A LECTURE ON RECENT PROGRESS IN THE PATHOLOGY AND TREATMENT OF CEREBRAL PARALYSIS.

Delivered at the Hospital for Epilepsy and Paralysis, Regent's Park.

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GENTLEMEN,—I purpose, in to-day's lecture, to lay before you the results of some recent investigations into the nature and symptoms of paralysis arising from brain-disease, and will at the same time endeavour to point out how far the clearer scientific notions which we have lately gained on this subject may be rendered practically useful for prognosis and treatment. Before, however, plunging into the intricacies of pathology, I must say a few words on certain anatomical features of the motor zone of the nervous centres, which are of importance for the right comprehension of the diseases to which its several portions are subject. Our systematic handbooks of anatomy do not as yet supply that kind of knowledge which is so much required for a due appreciation of recent medical doctrines, and which has been gained not so much by systematic slicings of brains and cords of healthy adults, as by the infinitely finer and more instructive dissections made for us by disease, and which have thrown an entirely new light on the facts of normal anatomy. This is a kind of vivisection which cannot be prohibited by Acts of Parliament, and which has led to far more reliable results than experimental physiology or pathology.

It may be truly said that most of what is solid in the edifice of localisation of power in the brain and spinal cord has been contributed by clinical observation and pathological anatomy; while in those points which have been chiefly studied experimentally, the greatest discrepancies continue to exist amongst the best observers. Thus Professor Goltz of Strasburg, one of the ablest physiologists of the present day, denies Dr. Ferrier's doctrines on the brain *in toto*; while Munk, Eckhard, and Gliky are greatly at variance with Ferrier in important particulars.

Experimental pathology, of which such brilliant results were at one time expected, seems to have been singularly unproductive in this special department. Vulpian, who is one of its chief apostles, accounts for this by the utter inability of the experimental pathologist to produce in animals maladies such as we see them in man. It is true that he may cause injuries or lesions, but he cannot make a disease; and, even where he seems to have succeeded in imitating one, the eventual results are disappointing. Thus glycosuria, which is experimentally brought about, is not diabetes such as we observe it clinically, but only a passing physiological storm, which is certain to disappear in a short time, and which moreover reproduces only one of the symptoms of diabetes. Again, a form of epilepsy may be caused in guinea-pigs which in some respects resembles human epilepsy, and has even been transmitted to the offspring of the animals; yet it has the tendency to disappear spontaneously, without the aid of digitalis or bromide of potassium, and is, after all, by no means the actual disease with which we are familiar in our patients.

Nobody has yet succeeded in producing in dogs or guinea-pigs locomotor ataxy, sclerosis in patches, or progressive muscular atrophy. The experimental pathologist may divide the posterior columns of the spinal cord, or even remove them bodily (which latter operation, by the way, proves rapidly fatal); but he is utterly unable to induce in those parts that peculiar state of irritation and gradual wasting of nerve-fibres which forms the characteristic feature of sclerosis. Such are the facts, quite independently of the great difficulty that is experienced in appreciating the alterations produced, not so much, perhaps, in the sphere of motion as in those of sensation, the instinct, and intellect. Experimental pathology can, therefore, never supplant clinical observation to any extent; all it can do is in some instances to account for symptoms, and perhaps lead us in time to clearer scientific notions on the nature of certain diseases. Nor has this branch of study as yet furnished us with any very important data for the prognosis and treatment of nervous diseases. It is true that a knowledge of the physiological effects of certain medicines, such as atropine and pilocarpine, may give

us hints as to their therapeutical powers; yet we must remember that the effects of medicines in healthy animals are not identical with those that may be produced in patients suffering from nervous affections, and cannot in many instances even explain them. Thus nitrate of silver, which does excellent service in the initial stage of locomotor ataxy, owes its well-established reputation exclusively to observations made at the bedside of patients afflicted with that disease.

To clinical observation and pathological anatomy, in which of late years more especially the French school of La Salpêtrière has done excellent work, we must, however, add, as an important link, the study of the *evolution of the nervous centres in the fœtus*, which has recently been pursued with the most gratifying success in Germany by Dr. Flechsig; and on this part of the subject I must now say a few words, as these researches, which have been given to the world in a singularly unattractive form, are as yet scarcely known in this country.

It was in the study of the successive and gradual formation of the myeline sheaths of the central nerve-fibres, that Flechsig found a new and important means of recognising peculiarities of organisation in the central nervous system, where other modes of examination appeared to encounter insuperable difficulties. He has shown that certain fibres and strands of fibres, which in the adult are so intimately welded together that they appear identical, may, during certain phases of embryonic life, be plainly distinguished from each other, inasmuch as some of them are still naked axis-cylinders, while others have already become covered with a sheath of myeline. By noting this fundamental difference, it is possible to trace, in the medullary masses of the brain and cord of the fœtus, certain peculiarities which later in life disappear altogether. Since, then, in the different periods of intra-uterine existence, some strands are seen to follow invariably peculiar laws of evolution, we are justified in assigning to them a separate place in the general plan of arrangement of the nervous centres. Fibres, the continuity of which is undoubted, have been found to become provided with their myeline sheaths at the same period of fœtal life; while others, apparently continuous with or contiguous to them, and which in the adult can no longer be distinguished, only become fully developed several months later. The study of evolution, therefore, shows such fibres and strands to be distinct from each other, and has served as an important factor in determining the relations of certain portions of the cord to other tracts in the medulla oblongata and the brain.

The main body of fibres appertaining to equivalent centres is provided with medullary sheaths at the same period; and where, in this respect, differences amounting to several months are encountered, any systematic equivalence of such strands can no longer be assumed. It has also been shown that the evolution of those strands of the spinal cord and medulla oblongata which are in direct connection with the higher cerebral and cerebellar centres takes place, without exception, at a very late period of fœtal life; and this fact alone throws doubt on the assumption that the posterior longitudinal strands have any definite connection with cerebral centres.

These considerations are sufficient to show what an important aid the study of evolution must afford to the pathological anatomy of what is now known as the secondary degenerations, in which we meet with considerable alterations in the morphological characters of certain strands of fibres throughout their course in the cerebro-spinal axis. In some instances, indeed, Flechsig is inclined to think that evolution furnishes more perfect data than pathology. At any rate, it cannot be denied that, where both lines of inquiry yield the same results, these are rendered much more reliable.

The specimens on which Flechsig founds his conclusions have been prepared partly with perosmic acid, which gives a black coloration to the fully developed fibres, but leaves those without a sheath of myeline quite clear; and partly by means of a new mode of impregnating the nervous centres with gold, which appears to furnish the most perfect preparations. If sections, which have otherwise been carefully prepared, be left for a short time in a half per cent. solution of perchloride of gold, the white matter is seen to assume a dark violet colour, and those nerve-fibres which already possess a sheath of myeline are more deeply tinged than others. All the other parts appear light and transparent, or have been destroyed altogether, whereby the appreciation of the points at issue is wonderfully facilitated.

The pathological doctrines of the school of La Salpêtrière have been considerably modified by these researches; and Charcot, its leader, has fully acknowledged this in his most recent lectures on cerebral and spinal localisation. This concession on his part is all the more welcome, as Flechsig had, with scant courtesy, qualified Charcot's evolutionary doctrines as "an airy structure" and an "ingenious speculation", so that another Franco-German war on a small scale appeared to be imminent.

The great automatic centre of motor power and muscular nutrition

and tonicity resides in the spinal cord, and, more strictly speaking, in those gigantic ganglion-cells of the grey anterior horns which are called motor or kinesodic cells, and some of which are of sufficient size to be visible to the naked eye when impregnated with carmine. In these cells, the power of motion is produced; and, unless they are in a state of integrity, there can be no effectual transmission of motor impulses from the brain to the extremities. Even while the muscles are at rest, and withdrawn from the influence of volition, as during sleep, these giant-cells keep up the muscular tone, which is an intermediate state between action and paralysis. The giant-cells send the force which constantly originates in them to the motor nerves and muscles, by means of the so-called Deiters's elongation or axis-cylinder. This latter is a large nerve-process, which is distinguished from a number of other similar ones branching off from each cell, by having darker and better

development of motor power is interfered with—as, for instance, in cases of infantile paralysis occurring very early in childhood—the histological evolution of these cells is arrested, and the parts remain rudimentary. Again, where motion becomes impossible later in life, as when limbs have had to be amputated, the cells corresponding to the removed limbs may waste away altogether. Giant-cells are absent in those portions of the brain which are not concerned with motion, and their intimate relation to this special function is firmly established. We have, therefore, an automatic and a volitional centre of motion, both being intimately connected by a commissure of white conducting fibres, known as the pyramidal strands, by means of which the will acts on the medullary centres.

A third important centre of motor power is constituted by the central ganglia which are situated on the floor of the lateral ventricles; or,

Fig. 1.—I. Sphere of the anterior cerebral artery. II. Sphere of the middle cerebral artery. III. Sphere of the posterior cerebral artery. IV. Lateral ventricles. V. Posterior cornua of the same. CM. Corpora mammillaria. TO. Thalamus opticus. GC. Grey commissure. TV. Third ventricle. IR. Island of Reil. IC. Internal capsule. LN. Lenticular nucleus. PC. External capsule. CL. Claustrum. CA. Cornu ammonis. PV. Pons Varolii. M. Medulla oblongata. CC. Crura cerebri.

defined contours. It also does not ramify like the others, but remains undivided, and, after proceeding for some distance, is surrounded by a sheath of myeline, and changed into a nerve-fibre which mingles with the anterior or motor nerve-roots. Destruction of these giant-cells, which occurs in infantile paralysis, causes loss of muscular power, tone, and nutrition; while irritation of them, which occurs through secondary sclerosis of the adjoining parts of the cord after attacks of apoplexy, produces that singular condition of *late muscular rigidity* which is one of the most striking consequences of cerebral hæmorrhage, and which is owing to an exaggeration of the normal function of these cells.

While, therefore, the giant-cells of the anterior horns furnish an instrument of motor power always ready to act if called upon to do so, the volitional impulses of motion originate in the hemispheres of the brain, where they are located in the grey convolutions bordering the fissure of Rolando. The intimate histological structure of these latter closely resembles that of the anterior horns, the principal feature in them being giant-cells, which have about the same dimensions as the cells of the anterior horns, and possess Deiters's elongations, which proceed from the grey cortex to the subjacent white medullary matter. These cells are scantier in children than in adults, and become gradually more developed as age advances, and as motor power is more exercised and differentiated. If, for some reason or another, the deve-

lopment of motor power is interfered with—as, for instance, in cases of infantile paralysis occurring very early in childhood—the histological evolution of these cells is arrested, and the parts remain rudimentary. What- ever may be the function of this nucleus of grey matter—whether it is a centre of common sensation, as many believe, or whether it has anything to do with the sense of sight, which is less probable—there can be no question that the presence of paralysis speaks against, rather than for, disease of the thalamus.

The corpus striatum consists of two grey nuclei and an intervening white tract, which is known as the internal capsule. The caudate nucleus is intraventricular, and is now by some pathologists called "*corpus striatum*" *per se*; the lenticular nucleus is extraventricular, and imbedded in the cerebral substance. The white internal capsule, which contains the pyramidal strands of the spinal cord and medulla, forms the connecting link between the two grey kernels, and also between the upper and lower centres; viz., the cord, medulla, pons Varolii, and crura cerebri on the one hand, and the convolutions of Rolando on the other. The two grey kernels generate motor power, while the white internal capsule simply serves as a conductor.

The exact functions of the lenticular and caudate nuclei are as yet more a matter of inference than of actual demonstration. It appears, however, probable that they are intended to render certain complex movements which are intimately connected with sensations, and which

are in the first instance only excited by volition and consciousness, gradually, as it were, mechanical and automatic, so as to leave the grey surface of the brain at liberty for the finer and more difficult kinds of work which falls to our lot in life. Thus full attention is required at first for learning the actions of walking, talking, writing, dressing, dancing, riding on horseback, singing, playing on musical instruments, and so forth, all of which are first carried out by conscious efforts on the part of the hemispheres, while after a time they may be performed mechanically and without conscious attention; and there is reason to believe that this organisation is carried on in the caudate and lenticular nuclei, which are, therefore, as it were, the familiar servants or private secretaries of the motor convolutions of the hemispheres. We have, therefore, three great motor centres—viz., the anterior horns, the corpora striata, and the convolutions of Rolando—disease of each of which will lead to certain well-marked forms of paralysis. But paralysis may also be owing to interruption in the conduction of the motor influence which is generated in these centres; and practically, therefore, disease of the conducting paths is as important as disease of the centres themselves.

The motor impulses, which are generated in the convolutions of Rolando and the corpora striata, are conducted to the centre of muscular tonicity and nutrition in the spinal cord by means of tracts of white fibres which are known as the *pyramidal strands*. Much light has been thrown on the relations of these parts by the researches of Flechsig, who found that they have a separate and individual existence at a period of foetal life when other portions of the centre are still quite undeveloped; and they can then be plainly traced from the Rolandic convolutions down through the centrum ovale and the internal capsule to the crus cerebri, the pons Varolii, and the medulla oblongata. At this point of their course they form the structures known as pyramids, and undergo decussation, so that the right strand crosses over to the left side, and *vice versa*; and they then proceed to the middle portion of the lateral column of the spinal cord.

The manner in which *pyramidal crossing* takes place has been particularly studied by Flechsig. You are no doubt aware that this crossing has given rise to warm controversies amongst pathologists. In the immense majority of cases, indeed, paralysis is owing to brain-disease appears on the side opposite to the lesion; and this has always been explained by pyramidal decussation. In a small proportion of instances, however, paralysis has been observed on the same side as the lesion; and they have furnished Dr. Brown-Séquard, who is a fierce opponent of cerebral localisation, with a text for controverting that theory. The supporters of cerebral localisation replied to his argument that in such cases the usual pyramidal crossing had not taken place. This, however, was rather an assumption than a proof, since no reliable anatomical data existed with regard to this point. Now, Flechsig has shown that there are three different types of decussation, viz.:

1. In a certain number of cases, there is total crossing, so that all fibres of one side pass over to the other side;

2. In other cases, there is total crossing of one pyramid—either right or left—and semidecussation of the other; and, finally,

3. There is semidecussation of both strands, of which there are again two varieties, viz.:

- a. Less than fifty per cent. of the fibres remain uncrossed; and

- b. More than fifty per cent. remain uncrossed. The uncrossed fibres which proceed straight on to the anterior columns of the same side of the cord are called direct pyramidal strands, or Türk's columns. Such varieties having, therefore, been clearly shown to exist in the anatomy of these parts, we can now experience no difficulty in explaining Brown-Séquard's cases of direct hemiplegia in perfect accordance with the leading facts of cerebral localisation.

After decussation, the fibres of the pyramidal strands, in their further downward course in the cord, communicate freely with the giant-cells in the anterior horns. They have their greatest development in the cervical enlargement, and become attenuated in their further progress; and they are ultimately so reduced that, below the lumbar enlargement, only traces are left of them. These facts are of importance for the explanation of the symptom of muscular rigidity after apoplexy, to which I shall presently draw your attention.

The anatomy of the internal capsule and of the relations of the pyramidal strands to it has been much advanced by the researches of Flechsig, who did not confine himself to vertical and oblique sections, which had been exclusively practised by the French school, but made systematic horizontal or antero-posterior sections, which allow a far better insight into the topography of its diseases. We see in such specimens that the capsule consists of two distinct parts—viz., the anterior segment lying between the caudate and lenticular kernels, and of the posterior segment, between the optic thalamus and the lenticular kernel. The point where these two segments unite is called the *knee of the capsule*;

and the pyramidal strands are found to be contained, not in the anterior segment, nor in the posterior third of the posterior segment, but in the two anterior thirds of the posterior segment, just behind the knee of the capsule. It is this portion which is frequently injured by hæmorrhage, leading to hemiplegia of the opposite side of the body.

Fig. 2.—N.c. Nucleus caudatus. A.s. Anterior segment of the capsule. N.L. Nucleus lenticularis. K. Knee of the capsule. P.s. Posterior segment. C. Caudate. Th.o. Thalamus opticus.

The chief peculiarity of diseases of the spinal cord is, that symmetrical and homologous anatomical and histological parts are affected, while neighbouring portions, which are intimately associated with them, escape. Thus we have, in locomotor ataxy, localisation in a portion of the posterior columns, in infantile paralysis affection of the anterior horns, and so on; while in the brain we find just the reverse. There is no systematic or symmetrical affection of histologically analogous parts, but disease progresses without the slightest regard to structure, affecting indiscriminately white and grey matter, and parts which are without any particular relation to each other, following simply the distribution of blood-vessels, whereby it is entirely guided in its origin and further progress. We have, therefore, as principal diseases of the brain, not affections of a set of convolutions, or of the whole of the thalamus opticus, or corpus striatum, etc., but hæmorrhage from, and thrombosis and embolism of, blood-vessels; and the alterations of brain-matter which follow are determined throughout by the extent of the vascular disease. No such maladies as thrombosis and embolism are met with in the spinal cord; hæmorrhage is likewise rare in that organ, and, where it occurs, is mostly owing to injury. A kind of neutral zone, however, exists in the pons Varolii and the medulla oblongata, where disease will sometimes take the cerebral, and at other times the spinal type, which is explained by these structures forming as it were a transition zone between the two great nervous centres.

Thus the most frequent disease of the medulla—viz., labio-glossolaryngeal paralysis*—is found to affect the ganglionic cells of the nuclei of the motor nerves, more particularly the hypoglossus, the accessory, and the pneumogastric, in the same way as progressive muscular atrophy destroys the motor cells of the anterior horns of the cord. On the other hand, hæmorrhage, which is so frequent in the central ganglia, occurs also sometimes in the medulla, and then causes that lightning-like apo-

* I take this opportunity to protest against the term "bulbar paralysis", which is frequently used in English medical literature, and which is a literal translation from the French, which has no *raison d'être*. The French term for medulla oblongata being *le bulbe*, *la paralysie bulbaire* is a perfectly rational term; but as in English the medulla is never by any chance called "bulbus", it seems absurd to speak of "bulbar paralysis" the proper term being "medullary paralysis".

plexus in which death is so sudden that one is inclined to attribute it to heart-disease; for any sudden interference with the structure of the medulla, and the cardiac and respiratory centres contained in it, is incompatible with life. Hæmorrhage into the pons Varolii, which is already nearer the brain proper, is more frequent than into the medulla; and, as this part ranks next in vital importance to the medulla, hæmorrhage into it is likewise almost invariably fatal, although not with that extreme suddenness as when the effusion takes place into the medulla.

[To be continued.]

ABSTRACT OF LECTURES ON THE ANATOMY, PHYSIOLOGY, AND ZOOLOGY OF THE CETACEA.

Delivered at the Royal College of Surgeons of England.

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LECTURE VII.—TOOTHED WHALES: THE PORPOISE.

THE *Odontoceti* or toothed whales form the second large group into which the cetacea are divided. While presenting the same general characters, they differ notably from the whalebone whales in possessing teeth instead of whalebone in both upper and lower jaws. In studying their anatomy, it is most convenient to take one species as a specimen of the group, in the same way that the *Balenoptera rostrata* was taken as a type of the whalebone-whales. The most convenient for this purpose is the common porpoise (*Phocaena communis*), since it is frequently obtained on our coasts, and, being of small size, is more easily dissected and managed than the larger members of the group. It was the first of the cetacea to attract the attention of naturalists. An excellent monograph on its anatomy was written by Tyson about two hundred years ago. Since then it has been the subject of no complete monograph, though many points in its anatomy and physiology are well worthy of more attention than has been hitherto devoted to them.

The full length of an adult porpoise is about 1.5 mètres (five feet). It is an inhabitant of the North Atlantic, our own coasts, and the coasts of Greenland, but does not enter the Mediterranean; so that it could not have been the species to which the name *Phocaena* was applied by the Greeks. An allied species has been found in the Pacific. In external appearance, it resembles the whalebone-whales, but differs from them in the small size of the head, the anterior part of which terminates abruptly in a rounded blunt extremity formed of a mass of fat situated immediately in front of the blow-hole. The lump of fat on the anterior portion of the head is not a peculiarity of the porpoise, as it is found in several of the toothed whales. A dorsal fin is present, and is situated a little posterior to the middle of the back. On the anterior part of the dorsal fin are a number of small tubercles, which are only found in this species of toothed whale.

Skeleton.—In some respects, the skull of the porpoise resembles that of the whalebone-whales, though it differs in many essential points of detail. The brain-cavity is placed on the most superior part of the head; the condyles are directed backwards and upwards. There is a great development of the facial portion of the skull, though not to such an extent as in the whalebone-whales. The nostrils open on the top of the head. The nasal passages, which are separate, bend round the front of the brain-cavity, and are therefore directed at first downwards and forwards, and then downwards and backwards. The nasal bones are perched on the top of the head, immediately in front of the anterior crest of the supra-occipital bone, which projects over the parietal bones and the frontal to a much greater extent than in the whalebone-whales. The large mesethmoids are continued almost to the end of the rostrum, between the premaxillaries, which extend to the extremity of the beak. The maxillaries are prolonged upwards till they meet the supra-occipitals; they have likewise lateral expansions which shelve over the orbits. The orbits are supported on each side by a style of bone passing underneath them; there is no distinct lacrymal bone. The palate is broad and flat; the pterygoid bones are involuted. The petro-tympanic bones are smaller and much more loosely attached to the skull than in the whalebone-whales. The lower jaw has a true

symphysis; there is a large funnel-shaped entrance for the inferior dental branch of the fifth nerve, which also contains a large arterial plexus.

The cervical vertebræ have thin bodies, consequently the series is short. The atlas is much larger and thicker than the others, which gradually become smaller towards the fifth, while the sixth and seventh are larger. All the cervical vertebræ are frequently ankylosed together, both by their centra and spines. Sometimes, however, the seventh is free. Ankylosis of the cervical vertebræ is a character common to many of the toothed whales. There are thirteen dorsal, fourteen lumbar, and thirty-two caudal vertebræ. The heads of a few of the anterior ribs articulate both with the lamina of the vertebræ and with the centra. Those farther behind in the series articulate only with the transverse processes of the vertebræ. This mode of articulation of the heads of the ribs is peculiar to the *Odontoceti*, and differs entirely from the manner in which the heads of the ribs articulate with the vertebræ in the *Mysticeti*, where they are attached only to the transverse processes throughout. The sternum is of considerable length, and has articular surfaces on each side for the articulation of the sternal ribs formed by the early ossification of the costal cartilages. Four of the true ribs articulate, through the sternal ribs, directly with the sternum, while several are attached to it indirectly by their sternal ribs, which are directed very obliquely. The scapula, which is placed very close to the head, is of much the same form as that of the *Balenoptera rostrata*. The anterior limb is reduced to a mere paddle. No clavicles are developed in this or any of the cetacea, the bones of the arm being very small, and flattened laterally. The carpus, which is fairly well ossified, consists of five bones arranged in two rows, the first of which contains three bones, and the second two. The digits are five in number; of these, the second and third are very long, and more completely ossified than in the whalebone whales. The larger phalanges have centres of ossification at each end. No muscles are developed in the limbs of the porpoise, except those which move the shoulder; but there are several bands of fibrous tissue to be found running down the limb, which may be the remains of muscles. Styliform pelvic bones are present; but there are no bony rudiments, such as are found in many of the *Mysticeti*, corresponding to the leg or thigh-bones. The hyoid arch consists of two sterno-hyals, connected to a flat and simple hyoid with large posterior horns by cartilages which sometimes become ossified. As the porpoise lives chiefly on fish about the size of herrings, and even larger, which it devours singly, like the sea-lions and seals, and does not take into its mouth large quantities of water with the food, its mouth is small, and the jaws are provided with numerous small flattened spade-like teeth, which differ from those of other dolphins in not being conical and sharp-pointed, but resemble them in being very simple; planted loosely in their sockets, not divisible into incisors, canines, and molars; and not preceded by a set of milk-teeth. The tongue is flat; its edges and tip are free, but it cannot be protruded. As the animal bolts its food, the œsophagus is wide. The stomach is very like that of the whalebone whales. The first cavity is thickly covered with epithelium. The second cavity is the glandular portion, and is smaller than the first, but possesses very thick walls and numerous rugæ. The third cavity is extremely small, so that it has been frequently stated to be absent, being only a small space between the walls of the second and fourth cavities. The fourth cavity is large and intestine-like, with a pyloric valve at its furthest extremity, beyond which is the duodenum, with the bile-duct opening into it. There is a great difference between the appearance of the stomach of a young and that of an adult animal. In both, the œsophagus opens at the junction of the first and second cavities, but in the young animal its opening is directed so that the food passes into the second or digestive cavity, which is of large size, the first being very small, with a narrow opening, whilst, in the adult, it opens into the first cavity. The intestinal canal is very simple, without any cæcum, and is slung on a simple mesentery. The liver is simple, and the gall-bladder is absent. The animal always comes to the surface of the water to breathe. The nostrils open externally in a single crescentic blowhole. Connected with the nares, is a curious arrangement of six air-sacs, the function of which is unknown. They are diverticuli from the passage between the anterior and posterior nasal passages, and seem to be homologous with the cavity in connection with the nose of the horse and some other animals. The larynx is very similar to that in the whalebone whales, but, if anything, rather more specialised. The arytenoid cartilages, which are united by fibrous tissue, pass up farther into the posterior nares, by which they seem always to be firmly grasped. The food, therefore, passes down into the œsophagus on each side of the elongated laryngeal opening. The passage of any water into the larynx during deglutition is thus rendered impossible.