NOTES ON SOME OF THE VISCERA OF RISSO'S DOLPHIN (*GRAMPUS GRISEUS*). By Professor Sir WILLIAM TURNER, F.R.S.

IN September 1889 I heard from my friend and former pupil, Mr Charles Anderson, M.B., of Hillswick, Northmavine, Shetland, that a small school of dolphins had been captured at that place, and that from their appearance he believed them to be Risso's dolphin. Through his most obliging help I was able to secure four skulls, two skeletons, and the thoracico-abdominal viscera of two of these animals. The dolphins ranged in length from 8 feet 7 inches to 10 feet 5 inches.

Although four specimens of this rare dolphin have been recorded[1] as captured in the English Channel, and a fifth specimen as probably caught there,[2] no example, so far as I know, had been described as seen in Scottish waters, until I recorded in December 1891 the capture of these animals in Shetland.[3] This dolphin may now, therefore, be added to the Scottish fauna, and Hillswick Bay is the most northerly point at which it has yet been seen.

It is unnecessary that I should give a full account of the anatomy of Risso's dolphin, for Professor Flower has already described at length and figured the skeleton. Supplementary observations on some of the bones have also been given by MM. van Beneden and Gervais,[4] M. Fischer,[5] and Mr Balkwill. M. Fischer has made some observations on the viscera, and a more complete description of many of the internal organs has been given by Dr Murie. I have, however, noticed some arrangements in the course of my dissection which have not been sufficiently explained by previous writers, and amongst

[1] Rev. C. A. Bury, *Zoologist*, 1845; Prof. Flower, C.B., *Trans. Zool. Soc.*, 1871; H. Lee, *Proc. Zool. Soc.*, 1877; F. H. Balkwill, *Trans. Plymouth Institute*, 1886–87.

[2] Prof. Flower, *op. cit.*, and Dr James Murie, *Jour. of Anat. and Phys.*, Nov. 1870, vol. v.

[3] *Proc. Roy. Physical Soc.*, Edinburgh, Dec. 1891.

[4] *Ostéographie des Cétacés.*

[5] *Annales des Sciences Naturelles*, viii., "Zoologie," 1867.

these I may especially refer to the male organs of generation, for the specimens examined by M. Fischer and Dr Murie were both females.

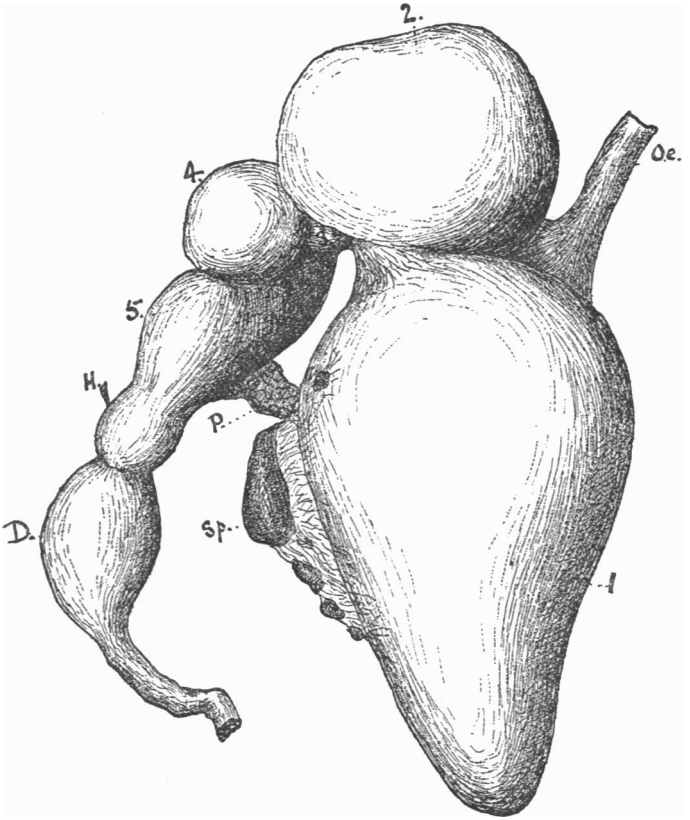
Organs of Respiration.—Dr Murie gives a very careful description of the spiracular cavity, its sacs and the larynx, so that I need not make further reference to these parts. All that he says about the lungs is that they comport themselves to those of the Pilot Whale. When the lungs were artificially inflated I noticed some points in their anatomy which have not been recorded by Murie in his description of *Globiocephalus melas*,[1] and to these I shall now refer.

Each lung might be regarded as possessing a sterno-costal and a vertebro-costal portion, the plane of demarcation between which was a deep indentation on the convex costal surface, which passed obliquely from the anterior and dorsal part of the lung ventrally and backwards to the diaphragmatic border. The sterno-costal portion, which was in relation to the pericardium, was characterised by its thinned and attenuated appearance. In some places it was so thin that in the collapsed state of the lung it was difficult to recognise it as consisting of lung-substance; but when artificially inflated from the windpipe the air freely entered it and dilated the air lobules. In a few places near the sternal border the air lobules were absent; the layers of pulmonic pleura on opposite aspects of the lung were in contact with each other, and in these places the lung was semitranslucent. The sternal border of the lung was indented and sinuous in outline. The apex of the lung was also indented and divided into lobelets, which varied in length from 1 to 2 or 3 inches; four were present at the left apex and three at the right, but those on the right were somewhat the larger. The costo-vertebral part of the lung was thick and adapted to the costo-vertebral hollow. The diaphragmatic border was attenuated, and the diaphragmatic surface was deeply concave. When the lungs were collapsed the pleural surface seemed as if tough and opaque, which is the character so often described in connection with the cetacean lung.

Abdominal Viscera.—The *Stomach* has been described both by M. P. Fischer and Dr James Murie, and has been shown

[1] *Trans. Zool. Soc.*, vol. viii. part iv., 1873.

by these naturalists to resemble in its form, in the number and in the general arrangement of its compartments, the stomach of *Globiocephalus melas*. My observations have led me to the same conclusion. As the stomach of *Globiocephalus* has been



Explanation of Figure 1.—Ventral surface of Stomach of Risso's Dolphin. *Oe.*, œsophagus; 1–5, the several compartments of the stomach; *D.*, duodenum; *H.*, hepatic duct; *P.*, head of pancreas; *Sp.*, Spleen.—From a drawing by Harry G. Melville, M.B.

described with considerable detail both by Dr Murie and myself,[1] I need not enter into any lengthy explanation of that organ in Risso's dolphin. I may, however, refer to one or two

[1] *Jour. of Anat. and Phys.*, vol. ii., 1868, and vol. iii., 1869.

points in its morphology. The stomach consisted of five compartments arranged according to the mode of describing the cetacean stomach, which I have followed in a previous paper,[1] into (*a*) an œsophageal compartment (1); (*b*) a cardiac compartment (2); (*c*) two intermediate compartments (3 and 4); (*d*) a pyloric compartment (5). The œsophageal compartment or paunch (1) was directly continuous with the œsophagus, and was lined by a continuation of its epithelium. It contained several pints of a brown fluid in which the beaks and eyes of cuttle-fish were found—its long diameter was 24 in. (610 mm.), its greatest transverse diameter 14 in. (356 mm.). The 2nd or gastric compartment (2), a true digestive chamber, also communicated directly with the lower end of the œsophagus; it was almost globular in shape, and measured 10 in. (254 mm.) by 9½. It contained the partially digested mantles of 34 cuttle-fish, some of which still had the arms continuous at their bases, also quantities of eyes and beaks. From the relations of compartments 1 and 2 to the lower end of the œsophagus, it is obvious that the food could pass directly from the gullet into either compartment, or from 1 into 2, or be regurgitated from 2 into 1. Compartment 3 was the smallest chamber, and measured 4 cm. by 1½; it was so placed in the angle, between 2, 4 and 5, as to be in danger of being overlooked. Compartment 4 was the size of a large orange. Compartment 5 was elongated, and measured 12 in. (305 mm.) by 5 in. (127 mm.) in greatest breadth; it was slightly sinuous, and had a shallow constriction about one-third the distance from the pylorus, which latter was deeply constricted. The dilated commencement of the duodenum was 12 cm. long, and received on its dorsal aspect the combined pancreatico-hepatic duct.

The *Intestine* from the pylorus to the anus was 76 feet 8 inches long. There was no cæcum or division into a small and a large intestine. The walls were thicker in the anterior half than in the posterior portion. The arrangement of the valvulæ conniventes, the mucous folds of the rectum, and Peyer's patches was so like to what Murie has described in *G. melas* that I need not enter into any detail. The rectum retained its cylindrical tubular form as far as its termination. The muscular coat was

[1] *Jour. of Anat. and Phys.*, vol. xxiii.

much redder at the anal end than further forwards, and the longitudinal arrangement of the muscular coat was distinct. The anal orifice was surrounded by a strong, red-coloured sphincter muscle.

The intestine contained mucus; at the duodenal end it was fawn or salmon coloured; lower down it was bile stained; but in the last few feet it was stained a rich brown colour. From its tint I was led to think that it contained sepia, derived from the ink bag of the cuttle-fish, on which the animal fed. The coloured mucus was then digested in water, when the colouring matter was dissolved. It was then precipitated from the aqueous solution by the addition of spirit, when a rich brown pigment was obtained, possessing the properties of sepia, and which was subsequently used in the preparation of some drawings of the animal's viscera.

From the fact that the mucus, in something like the upper three-fourths of the intestinal tract, was unstained by sepia, it would seem as if the wall of the ink bag had remained unruptured, and its contents undiffused through the mucus, until it had passed along a large part of the intestinal tube.

It has been shown by myself and others that cuttle-fish are a not unusual food for toothed whales. This has long been known as regards Hyperoodon, in the stomachs of several specimens of which the horny beaks and other parts of cephalopods have been seen.[1] Mr Beale states[2] that the food of the Sperm Whale consists almost wholly of the 'squid' or 'sepia octopus,' though at times when near the shore it may take bony fish; Mr Bennett in his *Whaling Voyage*[3] confirms the statement that the main food is cuttle-fish, and he also mentions that he has seen a bony fish which was ejected from the stomach of a Sperm Whale on being attacked. From my own dissection I have reason to think that Sowerby's Whale may also feed on cuttle-fish. Mr Robert Gray has repeatedly found the remains of cuttle-fish, probably *Gonatus fabricii*, in the stomach of the Narwhal.[4] The horny beaks of cephalopods

[1] See Gray's *Catalogue of Whales and Seals;* also my paper on the "Stomach in Ziphioid and Delphinoid Whales" in *Jour. of Anat. and Phys.*, vol. xxiii.

[2] *The Sperm Whale*, London, 1839. [3] London, 1840.

[4] *Zoologist*, April 1887 and 1889; in addition he found blood-red crustaceans, mostly *Pasiphaë tarda*, an abyssal form.

were seen by M. Fischer and Mr Lee in the stomachs of the two specimens of Risso's dolphin which they examined. Dr Charles Anderson observed that, as the fishermen opened the stomachs of this dolphin at Hillswick, they contained cuttle-fish; my dissections confirmed this observation. Four of the specimens of the cuttle-fish obtained in the stomach of Risso's dolphin were so far undigested as to enable me to count ten arms projecting from the ring around the mouth. Two of the arms were in three of the specimens much longer than the others, and were separated from each other by two short arms, but the suckers had disappeared in the digestive process. The remains of a pair of wings were attached to the mantle, and I thought that the animals were species of Loligo; but Mr W. E. Hoyle, to whom I referred the specimens for identification, regards them as the *Gonatus fabricii* of Lichtenstein. Mr Thomas Anderson has recently communicated to me an interesting fact, which adds another dolphin to the feeders on cuttle-fish. A few months ago a large school of the Pilot Whale (*Globiocephalus melas*) was chased ashore at Hillswick, and on cutting out the viscera the partially digested skins and numerous beaks of these cephalopods were seen in the stomachs. It was also observed that the shallow bay into which these dolphins were driven was strewn with the undigested skins of cuttle-fish, as if the whales in their fright had ejected a portion of the contents of their stomachs.

A number of years ago I described[1] a large cluster of *Lymphatic Glands* in *Globiocephalus melas* at the root of the mesentery, and another cluster close to the lower end of the rectum. Similar collections of glands were seen in Risso's dolphin. One of the rectal glands, about the size of a walnut, was almost completely invested by peritoneum, and projected towards the peritoneal cavity; at first sight it seemed as if it were a special gland associated with the hinder part of the rectum; but when more closely examined, it was seen to be the largest member of a chain of rectal lymphatic glands.

The *Spleen* was attached by a peritoneal fold to the right side of the back of the œsophageal compartment of the stomach. It measured 12 cm. by 6½, but several small accessory spleens were situated in the same peritoneal fold.

[1] *Jour. of Anat. and Phys.*, November 1867, vol. ii. pp. 76, 78.

The *Liver* measured 45 by 28 cm. Its diaphragmatic surface was divided into a large right and a small left lobe by a falciform ligament; in the free edge of which the obliterated umbilical vein formed a round ligament. On the hinder surface of the liver the umbilical vein became pervious for about 5 cm. before it joined the portal vein, with the lumen of which it was continuous. There was no gall-bladder, and consequently no quadrate lobe, neither was there a definite Spigelian lobe. The inferior cava did not groove the liver, but three capacious hepatic veins opened into the cava at the diaphragmatic border.

The head of the *Pancreas* lay in the curve formed by the duodenum and 5th compartment of the stomach, and its opposite end reached the dorsal surface of the 1st compartment. The hepatic duct descended close to the dorsal surface of the pyloric compartment of the stomach, and entered the head of the pancreas, where it was joined by the pancreatic duct. The combined duct formed a sinus-like dilatation, and then pierced the dorsal wall of the dilated commencement of the duodenum.

Genito-Urinary Apparatus.—The hinder end of the peritoneal cavity was prolonged backwards along the rectum. Four cæcal pouches were recognised in connection with it. Two were lateral, and in relation to the testicles, which, invested by peritoneum, projected towards the cavity. Each lateral pouch was prolonged backwards behind the hinder end of the testicle, and its dorsal wall was in relation to the epididymis, whilst its inner boundary was formed by a fold of peritoneum which extended inwards to the side of the bladder, with the peritoneal covering of which it was continuous. Two pouches were mesial; the deeper and posterior was in relation to the rectum, and was separated from a smaller and shallower pouch by a fold of peritoneum, which passed transversely across the mesial plane as far as the free border of the peritoneum, which bounded the pouch situated in relation to each testicle. This shallow pouch lay between the transverse fold and the dorsal surface of the bladder and urethra. If a male uterus had been present, one would have expected to have seen it in this transverse fold of peritoneum.

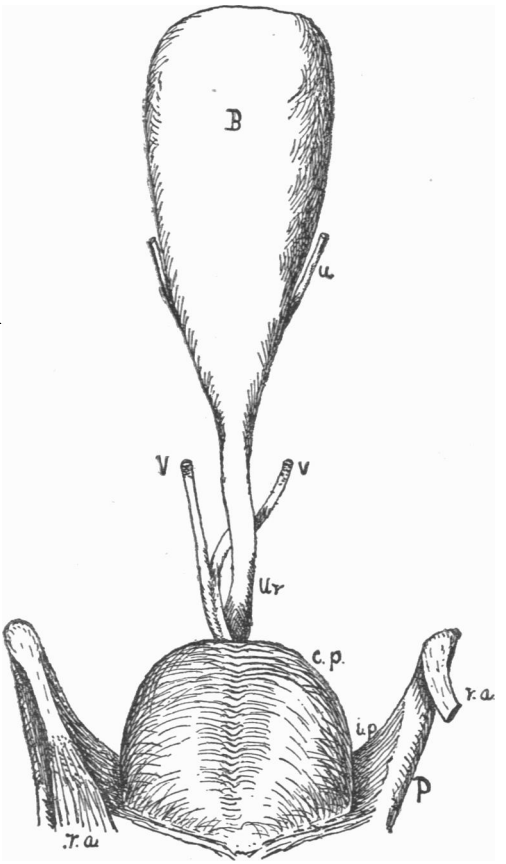
Testicles.—Each testicle was 16 cm. long, and 2½ cm. in its greatest transverse diameter. In relation to the upper border of each testicle was a large convoluted epididymis, which corresponded to the whole length of the attached border of the testicle, and projected a little beyond its anterior end. The vas deferens emerged from the posterior end of the epididymis. At first it was much convoluted, but in its passage backwards it became almost straight, and gradually approximating to its fellow, it became enclosed in a sheath common to the two. It was situated in relation to the dorsal surface of the urethra, and entered along with it, the compressor prostatæ muscle, to be subsequently described. The seminal ducts opened into the dilated prostatic part of the urethra, and their position was marked by a distinct longitudinal urethral crest. There was no appearance of a vesicula seminalis.

The *Kidneys* possessed the usual subdivision into lobules found in the Cetacea.

The *Bladder* was elongated, and when distended with air was 20 cm. long, and 7 cm. broad at its widest; it ended behind in a funnel-shaped prolongation, which was continued into a membranous cylindriform urethra. The two ureters opened into the superior surface of the bladder, a little in front of the urethra. The hypogastric arteries ran at the sides of the bladder as far as its apex, where they came into relation with the urachus, and along with it passed forwards on the abdominal wall.

The cylindriform part of the urethra ran backwards for 90 mm. and then entered the anterior end of what seemed to be a thick mass of muscle, 68 mm. in antero-posterior and 60 mm. in transverse diameter. This muscle completely surrounded both the urethra and the seminal ducts; it occupied the interval between the inter-pelvic ligament, which was on its ventral surface, and a strong recto-prostatic fibrous membrane, situated in close relation to its dorsal surface, which intervened between it and the rectum. The fibres of this muscle sprang laterally and ventrally from the inter-pelvic ligament, and arched in a forward direction to the dorsal surface of the mass, where the fasciculi from opposite sides seemed partly to blend with each

other, and partly to end in a median fibrous septum. When this muscle was cut into, it was seen to enclose a fawn-coloured body, into the substance of which both the urethra and seminal ducts penetrated. Both in colour and appearance this body



Explanation of Fig. 2.—Dorsal surface of Bladder and Urethra. *B*, bladder; *u*, ureter; *ur*, urethra; *vv*, vasa deferentia; *p*, pelvic bone; *ip*, interpelvic ligament; *cp*, compressor muscle of the prostate; *ra*, *ra*, retractor ani muscles, the tendon of origin of that on the right side is cut through and turned on one side.—From a drawing by W. Aldren Turner, M.B.

was obviously not composed of striped muscle, like the muscle by which it was surrounded. It had a granular texture, and when examined microscopically was seen to consist of gland

acini, containing cells, and bands of what seemed to be non-striped muscular fibre with connective tissue. Both in its position and relations to the rectum and inter-pelvic ligament, and in its structure, it may be regarded as a *prostate gland.* It is to be observed that it did not surround the neck of the bladder, but was some centimetres removed from the spot where the bladder and urethra were continuous with each other. The walls of the urethra when surrounded by the prostate were thin, and its lumen was dilated. Immediately on leaving the prostate the urethra pierced the inter-pelvic ligament, and turned sharply forwards into the corpus spongiosum.

The muscle which enclosed the prostate gland would, from its arrangement, act as a compressor of that gland and of the urethra and seminal ducts enclosed within it, and it may be called *compressor prostatæ.*

Pelvic Bones, Inter-pelvic Ligament, and Pelvic Muscles.—The most complete account of these structures in the Cetacea will be found in the very careful descriptions by Dr Struthers of the pelvic apparatus in the Greenland whale (*Balœna mysticetus*)[1] and the hump-backed whale (*Megaptera longimana*).[2] In dissecting the corresponding parts in the male Risso's dolphin, his descriptions and drawings were before us.[3] But as it was found that in various particulars the arrangement of parts in the dolphin differed from what Dr Struthers had seen in the whalebone whales, I have thought it advisable to write a description of these structures.

Each *pelvic bone* consisted of an almost straight bar, somewhat pointed at its two ends. Its length was 108 mm., and its greatest breadth was 14 mm. Its upper surface was flattened, and its lower surface was somewhat convex from side to side. No trace of a rudimentary femur was connected with it.

The *Inter-pelvic Ligament* was a strong fibrous membrane, which stretched between the two pelvic bones, and was attached to their inner borders for a little more than the anterior half of their length. It formed a distinct partition, on the perineal

[1] *Journal of Anat. and Phys.*, vol. xv., 1881.

[2] *Ibid.*, vol. xxii., 1888.

[3] In making these dissections I have been very materially assisted by one of my pupils, Mr J. R. Higson.

(ventral) aspect of which was the penis with its muscles and on the dorsal aspect were the prostate with the urethra and genital ducts and the rectum. Its posterior border was thickened and continuous with a strong recto-prostatic fascia, which was situated between the rectum and the powerful compressor prostatæ muscle. This border was indented in the mesial plane, to allow of the lodgment of the retractor penis muscle. The anterior border was free near its pelvic attachments, but nearer the mesial plane it was fused with the fibrous tissue of the corpora cavernosa penis.

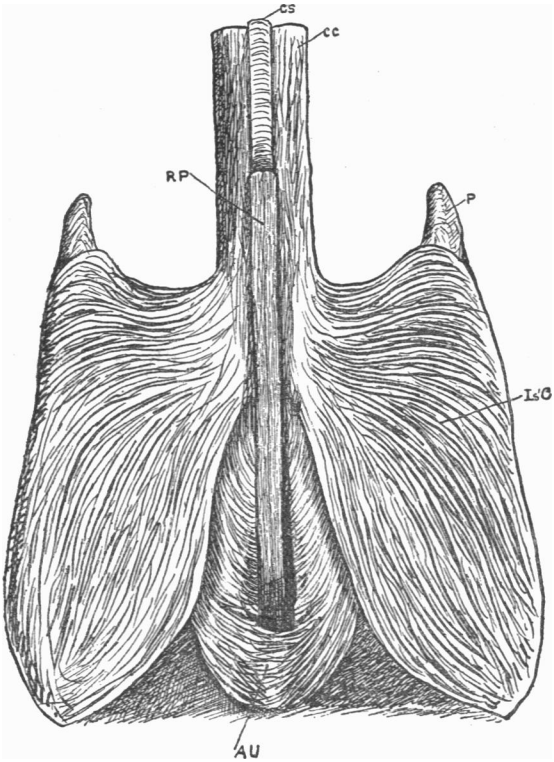
The Penis.—The penis arose by two short crura. Each crus, pointed posteriorly, sprang from the ventral surface of the pelvic bone in its posterior part for a distance of 31 mm., but did not quite reach the posterior end of the bone. The crura were also intimately united with the perineal surface of the inter-pelvic ligament, and near the anterior border of which they joined to form the body of the penis. The length from the point of the crus to the orifice at the end of the glans was 325 mm. The two corpora cavernosa were firmly united, and so overlapped the corpus spongiosum on the ventral surface of the organ that it was only partially seen. The glans, 95 mm. long, was elongated and tapered almost to a point at the urethral orifice. It was concealed by the prepuce and the genital slit in the abdominal wall.

Retractor Penis.—A well-marked retractor muscle was situated on the middle of the ventral surface of the penis. It consisted of two lateral halves, closely united together by areolar tissue, and formed an elongated, somewhat flattened, thick, pale band of non-striped muscle, which was inserted anteriorly into the penis at the root of the prepuce. When followed backwards it was seen not to be adherent to the corpus spongiosum. When midway between the two pelvic bones it pierced the accelerator urinæ muscle, passed behind the middle of the posterior border of the inter-pelvic ligament, and was then attached to the muscular wall of the rectum and the recto-prostatic fascia.

Ischio-cavernosus.—This powerful muscle arose from the ventral surface and outer border of the whole length of the pelvic bone except at its anterior end. It completely concealed the crus penis, into which it was inserted, but it was also pro-

longed for a short distance forwards, to be inserted into the side of the corpus cavernosum penis. The most anterior fibres did not, however, pass in front of a transverse plane drawn between the anterior ends of the two pelvic bones, so that its insertion was limited to the hinder part of the penis.

Accelerator Urinæ.—This muscle occupied the interval be-



Explanation of Fig. 3.—Ventral Surface of root of Penis with its Muscles. *cc*, corpus cavernosum, and *cs*, corpus spongiosum penis; *RP*, retractor penis muscle; *P*, anterior end of left pelvic bone; *IsC*, ischio-cavernosus muscle; AU, accelerator urinæ muscle.—From a pen-and-ink sketch by Dr James Musgrove.

tween the posterior halves of the two ischio-cavernosi. It consisted of two symmetrical halves, separated by a mesial interval. They were traced back close up to the muscular mass of the sphincter ani, and formed posteriorly a loop around the retractor penis. The fibres passed forwards from this loop to surround the

bulb of the urethra, and some were inserted into the perineal surface of the inter-pelvic ligament; but the most anterior fibres were inserted into the corpora cavernosa as far forward as about the middle of the insertion of the ischio-cavernosus muscle.

Retractor Ani.—A well-marked muscle, which arose from the dorsal surface of the anterior end of the pelvic bone by a strong and somewhat rounded tendon. It passed backwards in relation to the dorsal surface of the inter-pelvic ligament as far as its posterior border, from which it received an additional slip of origin. It was then prolonged backwards, to end in the muscular mass of the sphincter. From the presence of this pair of muscles it is probable that the dolphin, like the horse, protrudes the anal mucous membrane in the act of defæcation, and that the function of these muscles is to retract it on the completion of the act. The muscles are red and transversely striped. They are probably to be regarded as special modifications of the levatores ani of the anthropotomist.

A fragment of a muscle was attached by a strong tendon to the anterior end of the pelvic bone, but as its connections in front were not preserved, I cannot describe it. No muscle was seen to be attached to the posterior end of the same bone.