vaso-constrictor. Morat has demonstrated, however, that this antagonism is not absolute, he being able to demonstrate the inhibitory activity of the pneumogastric and, on the other hand, the excito-motor (augmenting) activity of the splanchnics.

One splanchnic nerve can functionally replace the other (van Braam-Houckgeest). Both the vaso-constrictor and the motor inhibitory action of the splanchnics are under the tonic innervation of the nerve centres (spinal) with which they are connected (van Braam-Houckgeest).

According to Contejean, the pneumogastric nerve in the frog innervates the longitudinal system of muscular fibres of the stomach, and contains also inhibitory fibres which may counteract reflex action of the stomach; the sympathetic, on the other hand, presides chiefly over the circular system of muscles.

Ehrmann, on the other hand (quotation from Hermann), finds that the pneumogastric excites the circular muscular fibres of the stomach and intestine and inhibits the longitudinal fibres, while the splanchnic excites the longitudinal fibres and inhibits the circular fibres. This conclusion is contradicted by Langley.

According to Langley, the splanchnic fibres are derived directly from the spinal cord; that is, they undergo no cell interruption in the ganglia of the sympathetic cords. But they have their termination in the semilunar ganglia, and from the cells of the latter new fibres arise which establish the connection with the muscles and blood-vessels of the stomach and upper intestine.

The lower segments of the intestine (colon and rectum) receive likewise a double nerve supply, namely from the lumbar (second to sixth in the cat), and from the sacral (second to fourth) nerve roots (Langley and Anderson). The fibres derived from the lumbar roots (visceral lumbar nerves) join the sympathetic and leave it for the most part with the cœliac or hypogastric nerves. The fibres derived from the sacral roots (visceral sacral nerves) pass into the nervi erigentes.

The two nerve plexuses differ not only in origin, but also in function (Langley and Anderson). In the first place the visceral lumbar nerves contain vaso-constrictor fibres for the descending colon, for the rectum, and for the mucous membrane of the internal sphincter. These nerves further contain inhibitory fibres for the muscles of the colon and rectum and for the mucous membrane of the internal sphincter. Finally, the visceral lumbar nerves have a relationship to the skin surrounding the anus; they supply motor fibres for the non-striated muscles and for the constrictors of the blood-vessels of this region.

The visceral *sacral* nerves are to a great extent antagonists of the visceral *lumbar* nerves. Excitation of them produces hyperæmia of the intestinal mucous membrane and strong movements of the longitudinal and circular muscles of the colon and rectum. The non-striated muscles of the skin of the anus are inhibited by these fibres.

In regard to the movements of the rectum Fellner had come to the following conclusions, which are, as we have seen, contradicted in part by Langley and Anderson: (1) The nervi erigentes cause contraction of the longitudinal fibres and relaxation of the circular fibres of the muscles, shortening and thickening of the rectum, increase of volume, and diminution of pressure; (2) the hypogastric nerves have the opposite effect: relaxation of the longitudinal, contraction of the circular muscular fibres, lengthening and narrowing of the rectum, lessening of volume, and increase of pressure.

(*b*) *The Movements of the Bladder.*—It is proven by the investigations of Budge, Sokownin, Gianuzzi, Nussbaum, Nawrocki and Skabitschewski, Langley and Anderson, and Sherrington that the bladder receives a double supply of motor nerves, viz: (1) From roots of lumbar nerves (lumbar supply); and (2) from sacral nerves (sacral supply).

The fibres derived from the *lumbar nerves* leave the spinal cord by the anterior roots of the (third) fourth and fifth (in the monkey from the second, third, and fourth) lumbar nerves, and join the abdominal sympathetic nerve by the rami communicantes. From the abdominal sympathetic part of the fibres pass directly to the hypogastric and vesical plexuses (Nussbaum); the greater part, however, reach the inferior mesenteric ganglion by way of the mesenteric (superior, median, inferior) nerves, and pass then into the hypogastric nerves, which latter connect the inferior mesenteric ganglion with the hypogastric plexus.

The fibres derived from the *sacral nerves* leave the spinal cord with the anterior roots of the second, third (sometimes also the fourth, and very seldom the fifth) sacral, and pass from these nerves *directly to the hypogastric plexus,* without mediation of the main trunk of the sympathetic.

According to Langley, part of the motor fibres of the bladder are interrupted by cells of the inferior mesenteric ganglion, others probably by the cells of the hypogastric or vesical plexuses.

As the descent of the fibres to the bladder occurs in two different pathways, so their origin in the cord is probably twofold; that is, we must assume for many mammals the presence of two separate spinal centres of the bladder, one being situated in the lumbar, the other in the sacral portion of the cord. The position of these centres, although not exactly known, is indicated more or less by the level of the roots through which the motor fibres for the bladder leave the cord. Gianuzzi claims that in the dog they are situated at the level of the third

and fifth lumbar vertebræ respectively. Sarbo reported a case of a man in whom there had been incontinence of fæces and of urine, and in whom the autopsy revealed a gliosis that had effaced the structure of the spinal cord almost entirely at the levels of the third and fourth sacral segments.

Erection and Ejaculation. The vaso-dilator fibres, stimulation of which causes erection, are contained in the nervi erigentes (Eckhard, quoted from Hermann) which are formed by filaments passing from the sacral nerves (chiefly the second and third) to the hypogastric plexus; but some of these vaso-dilator fibres come from the lumbar sympathetic (dog), passing from there to the hypogastric plexus (François Franck).

Concerning the pathways of the nerves presiding over ejaculation, nothing definite seems to be known. At least nothing is said about them in the well-known physiological text-books.

The centres of erection and ejaculation (dog) are situated in the lumbar portion of the spinal cord (Goltz).

As has been mentioned in another paragraph, the bladder can act independently of the spinal centres, at least in the higher mammalians (cat, monkey). After all the motor fibres leading to the bladder have been severed from the spinal cord, this organ still continues its functions for weeks (Zeissl). Its rhythmic action is the result of the nerve apparatus (hypogastric and vesical plexuses) placed within or on its wall (Zeissl, Sherrington).

(*c*) *The Movements of the Uterus.*—According to Langley, all motor fibres to this organ are supplied exclusively from lumbar nerves, and their further course is within the main trunk of the sympathetic, from which they pass through the inferior mesenteric ganglion to the pelvic plexuses. Some authors, however (Frankenhauser, Kehrer, and others), claim a sacral supply in addition to the lumbar, stating that part of the motor fibres of the uterus pass directly from sacral (third, fourth) nerves to the pelvic plexuses. According to Basch and Hoffmann (quotation from Hermann), the lumbar nerves act as motor nerves only of the longitudinal fibres, the sacral only of the circular fibres of the uterus. These statements are contradicted by Langley.

A great part of the motor fibres to the uterus are interrupted by cells of the inferior mesenteric ganglion (Langley).

For parturition, the centre situated in the lumbar portion of the spinal cord is sufficient, as this act has been observed in bitches with isolated lumbar portion of the spinal cord (Goltz and others). As to whether parturition can take place if the connection with this spinal centre is severed, we can find no data.

Chapman and Foote conclude that the ovarian plexus is the controlling nerve supply to the ovary, tube, and uterus, and the path along which are conveyed the most important stimuli passing to these organs. For further details of their work, see the paragraph on the "Nerves of the Uterus" in the anatomy of the sympathetic, page 579.

(*d*) *The Erector Muscles of the Hair Follicles and the Pilomotor Nerves.*—The name of pilomotor nerves is given by Langley and Sherrington to those nerve fibres which innervate the erector muscles of the hairs. According to these authors, the pilomotor fibres pass through the anterior roots into the sympathetic nerve from which they take their course to the periphery. Experiments with nicotine prove that the fibres become interrupted* by cells of the sympathetic ganglia of the two gangliated cords. The pathway that the impulse takes from the spinal cord to the periphery consists thus of two sets of neurones, one of which originates from cells of the spinal cord, the other from cells of the ganglia of the main trunk of the sympathetic.

The outflow of the pilomotor nerves from the spinal cord occurs through the rami communicantes of the fourth dorsal (seldom the third) down to the third or fourth lumbar nerves. (In cats and monkeys it is somewhat otherwise.)

Excitation of the individual ganglia of the sympathetic nerve causes erection of hairs in definite circumscribed regions. Usually, but not always, the sympathetic (peripheral) fibres arise from cells of the nearest sympathetic ganglia, sometimes from the second nearest.

The pilomotor fibres and the sensory fibres can be traced running together up to their entrance into the skin. There is no difficulty in showing that the greater part of the area supplied with pilomotor nerves by a given gray ramus is also supplied by sensory fibres of the corresponding spinal nerve (Langley).

Langley and Sherrington allot to the various communicant rami definite circumscribed although partly overlapping areas of distribution of pilomotor fibres.

The results of some of the experiments conducted by Dr. J. Collins and the writer lead us to the conclusion, however, that although the pilomotor nerves probably have, on the whole, the segmental distribution which Langley and Sherrington attribute to them, there must be a collateral supply or a direct cerebro-spinal supply, which in the case of removal of three or four successive ganglia can in the course of time entirely replace the functional loss thus created.

(*e*) *Influence upon the Pupil, Eyeball, and Eyelids.*—In 1727 Pourfour du Petit first demonstrated that section of the cervical sympathetic nerve is followed by contraction of the pupil and sinking in of the eyeball of the corresponding side. The contraction of the pupil was interpreted as being due to paralysis of the dilator pupillæ muscle. The sinking in of the eyeball was explained partly by vaso-motor effect, partly by the paralysis of Müller's muscle (Heese).

G. Fischer (quotation from Moebius) excited the cervical sympathetic nerve in the heads of two decapitated men. Faradic excitation produced opening of the palpebral fissure, dilatation of the pupil, protrusion of the cornea, and considerable lachrymal secretion. These effects on the pupil, palpebral fissure, and eyeball in man were confirmed also by Jonnesco in epileptics in whom for therapeutic purposes the cervical sympathetic was resected or cut.

Budge and others showed that the pupil-dilating fibres of the cervical sympathetic are derived from the anterior roots of certain spinal nerves, which, joining the sympathetic nerve of the thorax by means of rami communicantes, pass through the ansa Vieussenii to the stellate ganglion, from whence they take their course within the cervical sympathetic to the pupil.

Comparing the results of the investigators (Budge, Salkowski, Nawrocki, Sherrington, Langley, Müller) in this field, we find that the outflow of the pupil-dilating fibres from the spinal cord occurs with the greatest constancy in the anterior roots of the first dorsal and almost as constantly of the second dorsal, to less extent and less constantly of the eighth cervical and third dorsal, and least constantly, it would seem, of the seventh cervical and fourth dorsal nerves. This distribution varies not only with the species of the animal, but also individually in the same species.

Budge placed the origin of the pupil-dilating fibres of the cervical sympathetic in the so-called cilio-spinal centre, which he found to occupy the region between the exits of the sixth cervical and third dorsal nerves in the

* Langley believes that there are justifiable grounds for the conclusion that by stimulating the nerve fibres running to and from any peripheral ganglion before and after applying dilute nicotine to it, the class of nerve fibres which end around nerve cells of the ganglion can be distinguished from those which run through the ganglion without being connected with its cells. Nicotine seems to paralyze the conductive action either of the nerve cells of the ganglion or of the nerve endings in the ganglion, that is, it seems to prevent the transmission of a stimulation from one neurone to another while it does not affect the conductivity of the nerve fibres. Therefore, if the ganglion is smeared with nicotine, direct stimulation of the nerve fibres passing out *from* the ganglion to the periphery retains in every case its full effect; but if, after the application of the nicotine, stimulation is applied centrad of the ganglion, *i.e.*, to the nerve fibres passing *into* the latter (instead of *from* it) this stimulation will remain effective if the said fibres pass uninterruptedly through the ganglion, while it will have *no* effect if the stimulated fibres terminate around cells of the ganglion.