XI.—*An Account of the Great Finner Whale* (Balænoptera Sibbaldii) *stranded at Longniddry.* Part I. The Soft Parts. By Wm. Turner, M.B. (Lond.), Professor of Anatomy in the University of Edinburgh. (Plates V., VI., VII., VIII.)

(Received November, 1870.)*

CONTENTS.

On the 3d November 1869, a huge Finner whale was stranded on the beach at Gosford Bay, Longniddry, Firth of Forth.

Most of the large Fin whales which have been examined by British and Continental anatomists have been found floating dead on the surface of the sea, and have then been towed ashore by their captors. But, from the account which was given in the Edinburgh daily newspapers, it would appear that, for some days previously, this animal had been recognised by the fishermen, swimming to and fro in the Firth. On the morning of the 3d it was seen from the shore, blowing with great violence from its nostrils, flapping its huge tail, and obviously struggling to disengage itself from the rocks and shoals, amidst which an unusually high tide had permitted it to wander. Shots were fired at it, and, from the wounds produced, blood poured forth which tinged the surrounding waves. As the tide receded, the animal was fairly stranded; and, after some vigorous but ineffectual attempts to disengage itself from its position, it slowly died. The animal lay some yards above low-water mark, so that for several hours each day it could be examined, and photographs taken from various points of view.

Under the powers conferred by Act of Parliament, the carcase was taken possession of by the receiver of wrecks for the Board of Trade and sold by public auction. It was purchased by Mr John Tait, Oil Merchant, Kirkcaldy, for L.120. After lying for a fortnight on the beach at Longniddry, a strong rope

* A preliminary account of this animal, illustrated by a number of specimens, photographs, and drawings, was read to the Society on the 20th December 1869, and an abstract of this communication was printed in the Proceedings of that date. By permission of the Council I have been allowed to supplement the preliminary notice with additional observations, and to extend it in a form for the Transactions of the Society.

was secured around the root of the tail, and, when afloat at high water, it was towed by a powerful steamer to Kirkcaldy, a town on the opposite shore of the Firth, distant about ten miles.

It was flensed on the beach, immediately to the east of Kirkcaldy harbour; and, as this could only be done at low water, the process of removing the blubber, taking out the fat within the abdomen, cutting off the baleen and flesh, disarticulating and removing the bones, occupied several men for nearly a month.

As one of the largest sized whalebone whales comes so very seldom within comparatively easy access of a great city, the opportunity was taken by crowds of persons to inspect the huge creature, not only as it lay on the beach at Longniddry, but whilst the process of cutting up was going on at Kirkcaldy.

As the classification and structure of the larger Cetacea possess many interesting points for investigation, I gladly availed myself of the presence of this rare visitor to devote such time as I could spare, in the midst of the work of the University session, to its examination.

The colour, general form, and dimensions of the animal were observed when the whale was lying on the shore at Longniddry. The observations on the internal structure were made as it was being cut up at Kirkcaldy, or on specimens which were brought over to the Anatomical Museum of the University, and submitted there to a more careful examination than could have been conducted on the sea beach.

The distance from Edinburgh at which the whale was lying, during the flensing, rendering a journey by rail and steamer necessary at each visit, the exposed position of the animal on the sea beach below high-water mark making access to it practicable only at low water, the great bulk of the creature, the difficulty of getting at the internal parts owing to the size of the cavities, the greasy, slippery condition of all the surroundings, and the impediments offered to handling or removing the viscera on account of their magnitude and weight, have made the examination of this whale a very laborious task. For these reasons, as well as from the putrid state into which the carcase passed, the extremely offensive gases generated by so huge a mass of putrifying flesh, and the great heat evolved by its decomposition, it was impossible to study many of the structures to which I should have wished to have devoted my attention. In many respects, therefore, I regret to say that my description will necessarily be incomplete and fragmentary.

In conducting the examination, I was most ably assisted by the thoroughly cordial and, I may say, enthusiastic, co-operation of my assistant, Mr Stirling, and my pupils, Mr Millen Coughtrey and Mr James Foulis, to whom I take this opportunity of expressing my thanks for the important aid which they rendered. To Mr John Tait of Kirkcaldy I and my assistants are indebted for

permission to examine the parts as they were exposed during the flensing, and to remove such specimens as could conveniently be taken away.

External form and dimensions.—The whale was a female. When I first saw the animal on Gosford beach, it was lying with its head pointing inland, and it rested on the right side of the belly, chest, and right lower jaw. The middle line of the belly was in contact with the ground, and the under surface of its horizontal tail lay on the shingle. The head, owing to its great weight, had fallen over to the right, so that it overhung the right lower jaw, and permitted the whole length of the inner surface of the left half of the lower jaw, and a large part of the dorsum of the tongue to be seen, together with the outer edges of the baleen plates on the left side (Plate V. fig. 1).

The length of the animal, measured with a graduated tape-line along the curve of the middle line of the back from the tip of the lower jaw to the end of the tail, was 78 feet 9 inches. The girth of the body immediately behind the flipper was estimated at 45 feet, dimensions which it preserved almost as far back as the extent of the abdominal plicæ, behind which it tapered off rapidly to the tail. Its girth in line with the anal orifice was 28 feet, whilst around the root of the tail it was only 7 feet 9 inches. In front of the flipper the girth was considerable, as far forward as the swell or greatest projection of the lower jaw, but in front of this it tapered off to the symphysis. The lower jaw arched outwards and forwards with a wide sweep from the angles of the mouth; then the two halves converging met at the symphysis and formed there a keel-like ridge. The tip of the lower jaw projected 1½ foot beyond the tip of the upper jaw. The inner surface of the lower jaw was bevelled off close to its upper border, so as to admit the edge of the upper jaw within it. The length from the angle to the tip of the mouth, along the upper curved border of the lower jaw, was 21 feet 8 inches, and 17 feet 4 inches in a straight line.

The dorsum of the upper jaw was not arched in the antero-posterior direction as in the *Balæna mysticetus*. It sloped gently upwards and backwards to the blow-holes, from which a low but readily recognised median ridge passed forwards on the beak, gradually subsiding some distance behind its tip. On each side of this ridge was a shallow concavity. Immediately in front of the blow-hole the ridge bifurcated, and the forks passed backwards for several inches enclosing the nostrils, and then subsided. The outer borders of the upper jaw were not straight, but extended forward almost parallel to each other from the angle of the mouth for some distance in a gentle curve, and then converging in front formed a somewhat pointed tip. Their rounded palatal edges fitted within the arch of the lower jaw. The transverse diameter of the upper jaw over its dorsum between the angles of the mouth, was 13 feet 3 inches.

From the blow-holes the outline of the back curved upwards and backwards, it was uniformly smooth and rounded, and for a considerable distance presented no dorsal mesial ridge. But somewhat in front of the posterior fourth of the back a ridge appeared, which culminated in the dorsal fin. Unfortunately the height of this fin could not be taken, as the summit had been cut away before I saw the animal. It was triangular in form, its anterior border convex, its posterior border falcate, whilst its apex had obviously projected upwards and backwards. A line drawn from its posterior border vertically down the side of the whale reached the ventral mesial line some distance behind the anus. From the tip of the lower jaw to the anterior border of the dorsal fin was 59 feet 3 inches. Behind the dorsal fin the sides of the animal sloped rapidly downwards to the ventral surface, so that both the dorsal and ventral mesial lines were clearly marked, and the sides tapered off backwards to the tail.

The lobes of the tail curved outwards and backwards from the terminal part of the sides of the animal; a rounded interlobular median notch marked the termination of the caudal spine, and separated the two lobes from each other. The anterior border of each lobe was rounded, and convex from root to tip, the posterior was sharp, and concave from root to tip; the tip was pointed and the surfaces flattened. The greatest girth of one of the tail lobes was 5 feet 8 inches, whilst the distance between the tips of the two lobes was somewhat more than 16 feet.*

The ventral surface of the throat, and the sides and ventral surface of the chest and belly, were marked by numerous longitudinal ridges and furrows. Some extended as far forward as the symphysis of the lower jaw, others to the angle of the mouth; some mounted as high as the root of the flipper, and even above its posterior border. These folds terminated at their hinder ends with great regularity along a line, which commencing some distance behind the root of the flipper sloped obliquely downwards and backwards to the ventral surface. The ventral folds were consequently the longest, one about the middle of the belly measured 45 feet. The number of these folds on each side of the ventral mesial line it was difficult exactly to determine, on account of the position in which the whale was lying, but at least thirty appeared to be present, though as a ridge occasionally bifurcated or gave off a branch, and as, after some time, its forks blended with adjacent ridges, the number necessarily varied in different localities. When I first saw the animal the furrows separating the ridges were not more than from $\frac{1}{4}$ to $\frac{3}{4}$ an inch broad, whilst the ridges themselves were in many places 4 inches in breadth, but as the body began to swell by the formation of gas from decomposition, the furrows were opened up, became wider and shallower, and the ridges underwent a corresponding diminution in breadth. At the same time a considerable change took place in the contour of the body in the thoracic and abdominal regions, which presented

* The extreme ends, probably one foot from each lobe, had unfortunately been cut away before the measurement was taken.

a huge lateral bulging, giving a greater girth than when it first came ashore. Close to the posterior ends of the mesial abdominal plicæ was a deeply puckered scar, the umbilicus.

The flipper projected from the side of the body 31 feet 4 inches behind the tip of the lower jaw, measured in a straight line, and 14 feet behind the angle of the mouth. It curved outwards and backwards, terminating in a free pointed end. Its surfaces were flattened; its anterior border rounded and convex from root to tip, measured 12 feet 3 inches; its posterior border concave from root to tip 10 feet, whilst its girth at the root was 9 feet 6 inches. The distance between the two flippers, measured over the back, between the anterior borders of their roots, was 18 feet 6 inches.

The slit-like entrance to the female passage was situated 22 feet in front of the fork of the tail. Its antero-posterior diameter was 16 inches. It was bounded laterally by elongated prominent folds of the integument, which represented the labia majora, and were indented by longitudinal furrows. In front of the aperture was a rounded elevation representing the mons, which was placed 10 feet behind the longitudinal plicæ on the middle of the belly. Behind the mons was a deeply depressed part of the integument, immediately posterior to which was a thick clitoris, triangular in its outline. Its length was 6 inches, the breadth at the root 4 inches (Plate VI. fig. 6). The clitoris curved backwards, and overlapped the external orifice of the urethra, which orifice was surrounded by a well-marked fold of mucous membrane. Both on its superficial and deep aspects it presented a rugose appearance. On each side of the root of the clitoris a projecting fold lying between the labia majora passed backwards, external to the urinary meatus. These two folds formed the labia minora; they bounded the vestibule, and their inner surfaces, as well as the floor of the vestibule, possessed a number of complex ridge-like elevations of the mucous membrane. When this membrane was cut through, a quantity of erectile tissue, in which were many large veins, was seen. Eight inches on each side of the female passage was a funnel-shaped elevation of the integument, at the summit of which a circular aperture, which readily admitted the tips of the fingers into a fossa about 4 inches deep, was seen. Projecting from the bottom of this fossa, but not through the circular aperture at its summit, was a large nipple about 3 inches long, which possessed an orifice at its free end—the termination of the great lacteal duct—into which the forefinger could be passed. A number of pedunculated papillæ were situated at the summit of the nipple around this orifice (fig. 7).

Thirteen inches behind the female passage was the orifice of the anus, which was small and contracted, but could easily be dilated so as to admit the hand. The integument immediately around the orifice was rugose, and in the neighbourhood both of the intestinal and genital openings the skin was indented by several longitudinal furrows (fig. 8). A well-marked sphincter was observed beneath the integument around the anus. The mucous membrane at the anal end of the rectum had a blackish tint.

The eye was situated immediately above the angle of the mouth, from which it was 1 foot 6 inches distant. The fissure between the lids lay antero-posteriorly. The ear orifice was a narrow slit situated in a line behind the eye, from which it was distant 3 feet 10 inches. The transverse distance over the dorsum between the two eyes was 11 feet 5 inches, the corresponding distance between the two ears was 13 feet 7 inches.

The blow-holes were placed in the fossa between the two subdivisions of the dorsi-mesial ridge of the beak. Two longitudinal slits or nostrils, each large enough to admit the extended hand, were separated by an intermediate septum. Anteriorly the slits were only 4 inches asunder, but owing to their divergence the posterior ends were 15 inches apart, and the transverse diameter of the septum was correspondingly increased. The upper surface of the septum was marked by a longitudinal mesial groove. The antero-posterior diameter of the blow-holes was 1 foot 6 inches. From the tip of the lower jaw to the anterior end of the blow-holes, 14 feet 9 inches. From the anterior end of the blow-holes to the mesial notch of the tail 64 feet.

Colour.—On the dorsum of the beak and of the cranium, on the back of the body, and for some distance down its sides, the colour was dark steel grey, amounting in some lights almost to black. On a line with the pectoral flipper the sides were mottled with white, and on the ventral surface irregular, and in some cases, large patches of a silvery grey or milk whitish tint were seen. An experienced whaling seaman, Mr WALTER RODDAM, who had charge of the carcase, told me that he had repeatedly seen this kind of whale in the northern seas, and stated that, owing to the silvery hue of the belly, it was known to the whalers by the name of "silver bottom."* The surfaces of the clitoris and of the labia minora were mottled with black and silvery grey tints like the skin of the belly.

The dorsal fin was steel-grey or black, except near its posterior border, where it was a shade lighter and streaked with black lines. The anterior margin of the lobes of the tail, its upper surface near the root and for the anterior two-thirds, were black, whilst the posterior third of the same surface and the interlobular notch were lighter in tint. The ventral folds had a light sepia colour, and the furrows were not so dark as the ridges. The upper surface of the flipper was steel-grey, mottled with white at the root, at the tip, along its

* In the 2d vol. of Dr SCORESBY'S Account of the Arctic Regions, p. 531, it is stated, on the authority of Captain DAY, that amongst the whales pursued by the southern whale-fishers is one called "sulphur bottom," a species of Fin whale of great length and swiftness. Can it be that sulphur bottom is a corruption of silver bottom? and that this whale frequents both the northern and southern oceans?

posterior or internal border, and on the under surface; white patches were also seen on the upper surface near the tip, and here they were streaked with black lines running in the long axis of the flipper. White patches also extended from the root of the flipper to the adjacent parts of the sides of the animal. The outside of the lower jaw was black, whilst the inside was streaked with grey and brown.

A few days after the death of the whale, the scarf skin had become loose, and large portions of it had separated, leaving the pinkish-white cutis exposed, and giving therefore a different colour to these parts of the integument than they had originally possessed. This circumstance is worthy of note, and may serve to explain appearances which have been described by some authors in connection with the colour of the skin in specimens of fin whales which they have examined. The surface of the skin was smooth and shining. No parasites were found attached to it, and no hairs or bristles were observed to project from any part of its surface.

Although the animal had reached the enormous length of nearly 80 feet, yet it had not attained its perfect adult state. For, as the subsequent examination of the skeleton showed, the disk-like epiphyses of the thoracic and lumbar vertebræ were not yet united to the bodies of those bones. The whale, therefore, was at the period of growth which, as Professor FLOWER has pointed out,* may very appropriately be termed "adolescent."

Fœtus and Membranes.—When the whale was lying on the beach at Longniddry, the seaman in charge told me that he believed the animal to be in calf. On the fourth day after the operation of flensing on the beach at Kirkcaldy had commenced, as I was watching a man taking away the blubber and muscles from the posterior part of the side of the abdominal wall, I observed an elongated, dark-coloured mass lying loose amidst the coils of intestine, almost opposite the umbilical scar. I requested the man to hand it to me, and at once recognised it to be a wreath of young baleen about 4 feet long, which had obviously become detached from the roof of the mouth of a young animal, and had by some means or other escaped into the abdominal cavity of the parent. The discovery of this baleen clearly proved that the whale was in the gravid state. We at once commenced to remove a larger portion of the abdominal wall in order to obtain a view of the uterus, but before this could be accomplished, the rising tide compelled us to cease our operations. As this happened on a Saturday, work could not be resumed until the Monday following, and as my University duties prevented me from being present, the search was conducted by Messrs COUGHTREY and FOULIS, who after several hours of hard work exposed the head of the calf by the removal of a mass of blubber from the right

* Proc. Zoological Society, Nov. 8, 1864.

side of the neck of the parent animal. The head of the calf indeed was so far forward that the tip of its beak was only 2 feet 9 inches behind the condyle of the mother's right mandible. An additional mass of blubber was then taken away from the exterior of the ribs on the right side, when more of the calf was exposed. It was lying obliquely between the blubber and the muscles which covered the outer surfaces of these ribs, and the space in which it was contained had obviously been formed by a forcible separation of the blubber from the subjacent muscles; for when the blubber was cut through, the pressure on the calf, owing to its position between a weighty mass of blubber and the elastic ribs, was so great that its head protruded through the incision, and even partially tore through the superficial textures.

The lower jaw of the calf was directed towards the ventral surface of the mother, and the left side of its body was in relation to the outer surface of her right ribs, and its tail was directed to her abdominal cavity. After the removal of an additional portion of blubber, the calf was extracted by my assistants, and in the process of removal it was observed that about 5 feet from the tail the body of the calf was so twisted on itself, that the position of the two lobes of the tail was reversed. A large quantity of the fœtal membranes lay alongside of the calf, more especially near its caudal end; but they were torn, and had lost their bag-like form. Some coils of the intestine were also situated beside the tail. It is much to be regretted that the uterus could not be preserved in the course of this examination. The huge size of the coils of the intestine, and the desire which the men employed had to get rid, on account of the smell, of the contents of the abdominal cavity, rendered it impossible to make such an examination of these viscera as was desired.

From a consideration of the position of the calf there can be no doubt that either immediately before or after the death of the mother, the fœtus had been disconnected from its proper attachments and extruded into an artificial space external to the abdominal cavity. The torn state of the fœtal membranes and umbilical cord, the presence of coils of the intestine in the space in which the fœtus was lying, and the loose mass of baleen in the abdominal cavity of the mother, all point to a rupture not only of the uterus, but of the wall of her abdomen, which had permitted the passage out of the cavity both of the fœtus and of portions of the gut.

To what cause, then, are we to ascribe the rupture and consequent displacement? Some of those who examined the whale were of opinion that they had been occasioned by a severe injury sustained by the mother prior to, or at the time she came ashore. But I am rather inclined to think they must have occurred whilst she was being towed by the tail across the Firth from Longniddry to Kirkcaldy. For, during the two weeks she lay on the beach at the former place, decomposition had advanced to a considerable extent, putrid gases were disengaged, and consequent softening of the soft parts had occurred. As the sternum is short, and only articulates with the first pair of ribs, and as the inner ends of the remaining ribs diverge considerably from each other, and have no strong attachments in the ventral mesial line, the great pressure of the sea on the wall of the abdomen, as she was towed by the tail, would tend to rupture the uterus and abdominal wall, to drive the contents of the abdomen forwards towards the head, and to force the fœtus into the position in which it was found.

Owing to the displacement of the fœtus, the dissection of this animal does not enable me to state with certainty the normal position of the fœtus in utero in this cetacean. Very little indeed is known of the uterine position of the fœtus in this group of mammals. In a communication made to the Royal Belgian Academy,* M. VAN BENEDEN figures the position in utero of the fœtus in *Globiceps*. Its head is directed to the maternal genital orifice, its body is bent, and the tail is folded backward under the thorax, so as to lie close to its flipper. He believes that the fœtus of *Balænoptera rostrata* has the same position in utero, and doubts the statement made by M. BOECK, that the young of *rostrata* is born first by the tail. In the Longniddry *Balænoptera*, on the other hand, the head of the fœtus was directed towards the head of the mother; and unless we suppose that during the displacement a complete revolution in the relative position of its caudal and cephalic ends had taken place—an occurence which, owing to the great length of the fœtus, scarcely seems possible—the uterine direction of the young one would have been with its tail towards the maternal genital passage.

The gravid state of the whale necessarily exercised an influence on its shape, more especially by increasing its girth in the abdominal region—a circumstance which should be kept in mind in comparing the drawing of this animal (fig. 1) with those which have been given by other naturalists of the Finners which have come under their observation.

The form of the fœtus differed in several particulars from that of the mother. Its greatest girth was around the head, from which it tapered forwards along the beak, and backwards to the root of the tail. From the unexpanded condition of the lungs, and the flaccid state of the hollow viscera of the abdomen, the thoracic and abdominal cavities had not attained their proper girth, and the body and caudal end of the fœtus presented a peculiar, elongated, worm-like appearance. The dorsal fin did not rise so abruptly in the fœtus as in the adult, so that it was difficult to determine its exact antero-posterior length. Its posterior border had a well-marked falcate curve (Plate V. fig. 2).

The fœtus was a male. The penis, 11 inches long, hung pendulous from the ventral surface, and at each side of its root a crescentic fold of skin arched out-

* Bulletins, vol. xx. 2d series, No. 12.

wards (Plate VI. fig. 9). Behind each of these folds was the mouth of the shallow nipple fossa; the nipple was rudimentary, and concealed by the prominent anterior border of the fossa. The posterior border was feeble, and here the fossa blended with the general surface of the abdominal wall. Passing backwards, midway between these fossæ, was a well-defined raphé reaching to the anus. The abdominal wall was much torn in front and at the root of the penis, and the exact attachment of the umbilical cord could scarcely be recognised, but it was estimated to be connected about 18 inches in front of the root of the penis; for the cord, though carefully divided at the time when the fœtus was removed from the mother, had been used, along with the penis, as a convenient object to lift with by the men employed to carry the calf, and consequently both they, and the part of the wall to which they were connected, had sustained injury. The tail was subdivided into two elegantly curved horizontal lobes (fig. 3). The sides and ventral surface showed the characteristic plicated appearance (fig. 4). On the top of the head, 1 foot 5 inches behind the blowhole, was an oval patch 1 inch long by $\frac{3}{4}$ths broad. It was raised somewhat above the level of the integument. The shape of the flipper is represented in fig 5.

The colour of the integument was a warm grey, mottled here and there with yellow. Patches of dark steel-grey pigment were observed on the back; but none of the light silver-grey tints, seen in the large whale, were observed on the belly. I believe that desquamation of the cuticle had taken place very extensively before the calf came into my possession.

I had anticipated that the comparatively small size of the fœtus would, by giving me greater command over the dissection, have enabled me to have worked out all those points in the anatomy of this whale, which I could not overtake in the older animal. But in many respects I was disappointed, for the weight of the fœtus, which amounted to about half a ton, and its length of almost twenty feet, rendered it a most unwieldy object to transport to the Anatomical Museum. Moreover, putrefaction had to some extent advanced before I had the opportunity to examine it; the abdominal wall was torn, and the viscera in that cavity were so much injured, that but little definite information respecting the stomach and intestines could be obtained. The muscles also had undergone a remarkable kind of decomposition; the odour exhaled from them was peculiarly acrid and offensive, which, together with their softened condition, rendered it impossible to make a proper study of those important parts of the locomotory system. The bones of the skull and spine were also to some extent displaced.

A number of measurements were taken, a table of which I subjoin; but in consequence of the displacement just referred to, some of the dimensions are probably not absolutely exact, but are to be regarded as the closest approximation which could be obtained:—

	Feet.	Inches.
Length of male fœtus,	19	6
From tip of lower jaw to posterior end of blow holes,	3	9
From posterior end of blow-holes to posterior border of dorsal fin,	10	8
From posterior border of dorsal fin to interlobular median notch of tail,	5	1
Antero-posterior diameter of blow-holes,	0	6
Transverse diameter of blow-holes,	0	3½
From tip of lower jaw to angle of mouth in a straight line,	3	11
From tip of lower jaw along curve to angle of mouth,	4	6
From angle of mouth to anterior border of root of flipper,	1	10
From tip of lower jaw in a straight line to anterior border of root of flipper,	5	9
Length of flipper along anterior border,	3	7
Greatest diameter of flipper from anterior to posterior border,	0	9
Girth of flipper at root,	1	10½
Girth of body just behind dorsal fin,	3	6
Girth round root of tail,	1	6
Between extreme points of tail-lobes in a straight line,	4	7
Between extreme points of tail-lobes along posterior concave border,	5	6
Greatest girth of tail-lobe,	2	7
From median notch of tail to anal orifice,	6	2
Transverse distance between nipple fossæ,	0	3
From anal orifice to midway between nipple fossæ,	0	8½
From nipple fossa to fold of skin at root of penis,	0	5¼
Length of penis,	0	11
Vertical diameter of dorsal fin,	0	6½
Greatest transverse diameter of cavity of mouth,	1	9

A vertical line, drawn from the root of the posterior border of the dorsal fin to the ventral mesial line, was 16¼ inches behind the anal orifice.

The displacement of the fœtus and the torn state of the membranes did not give me the opportunity of observing the exact relations of the latter to the fœtus and to the mucous surface of the uterus. Although several square yards passed through my hands, yet I did not succeed in recovering the whole extent of these important structures. Notwithstanding these deficiencies many points of interest bearing on the placentation of the cetacea were observed.

The outer surface of the chorion had the general villous appearance which is characteristic of the diffused form of placenta. In my first, and somewhat hurried inspection of this membrane, I did not notice any portion which did not possess villi. But on a second examination, made at more leisure on the membrane preserved in spirit, I observed that a portion of the chorion was bare. Unfortunately this had been torn across and a portion lost, so that the proper form of the non-villous part could not be ascertained. It had apparently, however, been of some extent, for the portion preserved was oblong in form, and measured 11 inches by 3. In all probability it had formed a part of one of the prolonged poles of the membrane.

The villi began at the edge of this bare part by a well-defined line; immediately beyond and parallel to which the chorion was doubled on itself, so as to form a strong marginal fold, which projected for about one inch, and was thickly studded with villi on its surface and free edge. (Plate VII. fig. 17.) A second fold, also covered with villi, lay close and parallel to the marginal fold. Similar villous covered folds of the chorion, many of which were one foot and upwards in length, traversed the chorion in various parts of its extent; frequently they ran parallel to each other, and two or more were sometimes close together, but at other times they were separated by intervals of 3, 4, or 5 inches. Usually the greatest projection of one of these folds was about 2 inches, though sometimes it reached 3, or even 4, but towards their extremities they gradually subsided to the general plane of the chorion.

Besides these elongated folds, villous covered folds of another form, but not so numerous, projected from the surface of the chorion. They were triangular in shape, flattened on their surfaces, and with the apex and lateral borders free. A very characteristic specimen is represented in Plate VII. fig. 18. Its margin of attachment was 4 inches, whilst its diameter from this margin to the free apex was $5\frac{1}{2}$ inches. On the elongated and triangular folds, but more especially the former, the villi were thickly studded, but on the intermediate surface of the chorion they were more sparingly distributed, and were for the most part collected on minute and ridge-like elevations, which intersected each other, and presented an irregularly reticulated appearance. The membrane between these slight ridges was comparatively smooth and transparent.

The mucous surface of the uterus in the mother must have possessed numerous depressions of considerable length and depth, into which the elongated and triangular folds of the chorion would have fitted. In the special aggregation of the villi on these folds an approach to the cotyledonary type of the placenta found in the Ruminantia may be traced.

The opposite surface of the chorion was in relation to the placental blood-vessels, some of which were of considerable size; one, which was measured, had a circumference of $2\frac{3}{4}$ inches. Where the folds on the villous surface were well marked an artery coursed along and gave off many collateral branches, which entered into the fold to end in the villi. The chorionic vessels were surrounded by a delicate connective tissue, which was loosely connected with the attached surface of the amnion. Lying in this connective tissue were numerous opaque, white, slender threads, which differed from the small arteries in not being tortuous, and in giving off their branches at very acute angles. These threads had to the naked eye the appearance of fine nerves. When examined with the microscope, they were found to possess an external investment of well-marked connective tissue, which surrounded lines of an irregular granular or semi-globular substance which looked like the disintegrated medullary sheaths of nerve fibres. The free surface of the amnion was smooth and glistening.

Although nothing definite seems to be known of the period of gestation of the Finners, yet from the length of the calf, and the well-developed state of its parts, it is probable that the whale was at or about her full time. Dr SCORESBY considered that February and March were the months in which the *Balæna mysticetus* gave birth to her young,* but ESCHRICHT and REINHARDT, from observation made at the Danish whaling factories, think that it is between the end of March and the beginning of May.† If my supposition be correct that the whale was at her full time, then this *Balænoptera* gives birth to its young in the later autumn months, and not, like the Greenland Right whale, in the spring of the year.

This view of the period of parturition of the great Finner is strengthened by evidence which I have received from another source. In the month of October 1869, a large female Finner, which, from information that I have obtained,‡ I believe to be of the same species as the Longniddry whale, was found in a creek about a quarter of a mile to the south of Hamna Voe, Northmaven, Shetland. It was dead, and floating by its side was a dead calf, which was well developed, and bore to the mother about the same proportion as the Longniddry animals did to each other. Alongside the calf was a quantity of membranes, which, from the statements of the fishermen, were evidently the fœtal membranes. The calf had obviously been born about the time of the death of the mother, and had apparently reached the full period. The maternal mammary glands were so charged with milk that a quantity was observed to flow out through the teats.

The capture of two of these whales in the pregnant condition within so short a period in arms of the sea, lends support to the statement which has more than once been made, that the Finners resort to bays and creeks for the purpose of bringing forth their young.

Skin and Blubber.—The colour of the skin has already been described; a few words may, however, be said on its structure. The epidermis readily peeled off the cutis when decomposition had begun. It was distinctly laminated and thicker than the human cuticle. On the belly, for example, it measured $\frac{1}{8}$th of an inch, and on no part indeed of the surface of the trunk was it seen to possess a greater thickness. In this respect it contrasts strongly with the skin of the *Balæna mysticetus*, which in some places has the cuticle one inch thick.§ The superficial layer could be peeled off as a thin horny stratum,

* Account of the Arctic Regions. I., 470.

† Memoir translated for the Ray Society, p. 10.

‡ I am indebted for information regarding this whale in part to Mr J. WALKER of Maryfield House, Bressay, and in part to Mr COUGHTREY. The latter gentleman has just returned from a visit to the Shetland Isles, and when there not only collected at my request various interesting facts about this animal, but also procured for me a number of its bones.

§ Dr KNOX (Catalogue of Anatomical Preparations of the Whale, Edinburgh, 1838) points out the thinness of the cuticle in the species of the great northern Rorqual which he dissected; nowhere, he says, did it exceed $\frac{3}{16}$ths of an inch. He compares it with the *B. mysticetus*, and shows how in the one there are conjoined thin cuticle and short baleen, in the other thick cuticle and long baleen.

which, when dried, had the appearance of gold-beater's skin. The deeper layers contained more pigment than the superficial, and in those parts of the skin where the colour was most marked the deep surface of the cuticle had a rich black hue. When the epidermis was removed, rows of distinct elongated papillæ were seen; and in vertical sections through the entire skin the relations of these papillæ to the cuticle* could be studied (Plate VIII. fig. 29). The papillæ were filiform, and as a rule simple, but in some cases two or even three papillæ arose by a common stem, which then subdivided. They were comparatively long, and their apices reached therefore much nearer to the surface of the skin than might have been supposed. In some of the sections I observed distinctly the small arteries of the cutis giving off branches which entered the bases of the papillæ and extended for some distance within them.

The blubber or subcutaneous tissue was composed of adipose tissue, for the oil was contained in well-defined fat cells. These cells were supported by bands of connective tissue, many of which possessed considerable breadth and strength. Blood-vessels passed in some numbers through the blubber, partly for its nutrition, and partly for the nutrition of the integuments on its surface. The blubber varied considerably in thickness in different parts of the subcutaneous tissue of the adolescent animal. On the sides and upper edge of the lower jaw, it was from 10 to 16 inches. Beneath the ear-slit 8 inches; along the ventral surface about 4 inches. On the top of the beak and cranium 8, 12, and even 15 inches. In front of the dorsal fin from 12 to 16 inches, and behind this projection from 14 to 21 inches, which seemed to be the maximum thickness. The thickness of the blubber at the tip of the caudal spine was 3 inches, and at the symphysis of the lower jaw 4½ inches, so that the length of the skeleton was within 7½ inches that of the entire animal. In the fœtus the blubber was very imperfectly formed; and the thickness of the subcutaneous tissue was almost uniform, on the belly not exceeding one inch; and on the back scarcely reaching two inches.

In the older animal, an enormous mass of soft fat was situated within, and formed a sort of fatty lining for the abdominal cavity. From the heat which was disengaged by the putrefaction of the carcase, this fat was liquefied, and ran in streams on to the shingle, where it again solidified, and was collected into barrels.

Mr Tait estimated that he had obtained from the blubber ten tons of oil, and from the inside fat six tons, so that the pecuniary value of the whale from

* In the Anatomical Museum of the University of Edinburgh are several specimens (161 to 164) prepared upwards of twenty years ago by the late Professor Goodsir, one from the *B. mysticetus*, three from a "Rorqual," probably the *Balænoptera musculus*, which give most illustrative views of the filiform papillæ of those animals.

these sources alone was very considerable. He has also furnished me with an estimate of the weight of the other portions of the carcase, from which we may make an approximation to the weight of the entire animal. The flesh and viscera 36 tons, the baleen and "gum" 10 cwt., the skeleton 9 tons 10 cwt., the blood and refuse 12 tons, which, with the oil and fat, make in all 74 tons as an estimate of the weight of the entire animal.

Mammary Gland.—The position of the nipple has already been described in the section on the external form of the animal. The gland itself was exposed by the removal of the blubber on one side of, and for several feet anterior to, the genital fissure. It formed an elongated body, and measured between 7 and 8 feet in its antero-posterior diameter, and of this extensive mass only 8 inches lay behind the nipple. Its greatest transverse diameter was 20 inches, and the thickness of the gland substance, which surrounded any part of the great central duct, was more than 6 inches. Its broadest part was in the region of the nipple, gradually tapering off to its anterior end. Its colour was a rich red; and its subdivision into lobules by bands of connective tissue could be readily recognised by the naked eye. When cut into, it was seen to be traversed along its entire length by a central duct, which increased in size as it passed from before backwards, and at the base of the nipple formed an enormous sinus, the transverse diameter of which was about 8 inches. Numerous large ducts, into many of which the closed hand could be passed for some distance, opened out of this central duct, and extended into the various parts of the gland. The transverse diameter of one of these ducts was $5\frac{1}{2}$ inches. The orifices of the primary ducts opening into the great central canal, and those of the smaller ducts which opened into the primary, were mostly oblique in their direction, and a well-marked fold of the mucous membrane bounded one-third, and sometimes more, of the aperture. As a general rule, the direction of these ducts was towards the nipple, but some ran in the opposite direction. The mucous membrane which lined the ducts and central canal was firm, and marked on its free surface by a characteristic ridge and furrow-like appearance (Plate VI. fig. 11). These ridges were parallel to the long axis of the duct. At the base of the nipple the great sinus-like dilatation of the central canal suddenly narrowed to the duct within the nipple, which was not larger than would admit the middle finger or thumb. The lobules of the gland were polygonal in shape and variable in size; some of the larger ones had a diameter of $\frac{1}{5}$th inch. Sections through the lobules examined microscopically gave very illustrative views of the structure of a compound racemose gland. The clusters of acini or gland vesicles, with their contained secreting cells, could be seen with great distinctness, and the arrangement of the interlobular connective tissue could be traced.

In the subcutaneous tissue around the nipple and at its base, numerous plexiform vessels were seen, so that it is probable that erectile tissue exists in this locality. Lying outside the mammary gland was a muscle which, by its contraction, would aid in expelling the milk along the ducts, and through the orifice of the nipple.

The size of the secondary ducts of this gland, and the dilatation of the single central duct into a great reservoir for the collection of the milk, have obviously special reference to the aquatic mode of life of an animal which suckles its young. For, as JOHN HUNTER long ago pointed out,* the mode in which these animals give suck is very inconvenient for respiration, as if the mother were to turn round so as to elevate the nipple to the surface then her nares would be under water; whilst, if the mother remains in her normal position, then the nose of the calf must be under water, and the time of sucking can only be between each respiration. It is necessary, therefore, that the gland should be so constructed as to allow of a considerable accumulation of milk in the ducts, which may be readily drawn off by the calf in the intervals between the respiratory acts.

Baleen.—When the lower jaw was removed by cutting through the massive fibrous columns, which connected the condyles of this bone to the base of the skull, and when the occipito-atloid joint was disarticulated, the skull was turned over on its dorsum, and a complete view of the roof of the mouth, and of the baleen *in situ* was obtained. Extending from behind forward in the mesial plane of the palate was the great central crest or keel, which was much broader and more prominent posteriorly than anteriorly, and was covered on its free surface by a black mucous membrane. Immediately on each side of the base of the keel the palate was covered by a smooth and almost flat, black mucous membrane, and external to this again was the lateral series, or wreath, of deep black baleen plates with their inferior free edges fringed with black setæ.

The wreaths of baleen plates on the two sides converged as they passed forwards, and at the anterior part of the mouth they became continuous with each other, as is the rule indeed in the Finner whales.† Posteriorly, where they lay close to the entrance into the gullet, they were separated by a considerable interval; though here also they inclined inwards to the base of the great mesial palatal keel. The inner edge of each wreath had a curved outline with the concavity towards the mesial keel. The outer edge was convex, and in its curvature closely corresponded to that of the margin of the beak itself. This border was bounded by a raised fold, the coronary or wreath-band (*Horn-Kranzband* of ROSENTHAL), and was situated one foot within the outer edge of the beak. Where the two wreaths became continuous in front, the junction took place seven inches within the tip of the beak.

* Structure and Economy of Whales. *Phil. Trans.* 1787.

† ESCHRICHT and REINHARDT. I have also seen this in two specimens of *Balænoptera rostrata.*

Each wreath was estimated to contain about 370 rows of plates,* and each row consisted of several plates or blades or bristles. The rows lay transversely and parallel, though not in straight lines, for they were somewhat curved, the convexity forwards, the concavity backwards, and the smaller inner subsidiary plates were arranged in an oblique manner. Intervals varying from one half to three-eighths of an inch existed between the rows in different parts of the series. The transverse and vertical diameters of the plates varied considerably, not only in different parts of the wreath, but also in each row, for the plates diminished in size from the outer to the inner edge of the row. At the anterior part of the mouth they were little more than coarse black bristles, and the free part of these projected in some only half an inch, in others one inch and a half, into the cavity of the mouth. Extending backwards along the outer or labial part of the wreath the baleen increased in size, at first being somewhat elongated narrow plates, and then increasing in their transverse diameter at their base of attachment, until they assumed the unequally four-sided form, with its surfaces directed forwards and backwards, of the blade represented in Plate VI. fig. 12, which may be regarded as a very characteristic specimen of one of the large plates of this *Balœnoptera*. The dimensions of this plate were as follows. The transverse diameter along its base of attachment 1 foot 6 inches; vertical diameter, inclusive of the part imbedded in the intermediate substance, along outer free border, 2 feet 9½ inches, along inner free border 8 inches. Length along the border fringed with setæ 3 feet 3 inches. The setæ varied in their length, some measuring as much as 17 inches. On the surface of the plate numerous longitudinal parallel lines, which at its inferior edge became continuous with the setæ, were observed. Transverse rings, which sometimes were close together, at others were separated by wider intervals, passed from one surface to the other around the outer and inner free edges of the plate. A plate of this form and of somewhat similar dimensions formed the external or labial blade of each transverse row in by far the greater portion of the wreath.

Internal to this large plate the baleen, though of the same black colour, was elongated and narrow; the blades possessed the form represented in Plate VI. fig. 13, their transverse diameter was not more than $\frac{8}{10}$ths of an inch, and their vertical diameter, inclusive of the part imbedded in the intermediate substance, was in some 7, in others 6, in others 5 and 4 inches. Each of these narrow subsidiary plates had an uniform breadth, and the setæ, which were often more than 6 inches long, arose not from the sides, but only from

* Although the rows of plates were counted without difficulty in the greater part of the wreath, yet at the posterior end, and at the front, of the mouth the exact enumeration was attended with considerable difficulty, owing to the bristle-like baleen being arranged in less definite rows than were the blades of this substance.

the free end. Whilst the setæ generally had the same deep black colour as the plates, in some cases they had more of a deep soot brown tint. The baleen at the inner end of each transverse row consisted, not of plates, but of short bristles, similar to those already referred to at the anterior end of the series. As the vertical diameter of the plates and the length of the setæ were so much greater in the outer than in the inner parts of each transverse row, it followed that the lower bristle-fringed aspect of each wreath arched, from without, obliquely upwards and inwards, so that the roof of the mouth presented a considerable concavity from side to side.

The plates were all imbedded at their attached palatal borders in a dense semi-elastic, slate-coloured material, the intermediate substance or "gum" of the whaling seamen. This substance varied in its thickness from its attached to its free surface to from 1 to 4 inches in different parts of the wreath, and was thinner along the outer and inner borders than in the intermediate portions. It was continuous, along the inner border of the wreath, with the cuticle investing the palatal mucous membrane, and along the outer border, with the coronary or wreath-band already referred to. The free surface possessed an irregular softened, water-worn appearance.

After decomposition had begun the baleen and intermediate substance, intimately connected together, could be readily peeled off the surface of mucous membrane from which they grew, and their mode of growth and structure could be examined.

All anatomists know, who have studied the structure of whalebone, that, when a blade is carefully detached from the surface of the palate, the edge or base of attachment is cleft along the line of its transverse diameter into two laminæ. If these laminæ be drawn asunder numerous holes are seen at the bottom of the cleft, which open into tubes or canals that traverse the substance of the plate in the vertical direction. It has been pointed out by ESCHRICHT and REINHARDT, that in the short baleen plates of the Rorquals or fin whales the length of these tubes is comparatively greater than in the much longer plates of the Greenland Right whale. In the Longniddry whale, the deep black colour of the baleen made the plates so opaque, that the existence of the tubes could only be surmised by the longitudinal markings visible on a surface examination, and it was not until after sections were made in the vertical or transverse direction, that the tubes could be distinctly seen.

In vertical sections the tubes were cut longitudinally, and could be followed for some distance (Plate VII. fig. 19). They contained a delicate, brownish-yellow substance, which could be easily drawn out of the tube. In the part of the plate which surrounded the tubes numerous black pigment granules were distributed in such a manner as to give to the section the appearance of longitudinal striation.

Transverse sections of the plates, examined with low magnifying powers, were, however, the more instructive (fig. 20). The number and size of the tubes was by no means uniform in the different parts of the same transverse plane. Sometimes a single comparatively large tube was alone met with; at others two, or even a larger number, occupied the antero-posterior diameter, and in this case the tubes were considerably smaller. The soft brownish-yellow contents were readily recognised, and in many of the sections this substance was seen to be perforated with holes, which looked like transversely-divided small blood-vessels.

The solid portion of the plate was spotted with black pigment, and distinctly striated. The striæ ran in two different directions, and indicated a laminated arrangement. One set of striæ or lamellæ surrounded, in a concentric manner, the individual tubes, and in their arrangement might be compared with the lamellæ surrounding the Haversian canals in a transverse section of bone. They may be called the tubular lamellæ; and the tube, its contents, and the lamellæ surrounding it, might be termed a tubular system. The other lamellæ were situated on the peripheral part of the plate, and formed a sort of envelope enclosing the tubular system of lamellæ. These may be called the peripheral or cortical lamellæ; and they formed that part of the plate which has been called the cortical layer or "enamel" of the whalebone. When examined with higher powers of the microscope, the lamellæ were seen to be composed of elongated and flattened cells, each containing a distinct nucleus, and more or less black pigment (fig. 21). These cells were obviously peculiarly modified epithelial cells. The intervals between the outermost lamellæ of adjacent tubular systems were filled up by cells, which presented less of a flattened and more of a fusiform or rod shape; these cells, though interstitial in their position, were apparently continuous with the cells of the cortical layer.

Transverse sections through the setæ displayed in each a central tube or canal, surrounded by the usual arrangement of concentric tubular lamellæ (fig. 22). The tube within the seta contained a similar soft brownish material to that found in the tubes within the blade itself. Each seta represented, therefore, a single tubular system.

When vertical sections through the intermediate substance, in which the bases of the plates were imbedded, were examined with low powers of the microscope, the deep surface attached to the palate was seen to be much more highly charged with pigment than the more superficial parts, and so regularly was it disposed, that it might almost be described as a special pigmentary layer of the structure. The deep surface had an uniform rich black colour, and was perforated by numerous apertures, which in the vertical sections were seen to lead into clefts which passed some distance into the intermediate substance (fig. 23). The black pigmentary layer was prolonged along the walls of these clefts. Under higher powers of the microscope, the intermediate substance was seen to consist of flattened cells, epithelial in character (fig. 24), and the black pigmentary layer was due to a special accumulation of pigmentary granules in the deepest cells of this substance. This layer may be considered therefore as comparable to the *Rete Malpighii* of the human cuticle.

The intermediate substance was intimately united to the laminæ formed by the cleavage of each plate at its base; so close indeed was this union that it was impossible to separate them from each other without injury to the latter. It not unfrequently happened, in tearing away the substance from between the plates, that a portion of the cortical layer of the adjacent part of the plate peeled off along with it. A distinct horizontal lamination was seen on the surface of vertical sections made through the intermediate substance.

In my further researches into the structure of the baleen, I have derived considerable assistance from the examination which I made of the baleen of a recently killed, lesser Pike whale, *B. rostrata,* about 18 feet long, which was captured at Burntisland in September last. In this animal the plates were for the most part white, or yellowish-white, but, when quite fresh, a distinct pink or rosy colour was seen, more especially in that part of the blade which lay within and next to the intermediate substance. Some days after death the pink or rosy colour became converted into purple.

When a fresh blade was examined in a good light, the pink colour was found to be not on the surface, but within the substance of the plate, and arranged in regular lines, which ran parallel to each other from the attached border to the free border fringed with setæ, and in many cases it extended even into and along the latter. When a pocket lens was used in the examination, the colour was seen to be due to a red fluid contained in the numerous tubes which traversed the plate in its vertical diameter. Sometimes the fluid formed an unbroken column of one, two, or three inches in length; but at others the column was much subdivided, and reminded one of the appearance presented by a broken-up column of mercury in a barometer tube when out of repair. In some of the tubes, more especially those situated near the outer and inner edges of the plate, the red fluid was either absent, or extended only a short distance down the tube. Many of these tubes appeared as if subdivided by little septa passing across their canals, not unlike the arrangement one has seen in the medullary part of a hair. When the baleen plate was cut across transversely, and forcibly squeezed between the finger and thumb, the red fluid oozed out of the divided tubes, and when collected on a glass slide was examined microscopically. Under a high power numerous circular, disk-shaped, non-nucleated corpuscles, which possessed the optical characters of blood corpuscles, were found in it (fig. 25), and along with these were three-sided prismatic crystals, probably the triple phosphate, and numerous actively moving vibriones. It was clear, therefore, that the pink tint of the baleen in the Pike whale was due to the blood* situated in the tubes which traversed its substance in the vertical direction.

I am not aware that any explanation has previously been given of the cause of the pink colour of the baleen in the lesser Pike whale. Indeed many writers seem to have paid but scanty attention in their descriptions to the existence of this tint.

Both in the Longniddry and the Pike whales the surface of the palate, from which the baleen grew, possessed numerous transversely elongated folds of the palatal mucous membrane (the pulp-blades of ESCHRICHT and REINHARDT), corresponding in their arrangement and transverse diameter to the different sizes of the baleen plates in the various transverse rows, and fitting into their cleft basal edges (fig. 26). The largest of these folds in the former animal projected as much as $\frac{7}{10}$ths of an inch from the general palatal surface. The free lower edge of each fold was fringed with multitudes of well-marked elongated filiform papillæ, which fitted into and indeed filled up the tubes in the plates and setæ already described. These may be called the tubular papillæ. If great care was taken in stripping off the plates, the papillæ could be drawn out of the tubes, and in fig. 26 a view of a number of these structures from the interior of the tubes of a plate of the Longniddry whale is given. The tubular papillæ varied in length in this preparation, some being 3 inches long, whilst others were considerably shorter; but none of these papillæ represented the full length of the tubes they originally occupied, as they always broke short in the act of removal. They varied also in thickness, in correspondence with differences in the bore of the tubes; and they were thicker at their attached than free extremities.

Folds and papillæ of this character have been described with more or less fulness of detail by HUNTER, RAVIN,† ROSENTHAL,‡ KNOX,§ OWEN,|| ESCHRICHT and REINHARDT,¶ FLOWER,** and MALM,†† in connection with the baleen in the different whales which they have examined; and in the Anatomical Museum of the University of Edinburgh are several specimens, prepared, I believe, in the year 1843, by the late Professor GOODSIR, which furnish very illustrative views of the folds and larger papillæ of the baleen plates. They have been regarded as the nidus, matrices or pulps, from, and in connection with, which the specially

* As confirmatory evidence of this fluid being blood, I may state that I requested my friend, Dr ARTHUR GAMGEE, to apply the chemical test for blood. He found that the fluid gave with guaiacum and peroxyde of hydrogen the characteristic greenish-blue colour of hæmoglobin.

† Ann. des Sc. Naturelles, 2 Sér. t. v.

‡ Abhand. der Akad. der Wissensch. zu Berlin, 1829, p. 127.

§ Catalogue, *op. cit.*

|| Odontography, p. 312.

¶ Ray Society's Translation, *op. cit.*

** Proc. Zool. Soc., 1865, Nov. 28.

†† Monographie Illustrée du Baleinoptère, Stockholm, 1867.

modified, horny, epithelial cells of the baleen plates were developed. The vascularity of the folds and of the papillæ has also been recognised by these anatomists, but no exact description of the arrangement of the vessels has as yet been given.

The fresh condition of the baleen in the *B. rostrata* led me to think that it might be possible to inject its papillæ, and to obtain a more complete view of the arrangement of their vessels than had yet been described. I accordingly carefully detached the entire palatal mucous membrane, with its baleen wreaths, from the upper jaw; and after introducing injecting pipes into several of the palatine arteries, I succeeded with the aid of my assistant, Mr STIRLING, whose skill as a minute injector is so well known, in injecting the vessels of the baleen. But before proceeding to describe their arrangement, it will be necessary to speak of two other groups of papillæ, which appear hitherto to have been overlooked by anatomists. When the surface of the palatal mucous membrane, situated between the bases of the transverse folds, was examined with a pocket lens, it was found to be studded with short papillæ, which fitted into clefts similar to those already described (fig. 23), as extending into the intermediate substance from its deep attached surface. These papillæ we will call intermediate. Similarly, when the sides of the transverse folds were also examined with a pocket lens, they were seen to give origin to numerous minute papillæ, which passed into minute apertures in the inner wall of each of the laminæ, produced by the cleavage of the baleen plate at its base. These laminæ were continuous with the cortical layer of the plate to which they belonged, and their papillæ may be called peripheral or cortical.

In the injected preparations, the following appearances were seen in vertical sections (fig. 27). The palatal mucous membrane was highly vascular, and the principal vessels ran parallel to the horizontal plane. They gave origin to smaller vessels, which were distributed to the three groups of papillæ. Those which passed to the intermediate papillæ, occupying the spaces in the attached surface of the intermediate substance, did not enter the transverse folds or pulp blades; they were very slender, but formed distinct loops (fig. 27). The vessels for the other papillæ entered the transverse folds. Those destined for the peripheral or cortical papillæ formed a well-defined superficial network of small vessels, which gave off, at intervals, capillaries which entered these papillæ, and formed loops in the usual manner. The vessels for the elongated, filiform, tubular papillæ were considerably larger. As a rule, two entered the base of each papilla, and extended along its axis into the tube. These vessels preserved their size for a very considerable distance down the tube, and occasionally anastomosed. They were easily recognised by the naked eye, both in vertical and transverse sections of the plates and setæ; and it was in them that the blood was contained which conferred on the baleen of *B. rostrata* its characteristic pink markings.

When the papillæ were carefully extracted from the tubes, and examined with high powers of the microscope, they were seen to consist of a delicate, wavy, connective tissue, the filaments of which lay parallel to the long axis of the papilla. The nucleated corpuscles of the connective tissue were distinctly recognised after the papilla had soaked some time in glycerine. On the free surface of the papillæ a very distinct layer of flattened polygonal cells, with their borders in close contact with each other, like epithelial cells on a free surface, was met with. These cells were soft and delicate, and were evidently the youngest layer of epithelial cells lying next the papillæ, which had not yet undergone the horny transformation. In some of the papillæ I saw, more especially at their broader attached ends, elongated fibres, having a double contour, which I believe to have been medullated nerve fibres.

The baleen of the fœtus of the Longniddry whale possessed some features of interest, to which I may now refer. Only the wreath, which was met with early in the dissection of the mother, was preserved, for the opposite wreath, which had also been shed from the palatal surface, was lost in the course of the dissection. The wreath was 4 feet long, and $3\frac{1}{2}$ inches in its greatest transverse diameter. The anterior end had been broken away, and lost, but the posterior end was flattened, and terminated in an obtuse angle. Notwithstanding the loss of its most anterior portion, as many as 335 transverse rows were counted in the wreath, and they were slightly curved with the convexity forwards. Owing to the comparative thinness of the intermediate substance, the interval between any two adjacent transverse rows was not more than $\frac{1}{10}$th of an inch. Here, as in the adult, the outer or labial plate in each transverse row was by far the largest; indeed, those internal to it were little more than short bristles in the fœtus. In the greater part of the wreath seven, eight, or sometimes nine plates or bristles were counted in each transverse row. Towards the anterior end only five were counted; but posteriorly, where the external plate, like those internal to it, consisted of a mere bristle,—the number of bristles in the row had increased to about thirty, and at the same time the rows increased very materially in their obliquity. Quite at the posterior end the bristles were so feeble as scarcely to be visible.

In the fœtal wreath I recognised not only the transverse arrangement just described, but also a distinct antero-posterior or longitudinal arrangement of the baleen. The outer longitudinal row was formed by the series of large plates, whilst those internal consisted of the bristle-like baleen. The number of longitudinal rows varied, however, in different parts of the wreath, where variations occurred in the number of elements in the transverse rows.

The baleen had not the rich black colour so characteristic of the plates in the older animal. The plates were dark grey, intermingled with black. The setæ were light grey, and the intermediate substance had a similar tint. The substance bore a greater proportionate thickness to the vertical diameter of the entire plate than in the older animal. In one of the largest unequally four-sided plates, whilst the greatest vertical diameter was 2½ inches, the padding at its thickest part was 1·6 inch; but at the inner and outer border of the plate it was only 0·8 inch. The greatest transverse diameter of this plate at its attached border was 2·3 inches. The longest setæ projecting from the free lower border of the plate measured 1½ inch. The fœtal baleen plates had a distinctly fibrous appearance, and, from the thinness of the cortex, could be readily torn along the vertical diameter into numerous fine parallel horny fibres, which in each plate corresponded in number to the setæ, and consisted of the tubular systems, with their contained papillæ. The openings into the tubes were visible in the cleft between the basal laminæ of attachment of the plate. No transverse rings, such as have been described in the older animal, were seen on the surface of the fœtal baleen plates, a circumstance which adds to the probability of the view entertained by ESCHRICHT and REINHARDT, that the rings indicate a periodical change in the formation of the cortical part of the blade. When transverse sections through a plate were examined microscopically, the tubes, the tubular lamellæ, and the peripheral lamellæ were seen, but on a much smaller scale; the peripheral lamellæ especially being thinner, and not so distinct as in the older animal, so that the entire plate was consequently much thinner. The intermediate substance readily tore up in the vertical direction, and the torn surface was longitudinally streaked, to all appearance, in conformity with the development of its epidermal cells, in connection with the basal papillæ. Numerous black pigment granules were scattered through both the plates and intermediate substance.

The surface of the palatal mucous membrane, from which the fœtal baleen had been shed, presented folds or pulp-blades, which, in their general plan, though with some modifications in form, agreed with those already described on the palate of the mother. A series of transversely elongated folds corresponded to, and fitted within, the clefts at the bases of attachment of the large external plates of the transverse rows. Internal to these, owing to the baleen having so much more of a bristle than a plate-like form, the elevations of the mucous surface were not transversely elongated, but had more the shape of sub-conical papillæ (Plate VI. fig. 15). The corresponding surface of the baleen wreath, instead of presenting a series of transversely, elongated, short clefts, as in the mother, possessed polygonal pits, mostly of a regular hexagonal form (fig. 16), into which these sub-conical papillæ fitted. Towards the anterior part of the palate, the folds were so faintly marked as to be recognised with difficulty.

As the violence which had occasioned the rupture of the uterus, and the displacement of the fœtus, had in all probability, also, been the cause of the separation of the baleen wreaths from the palate, the elongated tubular papillæ had, for the most part, been torn off the folds of the palatal mucous membrane, and were included within the tubes of the baleen plates. In some localities, however, some of these papillæ still retained their proper attachments to the folds; and they presented an appearance which reminded one, though on a smaller scale, of that which has already been described and figured in the older animal.

JOHN HUNTER, in his account of the mode of growth of whalebone, pointed out very clearly that a baleen plate is formed upon a thin broad process of a vascular substance, which fits into the hollow at the base of the plate, and that the first part of the growth takes place on the inside of the hollow. He was also of opinion that the cortical layer of the baleen, and the intermediate substance arose on the surface of the vascular membrane, and were continuous with each other. He showed their relations to hair, nails, and other epithelial structures, and stated that the free surface of the intermediate substance softens like the old cuticle of the sole of the foot when steeped in water. ESCHRICHT and REINHARDT described epidermic cells as continually forming, not only on the pulp-blades, but on the smooth intervals of the palatal membrane between the blades, the cells of the latter constituting the comparatively soft intermediate substance, whilst those of the former hardened into the horn-like material of the baleen plate. The medullary or tubular portion of the plate formed on the free lower edge of the pulp-blade, and on the numerous, soft, elongated, filamentous papillæ which fringe it, whilst the cortical layer of the baleen plate formed on the free lateral surfaces, and inner and outer edges of the pulp-blade, which it ensheaths.

This description by the distinguished Scandinavian anatomists is, I believe, as far as it goes, perfectly accurate; but the observations which have just been recorded enable me to supplement it with some new and important particulars. For, in addition to the elongated, filamentous, vascular papillæ of the tubes, two other sets of vascular papillæ have been observed—a cortical and an intermediate—each of which has its appropriate epithelial investment. Hence we may now state, that each of the three great groups of epithelial cells found in the baleen wreath takes its rise from, and constitutes the epithelial investment of, a distinct set of vascular papillæ. The cells which form the tubular lamellæ, are the cornified epithelium of the filamentous tubular papillæ: those which form the peripheral or cortical lamellæ are the cornified epithelium of the cortical papillæ; whilst the softer intermediate substance consists of the epithelial cells, which invest the sides and summit of the intermediate papillæ.

Many anatomists, in discussing the characters and morphological position which whalebone occupies amongst the textures, have compared it with the teeth, and have regarded it as a special modification of the dental tissue, springing from the surface of the palate. But it seems to me, that a more exact comparison may be found in the well-marked vascular folds of mucous membrane, covered by epithelium, which lie transversely across the palate in the Ruminantia. In the giraffe, for example, these folds are very strong, and they are, moreover, fringed along the free edge with well-defined papillæ, which are also covered with an epithelium. If we were to suppose these papillæ considerably elongated, their epithelium cornified, and the whole series of papillæ, springing from any single fold, bound together by a cortical, cornified, epithelial layer, we should then have an arrangement of parts closely corresponding in structure to that of a plate of whalebone. But the Balænoidea are not the only placental mammals in which a cornified epithelium is developed in connection with papillary growths from the surface of the buccal mucous membrane. For, as is well known, in the Carnivora, the papillæ on the dorsum of the tongue are invested with a horny epithelium arranged in the form of retroverted spinules.

I am also of opinion that we must assign to the baleen a more important function than that of the mere hair sieve or filter, with which it is most usually compared. For structurally it is much more highly organised than hair. It is highly vascular, and, I believe, also nervous, and can therefore play the part of a whole series of tactile organs, by means of which the animal would be enabled to estimate the amount and character of the food which it receives into the cavity of the mouth.

As GEOFFREY ST HILAIRE* and ROBERT KNOX† had discovered rudiments of the teeth in the gum of the very young fœtus of the *Balæna mysticetus,* and as ESCHRICHT‡ had also observed them in the fœtal stage both of *Megaptera* and *Balænoptera,* I removed the gum from the edges of both the upper and lower jaws, with the view of examining if the rudiments of these organs still existed in the almost fully developed fœtus of the Longniddry Finner. I found in connection with the periosteal surface of each gum a well-defined band, which corresponded precisely with the margin of the jaw, and which received a number of arteries coming through foramina in the bones. This band, from its position, was obviously the part in which the teeth, if present, ought to have been found. A careful examination, however, both of the band and of the tissue on each side, failed to discover the smallest rudiment of a tooth. Hence it follows that in the Balænoidea not only do the teeth not pierce the gum, but all trace even of their rudiments disappear before the termination of fœtal life.

Alimentary Organs.—Owing to the wide sweep of the lower jaw, the cavity of the mouth was of great size, and the space included between the two halves of the lower jaw reminded one of a huge barge ; indeed it was no uncommon

* Annales du Museum. Vol. x. p. 364.

† Catalogue, *op. cit.* p. 22. KNOX's preparations are in the Anatomical Museum of the University of Edinburgh.

‡ Die Nordischen Wallthiere, 1848.

thing, when the animal was lying on the beach, to see a number of persons standing within the left mandible on the dorsum of the tongue as it was exposed by the falling over of the beak to the right side. The roof of the mouth was formed by the palate and baleen plates; its sides corresponded to the great antero-posterior cleft between the upper and lower jaws; its floor was formed by the dorsum of the tongue included within the two halves of the mandible. The dorsum of the tongue was almost flat near the front of the mouth, but somewhat further back it presented a considerable elevation, which arose like a hillock, and fitted within the concavity of the roof of the mouth between the opposite wreaths of the baleen. The tongue was very compressible and elastic. The mucous membrane on its surface was of a dark slate colour, and was at once reflected from the dorsum at the tip and sides of the tongue to the inner surface of the lower jaw, so that the tongue was tied to that bone, and obviously could not be protruded from the mouth. The surface of the mucous membrane was firm and tough; it was marked by ridges and furrows, which, for the most part, were placed longitudinally, though some extended in the transverse direction.

The mouth rapidly narrowed towards the posterior buccal orifice. In the adolescent animal the diameter of this orifice was 10 inches. The mucous membrane was, in this locality, brownish-yellow in colour, and spotted with patches of brown and black pigment. Numerous rounded or somewhat oblique orifices opened on its free surface. These communicated with pits, the largest of which formed depressions $\frac{3}{8}$ths of an inch deep in the mucous membrane, big enough to admit peas; these were obviously the mouths of gland follicles. The upper boundary of the orifice was formed by the soft palate, which was about an inch and a half thick, and distinct muscular fibres entered into its construction.

In the fœtus the posterior buccal orifice was much more constricted, for its diameter was only 2 inches. It was bounded above by a broad, well-defined velum, which extended backwards for $6\frac{1}{2}$ inches, and possessed a broad attachment on each side to the pharyngeal wall, sending also a posterior pillar backwards on each side as far as a line opposite the arytenoid cartilages (Plate VIII. fig. 30). The greatest breadth of the soft palate was 7 inches. Its position was almost horizontal; mucous membrane covered its upper and lower surfaces and posterior border, and from the latter no uvula projected. The absence of an uvula in the lesser Pike Whale had previously been noticed by Drs CARTE and MACALISTER.* Owing to the breadth of the attachment laterally of the velum, the passage from the mouth to the pharynx was much more in the form of a canal, which may be termed the bucco-pharyngeal canal, than a simple opening. This canal gradually

* Philosophical Transactions, 1868, p. 232.

widened in its backward passage, for whilst only the tips of the four fingers could be introduced into its buccal orifice, the fist could be readily passed through it from the pharyngeal end. The mucous membrane surrounding the buccal orifice and lining the bucco-pharyngeal canal, was spotted with pigment, and with pits, such as have been described in the same region in the older animal. The mucous membrane was also thrown into faint transverse folds, which corresponded in their direction with the fibres of the well defined palato-glossus muscle. The part of the pharynx situated immediately above the velum was greatly dilated, and measured 24 inches in circumference. It constituted the nasal subdivision of the pharyngeal chamber. The antero-posterior diameter of the pharynx from the posterior border of the soft palate to the commencement of the œsophagus was 9 inches. In its general form it was funnel shaped; for whilst the transverse diameter just behind the attachment of the velum was $7\frac{1}{2}$ inches, it rapidly narrowed behind, where it joined the œsophagus to a tube, $1\frac{3}{4}$ inch in diameter.

When the interior of the pharynx was more completely exposed by a mesial longitudinal incision, not only could the posterior buccal orifice be more clearly seen, but the relations of the superior laryngeal opening were exposed (Plate VIII. fig. 31). In front of this opening was the elongated, tongue-like flexible epiglottis, which projected forward and upward. It was invested by mucous membrane, and from its anterior surface a well-defined hyo-epiglottidean fold of mucous membrane passed forwards to the body of the hyoid. Projecting from the middle of its posterior surface was a vertical rounded elevation, which obviously corresponded to the "cushion" described by CZERMAK on the back of the human epiglottis, and which, doubtless, like that cushion, plays an important part in the closure of the laryngeal orifice during deglutition. From each side of the epiglottis a strong aryteno-epiglottidean fold of mucous membrane passed backwards to the lappet-like processes of mucous membrane which invested the horns of the arytenoid cartilages, which formed the posterior boundary of the orifice. These lappets were separated by a median cleft. No hood-like fold of mucous membrane, such as Drs CARTE and MACALISTER have described in *B. rostrata*, as affording protection to the orifice of the larynx during deglutition, existed in this animal. The superior orifice of the larynx was large enough in the fœtus to admit both fists at the same time.

The muscular wall of the pharynx was formed of the constrictors, the fibres of which passed from below upwards, to be attached to the superior mesial raphé of the pharynx. The fibres of at least two pairs of constrictor muscles, arising from the hyoid bone and thyroid cartilage, were distinctly recognised. The muscular coat of the œsophagus was comparatively thin, and presented the longitudinal and circular arrangement.

Numerous glands existed in the submucous coat of the pharynx. The position of many of these was marked, more especially on its lateral and anterior walls, by crypt-like depressions in the mucous membrane, some of which were large enough to admit a kidney bean, others not bigger than a pea (figs. 30, 31). These crypts were collected into groups, the best marked of which were situated close to the junction of the anterior border of the soft palate with the anterior wall of the pharynx.

In studying the method by which this and other whalebone whales collect their food in their huge mouths prior to deglutition, it should be kept in mind that they are not provided either with teeth, or with a protrusible tongue by which to grasp the prey. It is probable that when in search of food, the animal swims about with its mouth wide open, until a sufficient quantity of food is collected on the dorsum of the tongue, in the space between the two halves of the mandible, prior to being swallowed.

Though the depression of the lower jaw in the act of opening the mouth is doubtless due to muscular action, yet, when once open, the jaw may, I believe, remain depressed without the continued action of muscles. The huge fibrous columns, which pass, one on each side, from the base of the skull to the condyles of the lower jaw, so suspend that bone, as to support it without the need of calling into action any muscle; for it was observed, as the animal was floating at high water, that the lower jaw was open, and swayed gently to and fro with the movements of the waves. To draw the jaw back prior to deglutition, the temporal and other elevator muscles must be called into action; and, as the jaw is raised, the tongue is pressed upwards against the lower edges of the baleen, and the water contained in the cavity of the mouth is forcibly squeezed out between the rows of plates. The food retained in the mouth by the sieve-like fringes of the baleen, is then forced back through the bucco-pharyngeal canal, doubtless by the action of the tongue, into the pharynx, when the constrictors grasp it and force it back into the œsophagus. Here the soft palate acts as a valve to prevent its passage upwards to the nose, and the superior laryngeal orifice is closed by the co-aptation of the epiglottis, arytenoid cartilages, and aryteno-epiglottidean folds of mucous membrane, so that it cannot enter the larynx. In these respects, therefore, the mechanical arrangements for preventing the passage of the food into the respiratory passages, closely remind one of the structures found in the corresponding locality in the human subject. As it is also important that water should not pass from the mouth into the pharynx whilst the animal is collecting its food; and as the respiratory process is performed, not by the mouth but by the nose, the contraction of the fibres of the palato-glossal sphincter would effectually close up the bucco-pharyngeal canal at the time when these processes were going on.

The stomach was so injured in various places by the men engaged in flensing the animal, that little more was ascertained in connection with it, than that it was subdivided into at least four compartments, which communicated with each other by valvular orifices. One of these valves was secured, and reminded one on a large scale of the human pyloric valve, or of the valve I described and figured some time ago* at the end of the fifth compartment of the stomach of *Globiocephalus svineval.* The stomach was to all appearance empty.

An omentum was in connection with the stomach, which, when stretched out, was big enough, in the mother, to cover the floor of a large room. It was made up of fibres, composed of connective tissue, which crossed each other so as to form a most elegant lace-work pattern, with distinct perforations in the meshes of the net. Blood-vessels were seen in the larger bands of fibrous tissue which traversed the net. Scarcely any adipose tissue was found in it, which is the more remarkable, when we remember the enormous quantity of fat situated as a sort of inner padding for the wall of the abdominal cavity.

The intestinal canal was of great length, and by far the longer part of its extent consisted of huge coils, of which as many as fifteen were counted, though it is probable that a greater number existed. The hinder end of the gut, as it passed backward to the anus, was almost straight, and about 20 feet long. No accurate measurement of the length of the intestine could be taken, but it was estimated at about 80 feet, for the various coils, as soon as they were removed from the abdomen, were carted away to the manure heap. The circumference of the tube was not uniform throughout, varying in different localities from 20 to 30 inches. Extending along the border of the intestine at the line of reflection of the mesentery was a very remarkable looking tube with thick walls, which exhibited an alternating series of dilatations and constrictions, which gave it a beaded appearance (Plate VIII. fig. 32, *m*). This tube gave off a number of branches, which ramified in the subserous areolar coat of the gut, and formed there a complex anastomosing network. Along with this moniliform tube was a large vein (*v*), and accompanying it was a nerve (*n*), considerably larger than the human pneumo-gastric, which gave off branches to the wall of the intestine. This nerve was obviously a large offshoot of the sympathetic. The intestine possessed a distinct peritoneal coat (*p*), which rested on the subserous areolar tissue. The muscular coat was thick, and the longitudinal and circular arrangement of fibres was strongly marked. A distinct submucous coat was present. The mucous membrane was brownish-yellow, and thrown into strong valvulæ conniventes, some of which extended two-thirds, others half round the canal of the gut. The largest valvulæ projected at least one inch into the canal. Numbers of parasites were attached to the surface of the mucous membrane. I have not as yet had time properly to examine them, but they are in general appearance like the *Echinorynchus brevicollis* which MALM found in the intestine of the *Balœnoptera* which he examined.

* Journal of Anatomy and Physiology. Vol ii. p. 73.

I can say nothing more of the anatomy of the liver than that it was subdivided into two lobes. The pancreas was not recognised in the course of the dissection.

Organs of Circulation.—My observations on the arrangement of the heart and blood-vessels were made chiefly on the fœtus, but in several points were supplemented by a reference to the corresponding structures in the adolescent animal. The heart was contained in a well-formed pericardium. In the mother it was of enormous size; and in the fœtus it was considerably larger than the heart of an ox. It presented externally the usual arrangement of grooves, which marked its subdivision into four chambers, and in these grooves the coronary vessels ramified.

In the fœtus the right auricle, when opened into, showed a smooth inner surface for the most part, but the anterior wall and the interior of the appendix had well-defined fleshy columns projecting into the cavity. In the intervals between these columns the auricular wall was dilated, and formed a number of pouch-like recesses. The superior cava, large enough to admit five extended digits, opened into the anterior and external part of the cavity, and had no valve at the orifice. The inferior cava, large enough to admit the fist, opened into the posterior and external part of the auricle. No trace of an Eustachian valve was seen at its mouth. The mouth of the coronary sinus readily admitted the tips of three fingers, and opened between the inferior cava and the auriculo-ventricular orifice, and was also without a valve.

In the interauricular septum an almost circular foramen readily admitting five extended digits was situated. Surrounding this opening, and attached to its edge, a loose, membranous, annular fold, formed by a duplication of the endocardium was seen. When put on the stretch it projected into the auricle, and the projecting border was free and pierced with large fenestræ. Although this fold was situated in the right auricle, when I opened into that cavity, yet it could without difficulty be passed through the foramen into the left auricle. At the attached border, again, the membrane was almost entire, and most perfect in its anterior, external, and posterior portions, where the depth from the attached to the free borders was 4 inches. This membranous fold was situated at some distance from the mouth of the inferior cava, so that it could not be regarded as the Eustachian valve in the sense in which it is customary to use that term. From its position it would, however, seem to have served some purpose in connection with the flow of blood from one auricle to the other during fœtal life; but it is possible that, by growth both in thickness and surface, it might, after the birth of the creature, have closed up the orifice and completed the auricular septum. I think it probable that the structure described by Dr Knox (*Catalogue*, p. 24), in the heart of a fœtal *mysticetus*, as "a membranous sac, the size of a full-sized thimble, presenting at the bottom a delicate reticulated net-work, and projecting into the left auricle," was similar to the annular fold observed in this fœtal *Balænoptera*.

A well-defined tricuspid valve was placed at the right auriculo ventricular orifice. The cusps had the same relative position as in the human heart, and the arrangement of the carneæ columnæ, musculi papillares, and chordæ tendineæ was closely similar. In the older whale one of the cusps measured 10 inches in width at its base, and the depth from base to apex was 8½ inches. Some of the chordæ tendineæ were 12 inches long, and the girth of one of the largest of these, where it arose from a papillary muscle, was 2½ inches. As it subdivided before it joined the cusp, the size of its branches was very materially smaller.

The pulmonary artery arose from a distinct conus arteriosus. It ran forwards and to the left, and divided into two branches for the right and left lungs. Its left branch gave origin in the fœtus to a widely patent ductus arteriosus, which joined the arch of the aorta immediately behind a spot opposite the origin of the left subclavian artery (Plate VII., *x*).

In the mother a strong, fibrous, rounded cord, 5 inches long, passed between the pulmonary artery and aorta in the place of the ductus arteriosus. Its circumference at its aortic attachment was about 6 inches, and it was somewhat thicker at its opposite extremity. When transversely divided it was seen to be distinctly laminated, and extending along its axis was a canal readily admitting a large sized catheter. This canal widened out into a funnel-shaped passage at its two extremities, where it opened into the aorta and pulmonary arteries. Hence, even in the adolescent animal the arterial duct was patent, though, from the small size of the canal, any intermixture of blood which might have occurred would be so small as not to affect the characters of the enormous volume of that fluid contained in the arterial system. It is interesting also to note that KNOX found a pervious ductus arteriosus in the great Rorqual which he examined, and Dr MURIE observed it in an adult *Balænoptera musculus.** The trunk of the pulmonary artery in the mother was 3 feet 7 inches in internal circumference, and its coat, which was distinctly laminated, varied in thickness from 1¼ inch to ¾ths of an inch. The internal circumference of one of the primary branches was 1 foot 5 inches, the thickness of its coat ⅛th of an inch. The internal circumference of one of the pulmonary veins was 19 inches.

The left auricle, in the mother, had much thicker walls and a redder colour than the right; but in both, the appendages were large, and the fleshy columns within them, and on the adjacent part of the auricular wall, were enormously developed, one of the largest measuring 5 inches by 3, another 6 inches by 2, and so on. The pouch-like dilatations, already referred to in the description of the fœtal auricle, between these columns readily admitted one or both fists. From the mode in which the columns intersected each other, they and the pouches gave to this part of the auricle quite a cavernous character. The

* Proc. Zool. Soc., Feb. 14, 1865.

muscular wall at the bottom of some of the pouches was often so thin as to be translucent when held up to the light. Many of these pouches were situated parallel and close to the auriculo-ventricular groove.

The left ventricle had thicker walls than the right, and, in connection with its walls and auricular opening, carneæ columnæ, musculi papillares, chordæ tendineæ, and a bicuspid valve were seen.

The arch of the aorta in the mother rivalled in its calibre one of the main pipes for the supply of water to a district of a large city. The internal circumference of its ascending part was 3 feet 2 inches, whilst its coat varied in thickness from $1\frac{1}{4}$ to $1\frac{1}{2}$ inch. The coat was distinctly laminated, of a yellow colour, and very elastic. A well-defined inner membrane lined it and the other parts of the arterial and venous systems. The external circumference of the aorta in the fœtus was 10 inches. It then dilated prior to giving origin to the great branches of the arch, and immediately beyond these vessels it diminished materially in size as it became the posterior thoracic aorta. The external circumference of the innominate artery in the mother was 1 foot 9 inches.

The aorta arched to the left over the root of the lung (Plate VII. fig. 28). A pair of coronary arteries (*a*) arose from the commencement of its ascending part, one passing on each side of the root of the pulmonary artery. Each coronary immediately subdivided into three branches, the largest of which turned round its own margin of the heart in the auriculo-ventricular groove, and supplied the corresponding auricle and ventricle. The second branch of the right coronary entered the wall of the right auricle ; the third turned round the root of the pulmonary artery. The second branch of the left coronary artery descended in the anterior inter-ventricular groove ; the third passed to the substance of the left ventricle. In the mother each coronary artery was as large as the posterior aorta of an ox.

From the anterior surface of the transverse part of the arch three large branches arose, the brachio-cephalic, left carotid, and left subclavian (*b*, *c*, *d*). The right branch, by far the largest, was the arteria innominata or brachio-cephalic (*a*). Five inches (in the fœtus) from its origin it bifurcated into a right common carotid (*e*) and right subclavian (*f*). The right subclavian gave off, one inch from its origin, a large branch, the right posterior thoracic (*g*), which was traced into the great thoracic rete mirabile. One inch and a-half further on the subclavian bifurcated into the axillary (*h*) and internal mammary (*i*) arteries, the latter of which was somewhat the larger of the two, and supplied the inferior wall of the chest. The axillary passed in front of the first rib, immediately above the scalenus anticus muscle ; but before doing so it gave off a considerable branch which ran forwards along the side of the neck. The axillary was traced into the flipper, and, in the dissection of the fore-arm, branches of this artery were found lying, along with distinct nerves, in connection with the flexor and extensor muscles of the digits.

The right common carotid (*e*) ran forwards for 6 inches and then bifurcated. The branches should, I think, be regarded as the cervico-facial (*k*) and internal carotid (*l*) arteries. The cervico-facial, much the larger, passed to the deeper parts of the head, but gave off also a large branch to the face. The internal carotid was torn across; but branches arose from it which passed to a rete mirabile in the neck. The state of the parts prevented me from tracing out to their termination the branches of the right common carotid artery.

The second branch of the transverse part of the arch was apparently a left common carotid artery (*c*). It gave off a small branch to the side of the neck, and then bifurcated 7 inches from its origin. The larger branch of bifurcation was the cervico-facial (*m*), which divided into many branches for the head and face. The smaller branch was apparently the internal carotid (*n*).

The third branch of the transverse part of the arch was the left subclavian artery (*d*). It gave off a large branch, the left posterior thoracic (*o*), to the great thoracic rete, and then divided into the left axillary (*p*) and internal mammary (*q*) arteries. The rete mirabile was not confined to the thoracic cavity, but extended upwards into the neck, and prolongations were traced through the intervertebral foramina into the spinal canal. The large foramina at the roots of the transverse processes of the cervical vertebræ were also occupied by considerable masses of this highly vascular network.

The posterior thoracic aorta ran backwards, and gave off the series of intercostal arteries. It then entered the abdomen and supplied the various viscera; but the distribution of its branches, owing to the injured state of the viscera, could not be followed out. It was noticed that in the fœtus the hepatic artery was as large as the human common iliac. The abdominal aorta was prolonged backwards as the great caudal artery, which was protected by the series of arches formed by the chevron bones. From the caudal artery, opposite the body of each vertebra in the fœtus, two branches, which entered the middle of its ventral surface, were traced into the ossifying centrum of each vertebra.

It may not be out of place to refer to what has been stated as to the arrangement of the great arteries, which arise from the transverse part of the arch in some of the other Cetacea, where the vessels have been carefully dissected. KNOX,* ESCHRICHT,† and CARTE and MACALISTER‡ have all pointed out that in the *Balænoptera rostrata*, three great arteries, the brachio-cephalic, left carotid, and left subclavian arise from the transverse part of the arch. KNOX also states that, in his great Rorqual, the arrangement of the vessels arising from the arch

* Catalogue, p. 18.

† Die Nordischen Wallthiere, p. 104.

‡ Philosophical Transactions, 1867, p. 245.

followed closely that of man; and he refers to brachio-cephalic, left carotid, and left subclavian arteries; and MALM observed a similar disposition in his *Balænoptera.* It seems, therefore, that these great arteries have a similar mode of origin in different species of Finners. In *Delphinus* and *Globiocephalus,* however, the great arteries arise in the form of two brachio-cephalic arteries, and the left posterior thoracic arises usually quite independently; but as I have on former occasions * described these arrangements, I need not in this place enter into any further details.

It will be necessary now to give an account of the very remarkable moniliform tube, which I have referred to in the description of the intestine of the adolescent animal. It was found along the entire length of the mesenteric attachment of the gut, and extended back along the rectum. It exhibited an alternating series of dilatations and constrictions, which varied in their dimensions in different parts (Plate VIII. figs. 32, 33). The dilatations were sometimes globular, at others ovoid in form, and in some cases were flattened on their surfaces. The largest measured as much as 1 foot 6 inches in transverse external circumference, whilst the smallest were only 8 or 9 inches. When the dilatations were ovoid the elongation was mostly in the direction of the long axis of the tube, in which direction the circumference of the dilatation was therefore somewhat greater. The constrictions also varied in size, the smallest being about 4 inches in external circumference, the largest 1 or 2 inches more. The tube possessed very strong and dense walls, which varied in thickness in different parts. In the larger dilatations the thickness was as much as $1\frac{1}{4}$ inch, but in the smaller not more than $\frac{1}{4}$ inch. The walls were white, tough, and very resisting. Examined microscopically, the tissue which composed them was seen to be chiefly the white fibrous, but mingled with it were elastic fibres. The inner surface of the wall presented a corrugated appearance, owing to the presence of a number of permanent, circular folds, wrinkles or ridges, which passed quite around the inner surface of the tube (fig. 33). In many places these folds were situated close together; but elsewhere they were separated by intervals in which the inner wall of the tube was comparatively smooth. These ridges were in part formed of a folding of the lining membrane of the tube, and in part of the fibrous tissue of the wall. Some of the largest of these folds projected as much as 1 inch, or even more, into the lumen of the tube, and as this projection was carried all round the inner wall, the lumen was necessarily much constricted in these localities, and in the smaller divisions the bore was sometimes reduced to a hole in the middle of the fold less than 1 inch in diameter, whilst on each side of it the tube might perhaps dilate into a space 2, 3, or more inches in its diameter. Hence the dilated and constricted

* British and Foreign Medico-Chirurgical Review, October 1862, p. 479, and Journal of Anatomy and Physiology. Vol. ii. p. 66.

character of the tube visible externally was an index of important internal arrangements. Numerous branches, into which an injection was readily thrown, arose from the moniliform tube, and passed directly into the subserous coat of the gut. They were about the size, at their origin, of the human brachial artery, and ran straight and parallel to each other for some distance, giving off but few branches; then they altered their direction, and formed, by anastomosing, a series of arches from which numerous branches arose, which ran towards the free margin of the intestine, again to anastomose, and give rise to still smaller branches, which penetrated the muscular and mucous coats of the gut.

In connection with the exterior of some of the dilatations of the moniliform tube a peculiar structure was dissected. It consisted of a number of closely crowded lacunæ, varying in size from a pea to a walnut (Plate VIII. fig. 34), separated more or less perfectly from each other by septa formed of a delicate smooth membrane, similar to that which also lined the interior of the lacunæ. The arrangement to some extent corresponded with that of a multilocular cyst, the loculi of which communicated with each other. In one spot a distinct tube, the size of the stem of a common tobacco pipe, was seen to open into a group of these lacunæ. In some places, more or less elongated, and sometimes ovoid, bodies of a dark brown colour, were situated immediately beneath the delicate semi-transparent lining membrane. These bodies had the appearance of lymphatic glands, and this view of their structure was confirmed by a microscopic examination, for, notwithstanding that the specimen had been for sometime in spirits of wine, distinct, pale, circular, lymphoid corpuscles were seen to enter in large numbers into the structure of these bodies. I did not succeed in tracing out any connection between this lacunary system and the wall of the intestine, though it is possible that the small tube, just referred to, may have proceeded from or to the wall of the gut.

It was unfortunate that in the portions of intestine, with the moniliform tube attached, which were sent over to the Anatomical Museum for examination, none of the expanded part of the mesentery had been preserved. I was consequently unable to trace the branches which proceeded from the proximal surface of this tube to their origin. I have little doubt, however, but that they were derived from the mesenteric artery.

In the fœtus the intestine was, as a rule, so softened by putrefaction that it could not be preserved. One or two coils were, however, somewhat more perfect, and after being hardened in strong spirits of wine, I was enabled to effect a partial examination.

The mesenteric artery did not possess that complete series of arterial arcades, which we are familiar with in man. It branched comparatively seldom, and its branches ran towards the border of the intestine. Those which arose nearest the gut did not enter directly the intestinal wall, but passed to an elongated structure, which lay parallel to and next its mesenteric border. This structure occupied the position of the moniliform tube in the parent whale, but did not possess its beaded appearance. Indications, in places, of a tube traversing its long axis were seen; but in the greater part of its extent it was apparently subdivided into a large number of minute spaces, so that the surface of section had quite a cavernous aspect. From this structure numerous fine branches arose, which passed into the subserous coat of the intestine, to be distributed there like the branches of the moniliform tube in the parent animal. It would seem, therefore, that in the fœtus the moniliform tube is not developed in the same precise manner as in the adolescent whale, but that a series of inter-communicating spaces occupy the position in which it subsequently appears. The formation of the moniliform tube, out of this lacunary system, would be occasioned by a great increase in size of those lacunæ which lie in the same longitudinal series, and by the great hypertrophy of their originally delicate walls. It is probable that the lacunæ described on the surface of some parts of the dilated tube in the parent (fig. 34), represented in it the original condition of the mesenteric lacunary system of the fœtus.

In the Cetacea, important arrangements, in connection with the vascular system, exist in various parts of the body for the purpose of modifying and equalising the force of the blood current. The great cervico-thoracic rete mirabile, with its numerous offshoots into the spinal canal and cranial cavity, is the arrangement which has been most carefully studied by different anatomists. But in considering the function of this network, it is not sufficient to regard it as merely a reservoir, or huge sponge, which contributes, by its complex ramifications, to produce an enormously extended area for the reception of the blood, when the whale dives to a great depth from the surface of the ocean. It serves, I believe, the purpose, by minutely subdividing the arterial stream, of distributing and equalising the force of the blood current before it reaches those delicate organs the brain and spinal cord. It may be regarded, therefore, as the teleological equivalent of the arteries in the human pia mater, of the circle of Willis, of the tortuosities in the vertebral and internal carotid arteries, and of the rete mirabile in connection with the intra-cranial arteries in ruminants and in the pig.

With what, then, are we to associate the large moniliform tube in the mesentery of this whale? From its beaded character it might at the first glance be supposed to belong to the lymphatic system; but the careful consideration of the distribution of its branches, and of its relations to the mesenteric arteries, have led me to the conclusion that it is a remarkable modification of the mesenteric arterial system, which serves the same office, for the intestine, that the rete mirabile does for the brain and spinal cord.

The great size of the aorta and of the trunk of the mesenteric artery, the paucity of the system of arterial arcades, the proximity of the intestine to the aorta, the pressure, from the elastic recoil of the arterial wall, of the enormous column of blood in the aorta, would seem to render some mechanical arrangements necessary, by means of which that pressure may be distributed and regulated before the blood enters the slender arteries within the wall of the intestine.

The structure of the moniliform tube admirably adapts it for this purpose. The blood flows through it on its way to the intestinal arteries, and is diffused into the numerous dilatations or bays which bulge out from its sides. The transverse inflexible folds on its inner wall diminish at intervals the lumen of the tube, and where they project so far as to leave but a narrow aperture in the axis of the tube, they act as strictures in retarding the flow of the current. At the same time their circular arrangement enables them to act as internal girders, and to strengthen the walls so as to prevent over distension of the tube.*

I have already referred to the analogy between the rete mirabile in the cetacea, and the network in connection with the intra-cranial arteries in the pig. I may now allude to a modification which the pig exhibits in the arrangement of its mesenteric arterial system. The arteries subdivide in the middle of the mesentery, and form there a compact network—a rete mirabile—from which numerous small arteries radiate outwards to the intestine.† These radiating vessels closely correspond in appearance to those which I have described as arising from the moniliform tube in the Longniddry whale. The Cetacea, therefore, present affinities to the Pachydermata, not only in the diffused character of the placenta, but in the possession of closely allied modifications of the cerebral and intestinal arterial systems.

The presence of a moniliform tube, in connection with the intestine, does not seem to have been previously recognised in the Cetacea by anatomists.

The superior vena cava was formed by the junction of the two innominate veins, on the right of the ascending aorta. Each innominate vein began at the root of the neck in the form of a dilated sinus, into which the veins from the neck, flipper and inner wall of the chest opened. The inferior cava received a number of hepatic veins before it pierced the diaphragm. The umbilical vein was 27 inches long in the fœtus in its course from the umbilicus to the liver.

The portal vein in the fœtus had a diameter of 3 inches before it entered

* My colleague, the Professor of Engineering, Professor FLEEMING JENKIN, to whom I pointed out the structure of this tube, concurs in the opinion of its function expressed in the text.

† The mesenteric rete in the pig has long been known to anatomists—see BARCLAY on the Arteries, Edinburgh, 1812; T. J. AITKI in Reports of Edinburgh Meeting of British Association, 1834, p. 681; OWEN, Comparative Anatomy of Vertebrates, vol. iii.; GURLT, Anatomie der Haussaugethiere, Berlin, 1860. The complexity of the rete in the pig is due to the plexiform arrangement of both the mesenteric vein and artery.

the liver. In the coil of intestine from the adolescent animal, from which fig. 32 was taken, a vein larger than the human inferior cava, ran close and parallel to the great moniliform artery of the intestine, and received numerous veins, the rootlets of which took their origin within the coats of the gut. In the fœtus a vein lay along with the artery in the expanded part of the mesentery.

At the upper part of the cavity of the thorax in the fœtus, close to the apex of the pericardium, a well-defined, though small, thymus gland was found. It was subdivided into two lobes, each of which was brown in colonr, thin, and flattened in form, and 5 inches in length by $4\frac{3}{4}$ inches in its greatest breadth. The lobes were subdivided into distinct lobules by intermediate connective tissue, and they received numerous blood-vessels. In proportion to the size of the animal the gland was obviously smaller than might have been anticipated. The thyroid gland, supra-renal capsules and spleen were not recognised during the dissection.

Organs of Respiration.—When the cavity of the thorax was opened into, by the removal of the inferior wall, the lungs were exposed. In the fœtus each lung was an elongated, flattened organ 2 feet 8 inches in length. It was invested by a distinct and smooth pleura, and was not subdivided into lobes by fissures. A similar absence of fissures and lobes I have also seen in the lung of *B. rostrata.* The pulmonary artery, veins, and bronchus entered its substance through the hilum on its mediastinal surface. When the lung was removed and washed with a jet of water, the softened pulmonary substance broke down, and was washed away, and the arrangement of the intra-pulmonic part of the bronchus could be seen. This tube, as a rule, branched in a dichotomous manner, though collateral offsets sometimes proceeded from it. It was accompanied by the pulmonary and bronchial arteries, and by bronchial nerves of some size.

The cartilaginous framework was much more perfect than in the human bronchus. The tube was hooped with cartilaginous, spirally arranged, ring-like plates; in the larger tubes usually not more than once and a-half, but in the smaller tubes a greater number of times (fig. 35). Sometimes in these latter the cartilage formed perfect rings, and both in them and in the larger tubes the cartilaginous plates not unfrequently bifurcated. The branching of the plates was always well-seen at the angle of the bifurcation of the tubes. The plates were invested by a well-defined perichondrium. The hoop-like and spiral coils of these cartilaginous plates have an important office in connection with the respiratory process in this animal. They not only aid in keeping the tubes open, but, by their elasticity, aid in the recoil of the lung during the great expiratory effort which the whale makes in the act of blowing. The diameter of the right bronchus in the fœtus was 2 inches, that of the left $2\frac{1}{2}$ inches; in the mother one of the bronchi was 7 inches in diameter.

Three inches in the fœtus, above the place of bifurcation of the trachea, that tube gave off a supplementary bronchus, $1\frac{1}{2}$ inch in diameter, to the right lung, which seems to be, as SANDIFORT and ESCHRICHT have pointed out, the usual arrangement in the cetacea, the Greenland right whale being excepted.* The trachea had three, somewhat irregularly formed, cartilaginous hoops immediately above the bifurcation; but from the highest of these up to the arytenoid cartilages, a distance of $6\frac{1}{2}$ inches, which corresponded to two somewhat subdivided tracheal rings, and to the interval between the separated inferior borders and plate-like processes of the cricoid, the cartilage was deficient inferiorly, and the ventral wall of the wind-pipe was formed of fibrous membrane. The mucous membrane of the trachea, more especially on the anterior wall, was marked by numerous fine reticulated folds, the chief of which ran parallel to the long axis of the tube. The diameter of the trachea was about 5 inches.

The cartilaginous framework of the larynx consisted of a thyroid, a cricoid, a pair of arytenoid cartilages, and an epiglottis. The form, arrangement, and connections of these cartilages were examined in the fœtus (Plate VIII., figs. 36, 37, 38).

The thyroid cartilage consisted of a median and two lateral portions. It was a comparatively thin plate, and possessed two surfaces, a superior and inferior, which were flattened, and two margins, an anterior and a posterior. The median part, tongue-like in form, was bifid at its hinder border, and projected for some distance backward; a deep notch marked its superior border; from this notch, to the end of the forks of the tongue-like part, the diameter was $4\frac{1}{2}$ inches. The lateral portion curved outwards, and was then prolonged backwards, as the elongated and somewhat rounded posterior cornu to be articulated by a moveable joint with the outer surface of the cricoid. The anterior cornu was continuous with the anterior border of the cartilage; it was short and rudimentary. The cartilage was connected to the body and great cornua of the hyoid bone by a strong membrane, and a pair of thyro-hyoid muscles passed between them.

The cricoid cartilage was an incomplete ring; superiorly, it formed a thick mass of cartilage 7 inches in its antero-posterior diameter. Its surfaces were curved, and it turned round the sides of the wind-pipe towards its ventral aspect, and ended in the greater part of its extent in a free rounded border. From the hinder part of this inferior border, however, five plates, similar in form to the cartilaginous hoops of the trachea, arose and turned round the side of the larynx to the ventral surface; but the plates from opposite sides did not meet in the mesial line. An interval, varying in its transverse diameter

* Die Nordischen Wallthiere, p. 148, Ray Society's translation of Memoir on Greenland Whale, p. 103.

from 3 to 4 inches, separated the opposite inferior margins from each other. It was filled up by a strong fibrous membrane, which was continuous laterally with the perichondrial investment of the cricoid and its plate-like offshoots, anteriorly with the perichondrium investing the posterior horns of the two arytenoid cartilages, and posteriorly with the membrane which filled up the interval between the ventral borders of the first two cartilages of the trachea. This membrane, which may be called the inferior crico-tracheal membrane, was of great importance as completing the wall of the windpipe on its ventral aspect. The posterior margin of the cricoid was comparatively narrow; the anterior margin possessed at each lateral angle a broad surface for articulation with the body of the arytenoid cartilage, distinct capsular and synovial membranes connected the two cartilages.

Each arytenoid cartilage, irregular in form, consisted of a body and two cornua. The body formed a thick plate of cartilage. The anterior cornu curved upwards and forwards into the lappet-like fold of mucous membrane behind the superior laryngeal opening. The posterior cornu curved backwards and inwards within the area enclosed by the sides of the cricoid; it almost reached the mesial plane, where a transverse fibrous ligament connected it by the tip to its fellow. The two posterior horns formed an imperfect hoop, invested by the mucous membrane of the larynx, which was prolonged directly backwards and downwards to form the mucous lining of the laryngeal sac. The free rounded border of the cricoid was connected to the posterior cornu of the arytenoid by the inferior crico-tracheal membrane. A crico-thyroid muscle existed also on each side, and muscular fibres were seen to occupy the position of the crico-arytenoidei postici and arytenoideus.

The epiglottis contained a bar of yellow fibro-cartilage, which passed backwards along the axis of the entire structure, to be attached to the superior surface of the middle portion of the thyroid cartilage. In the older animal, from which it had been removed without much injury,* the entire organ measured 25 inches in length, whilst its breadth at the base was about 10 inches; it was thick and massive, and rounded in form at its free end. The fibro-cartilage was covered by mucous membrane, which was prolonged backward as the aryteno-epiglottidean folds, and forward as the hyo-epiglottidean fold. When this membrane was removed from the hinder surface of the epiglottis and its arytenoid connecting folds, a strong aryteno-epiglottideus muscle was exposed, which curved upwards and inwards, decussating with its fellow in the substance of the epiglottis, and obviously was arranged to act as a

* The other laryngeal cartilages were so much injured during their removal from the adolescent whale, that I was unable to examine them satisfactorily. I may, however, refer to their great size and thickness, more especially of the cricoid and body of the arytenoid. The cartilage was traversed in various directions by very distinct vascular canals.

powerful sphincter for closing the glottis during deglutition. A deeper set of fibres of the same muscle was exposed by the removal of the thyro-hyoid membrane.

There were no true vocal cords passing from the thyroid to the arytenoid cartilages, or laryngeal ventricles, but a slight fold of the mucous membrane, extended obliquely in the antero-posterior direction within the aperture of the glottis, on each side, a short distance below the free edge of the aryteno-epiglottidean folds. These might, perhaps, be regarded as rudimentary false vocal cords.

One of the most interesting structures connected with the larynx was the great laryngeal pouch or cul-de-sac. It was 10 inches in length in the fœtus, and extended backward from the thyroid cartilage, in close relation to the ventral surface of the inferior crico-tracheal membrane, to within 2 inches from the bifurcation of the trachea. Its outer wall was formed by a powerful muscle, which arose from the superior surface of the median tongue and adjacent lateral plate of the thyroid, from the inferior free border of the cricoid, and from the body of the arytenoid. The fibres were arranged in transverse rings around the walls of the pouch, and they formed a thick mass at its posterior end. The pouch was lined by a mucous membrane, which was continuous with the general mucous lining of the larynx, by extending upwards on the inner surface of the bodies of the arytenoid cartilages, and by passing round the free border of the hoop formed by their posterior horns. The mouths of numerous large crypts opened on the surface of this membrane.

Owing to the peculiar arrangement of the arytenoid cartilages and the presence of this pouch, the laryngeal chamber might be regarded as subdivided into three compartments. The supero-anterior which formed the glottis proper, was bounded by the epiglottis, the aryteno-epiglottidean folds, and the anterior horns and bodies of the arytenoid cartilages with their investing and intermediate mucous membrane. The posterior was bounded above and to the sides by the cricoid cartilage, in front by the two posterior horns of the arytenoids, which ran obliquely from above backwards and downwards; through the fissure between these horns it communicated with the glottis, whilst behind it was continuous with the canal of the trachea. The inferior was the laryngeal pouch above described, which communicated directly and freely with the glottis at the base of the epiglottis, but with the posterior chamber through the fissure between the arytenoid horns. This pouch is often regarded as occasioned by a deficiency in the ventral part of the ring of the cricoid cartilage. But from the description of the arrangement of these parts, and from the figure 37, it will be seen that although this plate of cartilage is defective, yet that the ring is completed ventrally by the strong inferior crico-tracheal fibrous membrane, beneath which the pouch is situated. The laryngeal sac is rather to be regarded as a diverticular prolongation of the mucous membrane between the thyroid and cricoid cartilages, accompanied by an imperfect development of the crico-thyroid membrane.

The air entering the lungs during inspiration would have to pass from the glottis into the trachea through the fissure between the posterior horns of the arytenoids; but the air, entering the laryngeal pouch, would pass into it below these two horns. The close approximation of these cornua would aid in the closure of the glottis, and in the retention of the air in the lungs when the whale has dived to a depth from the surface.

The presence of a laryngeal pouch or sac in the *B. rostrata*, which he dissected, had not escaped the acute observation of JOHN HUNTER. In his account of that animal he says,* "The arytenoid cartilage on each side sends down a process, which passes on the inside of the cricoid, being attached to a bag which is formed below (behind) the thyroid, and before (below) the cricoid; these processes cross the cavity of the larynx obliquely, making the passage at the upper part a groove between them." SANDIFORT † then pointed out and described its arrangements in two fœtuses of *Balæna mysticetus*. KNOX observed it ‡ not only in *B. rostrata*, and *B. mysticetus*, but in his great northern Rorqual, and he specially directed attention to the mode in which it was supported by the posterior horns of the arytenoid cartilages. ESCHRICHT has also recognised this sac not only in the fœtus of *B. rostrata*, but in that of the *Megaptera longimana*;§ and REINHARDT and he have anew carefully described it in the Greenland Right Whale. A description, with several figures, of the sac in *B. rostrata* has recently been published by Messrs CARTE and MACALISTER.‖

Of these authors the last named alone discuss the probable use of this very remarkable pouch. They consider, that by the contraction of its muscular walls, it may expel the contained air so as to augment the power of, and to sustain the expiratory current. They suggest that it might aid in the production or modulation of sound, if the whales possessed such a faculty, but think that the size of its aperture, and the absence of all constricting bands, or apparatus, militate against that view of its use.

The powerful muscular wall of the sac is unquestionably for the purpose of permitting the contraction of the wall on the contents, and as the pouch communicates above directly with the glottis, a rapid contraction of the investing muscle would aid the expiratory act. But there is another purpose to which this sac may be applied. It may serve the office of a reservoir in which a

* Structure and Economy of Whales.

† Nieuwe Verhand. van Wetensch. te Amsterdam, 1831.

‡ Catalogue, pp. 11, 17, 23.

§ Die Nordischen Wallthiere, p. 103, e. s.

‖ Op. cit., p. 236, e. s.

quantity of oxygenated air may be stored up to be made use of when the animal remains for some time below the surface, by permitting an interchange, by diffusion, to take place between the pure air in it and the carbonised air within the lungs.

It has been customary to consider, that because the *Balænoidea* have no vocal cords, therefore they have no voice, and cannot produce sound.* But although they do not possess a pair of elastic bands, extending horizontally across the larynx between the arytenoid and thyroid cartilages, such as we see in the mammalia generally, yet in the posterior horns of their arytenoid cartilages, united by the transverse ligament, they possess a pair of structures which can be approximated or divaricated, and by the vibration of which, as the air passes between them, into or out of the lungs, sounds may very probably be elicited.† Their vibration would, without doubt, be assisted by their close relation to the air-filled laryngeal pouch.

The nares consisted of two vertical passages, separated by a cartilaginous septum, which opened superiorly on the dorsum of the head by the external apertures or blow-holes, whilst by their deeper orifices they communicated with the nasal part of the pharynx. When looked at from below (fig. 39), the mucous membrane was seen to be pitted with the mouths of numerous gland follicles, and to cover the surface of an oval fibro-cartilage which formed a considerable convexity in the outer and anterior wall of the passage, and in contact with the outer surface of which was a muscle. When the external orifice was widely opened, a fold, occasioned by the position of a large postero-external cartilage, fitted into a corresponding depression on the antero-external wall (fig. 40). A muscle, apparently a dilator, lay beneath the skin to the outer side of the aperture, and was attached to the cartilage at its postero-external angle. It is clear that the nostrils can be readily and widely opened, and also forcibly and completely closed, during the respiratory movements, so as to retain the air within the windpipe and lungs when the animal dives below the surface of the water.

Genito-urinary Organs.—In fig. 9, the form and relation of the penis in the fœtus are represented. As all that portion of the organ in front of the crescentic folds was invested by integument, the penis in this animal seemed in its flaccid state, not to be altogether retracted within a sheath, but to be in part

* Dr MARTYN, in a paper published in the Proc. Roy. Soc., London, 1857, ascribed the supposed absence of the voice in the cetacea to the absence of a thyroid gland; but as I pointed out in a memoir published, in 1860, in the Transactions of this Society, a thyroid gland exists both in Phocæna and Delphinus.

† Whilst this memoir is passing through the press, Dr MURIE has published in the "Journal of Anatomy and Physiology," November 1870, an interesting paper on *Grampus rissoanus*, in which he points out that a laryngeal sac of moderate capacity exists in the toothed whales in the angle of junction between the enlarged epiglottis and the thyroid cartilage. He also describes a pair of folds within the larynx of RISSO's grampus, which he regards as representatives of the vocal cords.

pendulous from the ventral wall. The organ consisted of a distinct corpus spongiosum urethræ, and of a strong corpus cavernosum. These bodies extended backwards for eight inches behind the crescentic folds above referred to. The corpus cavernosum then subdivided at a very obtuse angle to form the crura penis, which were firmly connected to the perichondrial investment of the larger and more rounded end of the rudimentary and still cartilaginous ossa innominata, which represented, therefore, the ischial elements of the pelvis.*

A strong muscle, which must be regarded as the erector penis, arose from the ischium, close to the attachment of the crus, and passed forward to be inserted into the corpus cavernosum. Large vessels and nerves were also seen passing to the different subdivisions of the penis. From the posterior border of each diverging crus, and from the sides of a tendinous raphé, which extended backwards from the end of the corpus spongiosum, a broad and strong muscle arose, which passed backwards along the side and under surface of the hinder end of the rectum, and ended close to the anus. This muscle was apparently the retractor penis. The corpus spongiosum had unfortunately been torn across, where the crura diverged, and the rest of the urethra, the bladder, testicles, &c., were not distinguishable, owing to the soft and injured state of the parts.

The arrangement of the parts at the entrance to the female passage has been described on p. 201. The vagina was traced forwards for six feet from the external orifice. Numerous irregularly arranged, and much subdivided, folds of the mucous membrane projected from its surface into the canal. The uterus was not recognised with any certainty, but a bag-like membranous organ, a part of which was seen to project through a long cut in the wall of the abdomen, on the day on which the baleen wreath of the fœtus was found loose in the abdominal cavity, was supposed to be a portion of that organ.

The kidneys possessed the lobular construction so characteristic of the form of those organs in the cetacea.

I shall reserve for another communication the description of the skeleton and joints, and such observations on the arrangement of the muscles as I was able to record. I may, however, state that the vertebral formula, both in the fœtus and in the mother, was—Cervical, 7; Dorsal, 15; Lumbo-caudal, 41; in all, 63. The outline of the cranial beak was in conformity with that of the head, which is so well represented in fig. 10 from the fœtus.

The following are a few measurements of the skull, taken with a tape-line, which may be of service in comparing it with the crania of other described whales:—

* I have described and figured the innominate bones and the sternum in the "Journal of Anatomy and Physiology," May 1870.

	Feet.	Inches.
From anterior border of foramen magnum over vertex to tip of beak,	20	3
From nasal process of superior maxilla to tip of beak,	16	6
From anterior border of foramen magnum to nasal process of superior maxilla,	3	9
Breadth across upper ends of nasal processes,	1	8
Breadth of a single nasal process.	0	6
Breadth of dorsum of beak—		
3 feet in front of nasal end of superior maxillaries,	7	0
4 " " "	6	10
5 " " "	6	8
6 " " "	6	6½
7 " " "	6	4½
8 " " "	6	1½
9 " " "	5	9
10 " " "	5	4
11 " " "	4	10
12 " " "	4	5
13 " " "	3	8
14 " " "	2	11½
15 " " "	2	1
Breadth at the tip of the beak,	0	7
Breadth between the orbits,	9	3
Length of lower jaw along the convexity,	21	2
" " in a straight line,	19	5
Depth of ramus at coronoid process,	2	6
Length of humerus,	2	2
" radius,	3	9

Comparison with other Finners.—In instituting a comparison between the Longniddry whale and the other Fin whales which have been described by different authors, with the view of determining the species to which it should be referred, there is no need to compare it with either the *Balænoptera rostrata,* or the *Balænoptera laticeps.* For these animals never, apparently, exceed the length of 35 feet, and they differ so materially from the Longniddry whale in the number of vertebræ and ribs, that there can be no possibility of confounding it with either of them. My remarks, therefore, will be restricted to a consideration of those described specimens of fin whales which have reached the length of 40 feet and upwards. As I have not yet given an account of the skeleton of this large Finner, I shall almost entirely confine myself, on this occasion, to an examination of the external characters of these animals.

a. Sir R. SIBBALD, in his observations on rare whales cast on the Scottish coast,* describes two fin whales. One, he says, *rostrum acutum habet, et plicas in ventre;* the other *maxillam inferiorem rotundam, et superiore multo latiorem habuit.* The one with a sharp beak was cast ashore in 1690 near Burntisland, and measured 46 feet in length. It was in all probability an immature specimen of the Razor-back. The other with the rounded lower jaw, much wider than the upper, was stranded on the south side of the Forth, near the old castle of Abercorn, in 1692. It was a male, 78 feet long, and possessed

* Phalainologia nova. Edinburgh, 1692.

various points of resemblance to the Longniddry specimen. From the greater width of the lower jaw than of the upper, the latter was received within the circumference of the former. The upper jaw was contracted in front so as to terminate in a sharp end. The baleen was black, the longest plates having a vertical diameter of 3 feet, and they were fringed with black hairs. The bristles near the front of the palate were also black, and the intermediate substance was similar in character. The flipper was 10 feet in length, and 2½ feet in its broadest part. The dorsal fin was 2 feet high, and in it was a rounded hole made by a leaden ball. Through this hole in its fin the whale had been recognised by the herring fishermen for nearly twenty years, and was called by them the Hollie Pyke. The back was black and the belly whitish. The blubber was 4½ inches thick on the sides, and one foot on the head and neck.

Although it is customary for cetologists to regard this broad-jawed whale, described by SIBBALD, as the *Balænoptera musculus*,* yet the characters which I have just related are much more those of the species to which the Longniddry whale will have to be referred.

b. The best known of the large fin whales is the common Razor-back, the *Balænoptera musculus*, or *Physalus antiquorum* of GRAY, upwards of thirty specimens of which have come under the notice of, and been more or less perfectly described by, naturalists. Between the common Razor-back and the Longniddry whale there are many characteristic features of difference. In the former the beak is much more pointed than in the latter, and its width rapidly contracts from base to apex, instead of the borders forming a gentle convex curve; the flipper also is absolutely and relatively shorter in proportion to the length of the animal. In the *B. musculus*, captured near Gravesend, described by Dr MURIE,† whilst the animal was 60 feet, the length of the pectoral limb along the anterior curve was only 6 feet 3 inches; in the specimen 67 feet long, stranded at Pevensey, described by Professor FLOWER,‡ the flipper was 6 feet 9 inches; and in the specimen 61 feet long, beached last year at Langston harbour,§ the flipper had the length of 5 feet 4 inches. The external or labial baleen plates are in the common Finner neither so long nor so broad; their colour is slate-coloured, mottled, or striped with yellow, or white, or brown, or pale horn colour, the setæ are white, or yellowish-white; the palatal mucous membrane is pale, whilst in the Longniddry whale all these structures had a rich deep black colour. In the Razor-back, whilst the back is black, the belly is white or yellowish-white, instead of being mottled with silver-grey, or milk-white, tints. The blubber also is very much thinner in the common Razor-back,—not more

* ESCHRICHT, "Die Nordischen Wallthiere." VAN BENEDEN and GERVAIS, "Ostéographie des Cétacés," p. 188. Dr GRAY in his Catalogue says, probably it may belong to this species.

† Proc. Zool. Soc., Feb. 14, 1865.

‡ Idem., Nov. 28, 1865.

§ Idem., Dec. 9, 1869.

than four tons of oil were extracted from the Gravesend specimen,—so that the animal possesses very little commercial value, whilst several hundred pounds have been realised by the sale of the oil from the Longniddry animal. Further, it is very doubtful if the *Balœnoptera musculus* exceeds the length of 70 feet; the Gravesend and Pevensey specimens, already mentioned, were both adult males, and yet they did not reach that length. Several specimens which have been referred to this species are, it is true, stated to have been longer than 70 feet; but of these, some, I believe, belong to another species, whilst it is doubtful how far the others have been measured with sufficient exactness. Moreover, the vertebræ in *B. musculus* are not so numerous, and do not apparently exceed sixty-one.

It is not necessary to compare the Longniddry whale with the *Physalus Duguidii*, described by Mr HEDDLE* and Dr GRAY,† as that animal is apparently nothing but a young specimen of the *B. musculus*.

c. In the year 1827 a fin whale, said to have been upwards of 80 feet long, was found floating on the North Sea, and towed into the harbour of Ostend, from which circumstance it has been customary to term it the Ostend whale. Unfortunately, no satisfactory account of the dimensions and external characters of this animal have been recorded, and the descriptions of the skeleton are in some respects imperfect. Zoologists, therefore, are by no means at one as to the genus or even species to which this whale ought to be referred. Dr GRAY places it in his genus *Sibbaldius*, and calls it *S. borealis;* ESCHRICHT has termed it the *Balœnoptera gigas*, or *Pterobalœna gigas;* whilst VAN BENEDEN and GERVAIS, in their *Ostéographie*, have regarded it as merely an unusually large specimen of the *B. musculus*. Owing to the very imperfect data at my command, I cannot make any exact comparison between its external form and that of the Longniddry whale. I may state, however, that the length of the pectoral fin is said to have been about 10 feet; the distance from the point of the snout to the dorsal fin 61 feet; from the point of the snout to the genital organs 55 feet; that the back was black, and the belly whitish, the outer surface of the pectoral fin was black, and the baleen setæ also black.‡ In these respects it more closely approaches the Longniddry whale than it does the *B. musculus*. It must be admitted, however, that the measurements, which have been recorded by those who have described the animal, are not of a very reliable character, for, whilst VAN BREDA states its length to be about 84 feet, DUBAR makes it as much as 105 feet. I shall have again to refer to the Ostend

* Proc. Zool. Soc. 1856.

† Catalogue, p. 158.

‡ The notices of this animal which I have read, and from which the above statements are drawn, are by M. VAN BREDA in Cuvier's "Hist. Nat. des Cétacés," p. 328; by ESCHRICHT in "Die Nordischen Wallthiere," p. 176; by LILLJEBORG in the Memoir translated for the Ray Society, p. 262; by Dr GRAY in his "Catalogue of Seals and Whales;" and by DUBAR in his "Ostéographie de la Baleine." For the opportunity of consulting DUBAR's scarce pamphlet, I am indebted to my colleague Professor KELLAND.

whale when I describe the skeleton of the Longniddry whale, and to point out certain other points of correspondence between them. I may on this occasion, however, state that the small number of vertebræ, 54, described in the former animal is obviously owing, as DUBAR'S figure shows, to the loss, in the prepared skeleton, of several vertebræ in the caudal series. And there is good reason for believing that the double headed condition of the first rib which DUBAR figured in this creature, and on the presence of which Dr GRAY has to a large extent based his genus *Sibbaldius*, is merely an individual peculiarity, and may occur as a variety in more than one species of whale, just as it occasionally occurs as a variety in the human subject.

d. In the month of October 1831, a fin whale was observed floating dead on the surface of the sea off the mouth of the Firth of Forth, and was brought ashore near North Berwick, 23 miles from Edinburgh. It was purchased and anatomised by Dr and Mr FREDERICK KNOX. The skeleton was carefully prepared and publicly exhibited, and now forms the most noticeable object in the Natural History Department of the Museum of Science and Art, Edinburgh. Unfortunately no systematic description of this animal was ever published; but from one or other of the publications mentioned below* I have gathered the following particulars. The animal was a male, and measured 80 feet in length. The length of the head over the vertex was 21 feet; the pectoral limb 11 feet long; the circumference behind the pectoral limbs 34 feet, and even 52 feet when greatly distended with gas; the breadth of the tail 20 feet; the distance from the anus to the fork of the tail 21 feet.† The whole baleen, with its fringed edge, was of a clear shining black, and the longest plate measured 2 feet 2 inches in length, by 15 inches in breadth. Nothing is said as to the colour of the skin or the thickness of the blubber; but it is stated in the "Account," that "the fluid oil in the abdomen, particularly, was in very considerable quantity, and often gave a covering to the sea as far as the eye could reach."

KNOX named the animal the Great Northern Rorqual, or *Balæna maximus borealis.*

In July 1847, Dr J. E. GRAY stated to the Zoological Society of London,‡

* Abstract of a paper on the "Anatomy of the Rorqual (a Whalebone Whale of the largest magnitude)," by Dr ROBERT KNOX (Proc. Roy. Soc. Edin., March 18, 1833). "Account of the Gigantic Whale or Rorqual, the Skeleton of which is now exhibiting in the great rooms of the Royal Institution, Princes Street," by FREDERICK JOHN KNOX, surgeon, Edinburgh, 1835. "Catalogue of Anatomical preparations illustrative of the Whale, particularly the Great Northern Rorqual," by F. J. KNOX, Edinburgh, 1838. Although the name of Mr FREDERICK KNOX is attached to the catalogue, yet it would appear that the best part of it was from the pen of Dr KNOX ("Life of Knox," by Dr LONSDALE, p. 168). For the opportunity of consulting this scarce and valuable catalogue, to which I have referred on various occasions in the text, I beg to express my acknowledgments to my friend Dr JOHN ALEXANDER SMITH. The skeleton of this animal is figured in JARDINE'S "Naturalist's Library," vol. vi., Edinburgh, 1837.

† The Gravesend *B. musculus* was only 11 feet 1 inch between the points of the tail. The Pevensey Razor-back, about 13 feet; the Langston harbour specimen 11 feet. In the Pevensey whale the distance from the end of the tail to the middle of the anal aperture was 17 feet 9 inches.

‡ Proceedings, Part xv. p. 117.

that he had examined, though without being able to take any measurements, on account of its position, the skeleton of this animal. He considered it to be a *Physalus*, very nearly allied to the *Physalus antiquorum*, though it differed from a specimen of that animal taken at Plymouth in some of the characters of its cervical vertebræ. Since that time it has been customary to describe this great whale as the *Balænoptera musculus*, or *Physalus antiquorum*.*

A comparison of the measurements, which I have quoted, with those of the Longniddry whale, given in the early part of this paper, and the very decided statement made as to the clear, shining, black baleen and setæ, will, I think, suffice to show that in its general proportions, and the colour of its baleen, the North Berwick whale resembled closely the Longniddry whale, and differed, therefore, in many most material points from the common Razor-back, so that it can no longer be regarded as of that species. The shape of its cranium, also, differs most materially from that of the *B. musculus*. Knox, in his catalogue, has given a few measurements of its skeleton, which, if compared with those of the Longniddry animal, will show that a close resemblance exists between these animals in this part also of their frames. The breadth between the orbits was 10 feet; the length of the base of the cranium measured in a straight line, 19 feet; the length of the lower jaw, 21 feet 4 inches; circumference of ramus about the middle, 4 feet; depth of ramus at coronoid process, 2 feet 7 inches; depth of body of hyoid, 8½ inches; between the ends of the great cornua, 2 feet 6½ inches; length of the humerus, 1 foot 11 inches; of the radius, 3 feet 10 inches. But it is right also to mention that there are differences in the skeleton, especially in the form of the sternum and the pelvic bones, and whilst the North Berwick whale has thirty ribs, it possesses as many as sixty-five vertebræ. The more complete comparison of the skeletons of these two animals I shall reserve for the second part of this memoir.

e. In 1847 Dr GRAY described,† by the name of *Physalus Sibbaldii*, from the skeleton of an immature animal 47 feet long, in the museum of the Hull Literary and Philosophical Society, a new species of Finner, the baleen of which possessed a uniform deep black colour. In 1864 Professor FLOWER ‡ discovered in the collection of the late Professor LIDTH DE JEUDE, of Utrecht, the skeleton of a young finner about 44 feet long, which differed from the common Razor-back in possessing a much broader beak. He named it *Physalus latirostris*.§ Subsequently, on examining the skeleton in Hull, which Dr GRAY had observed, he came to the conclusion that the animals were of the same species, and he withdrew his specific name in favour of the prior one given by

* Dr GRAY, "Catalogue of Seals and Whales," p. 144; VAN BENEDEN and GERVAIS, "Ostéographie," p. 172; and various other writers on the cetacea.

† Proc. Zoological Soc., June 8th.

‡ Idem, Nov. 8, 1864, and June 13, 1865.

§ This skeleton has since been acquired by the British Museum.

GAY.R Since then Dr GRAY has changed the generic name to *Cuvierius*, and terms the animal *C. Sibbaldii.** Those zoologists who do not break up the great genus *Balœnoptera* into several smaller sub-genera, prefer to call the animal *Balœnoptera Sibbaldii.* The Hull and Utrecht skeletons agree in possessing each 64 vertebræ; but whilst the former has 16 pairs of ribs, the latter has only 15 pairs. No information existed as to the external characters of either of the animals from which these skeletons were obtained, so that it was difficult to identify them with any of the species of whales known to zoologists, up to that time, only by their external appearances.

In 1867, however, Professor REINHARDT published an important memoir, in which he gave an account,† from notes furnished him by Mr HALLAS, surgeon to a whaling ship, of a Finner of which the Danish whalers had captured several specimens. This whale was known to the Icelanders as the Steypireythr. The back was blackish grey; down the sides the colour was lighter; the belly, behind the plicæ, was uniformly grey, the ridges blackish grey; the furrows between them, light grey; the caudal fin, blackish grey on both sides; the pectoral fins, blackish grey, spotted with lighter specks on the outer surface, but milk white on the inner. The baleen was uniformly black. The animal was about 80 feet long, and was said to have a dorsal fin not more than 7 inches high.‡ No measurements are given of the caudal or pectoral fins, or, indeed, of the proportions of the other parts of the body. Mr HALLAS also forwarded the skull, hyoid bone, and atlas of this animal, of which REINHARDT gives figures. Further, he states that the animal possessed 64 vertebræ and 15 pairs of ribs. In his remarks on this whale, REINHARDT compares it both with the *Balœnoptera musculus* (*Physalus antiquorum*) and *B. Sibbaldii,* and considers that from its osteological characters it should be referred to the latter species.

By these observations, it was clearly established that a well-defined species of Finner exists in the northern seas, which differs from the common Razor-back, in possessing a greater number of vertebræ, a broader beak to the cranium, a greyish and not a whitish belly, and a uniform black baleen, instead of one mottled with various tints. In the distribution of the tints of the skin, in the uniform black colour of the baleen, and in the length of the animal, the Steypireythr obviously closely corresponds with the Longniddry whale. But what is even more important for the determination of the species, the cranium, atlas, and hyoid, as far as one can judge from REINHARDT'S figures, are almost identical in

* Appendix to Catalogue of Seals and Whales, p. 380.

† Vidensk. Meddelelser fra den Naturhist, Forening i Kjöbenhavn, 1867. Translated in "Annals of Nat. Hist.," November 1868.

‡ Although the end of the dorsal fin had been removed from the adolescent Longniddry whale before my measurements were taken, yet sufficient had been left to show that this fin had been more than 12 inches high. Consequently, I do not think that the shortness of the dorsal fin is so definite a character as REINHARDT supposes.

form with the corresponding bones in the Longniddry whale. Hence we arrive at the conclusion, that the Longniddry whale is a specimen of the *Balænoptera Sibbaldii*, or *Physalus Sibbaldii* of GRAY.

Two years before the publication of REINHARDT'S memoir, a fin whale, about 54 feet long, came ashore alive at Gothenburg, on the west coast of Sweden. It was secured by Professor MALM, the superintendent of the Museum in that city, and was carefully examined by him. He published an elaborate monograph, with numerous photographic illustrations, descriptive of the capture of the animal, its form, colour, proportions, and dimensions, with a detailed account of the skeleton, and a number of observations on its visceral anatomy.* The animal was a male, and had not reached its full growth. Its colour was a deep slate tint, with somewhat paler tints on the sides, whilst the lower surface was mottled with patches of milk white, of different sizes and shapes. The flippers were white on the inner surface, and the lobes of the tail at the under part whitish. The distance from the anterior part of the base of the flipper to its free extremity, measured in a straight line, was 7 feet 4 inches, whilst the distance between the extreme points of the tail was about 11 feet. The baleen was uniformly of a deep black slate colour, whilst the hairs at the free margins of the plates were of a brown soot colour. The vertebræ were 63 in number, and there were 15 pairs of ribs. MALM considered it to be a new species, and named it *Balænoptera Carolinæ*.

From a comparison of its osteological characters with those of the *B. Sibbaldii*, more especially the resemblance in the breadth of the beak, the form of the nasal bones, the relative and absolute length of the metacarpals and phalanges, and the spine of the axis, as well as from the uniform dark colour of the baleen, Professor FLOWER came to the conclusion,† that MALM'S whale ought not to be regarded as a distinct species, but was merely another immature specimen of the *Balænoptera (Physalus) Sibbaldii*. In this conclusion he has been supported by Professor REINHARDT, who states‡ that, in his opinion, "ESCHRICHT'S 'Tunnolik,' the 'Steypireythr' of the Icelanders, and, finally, the whale described by MALM, are only one and the same species, which appears to be one of the most common in our northern seas, and the systematic name of which must be *Balænoptera Sibbaldii*."

If I am correct in regarding the Longniddry whale as the *B. Sibbaldii*, then—Professors FLOWER and REINHARDT being also correct in their supposition—its characters should closely correspond, allowance being made for the different sizes of the two animals, with those of MALM'S whale. In the colour, both of the skin and the baleen; in the shape of the tail and pectoral fin; in the relative pro-

* "Monographie illustrée du Baleinoptère," Stockholm, 1867. For the opportunity of consulting this work, three copies only of which are, I believe, in this country, I am indebted to my friend, Mr J. W. CLARK, of Cambridge.

† Proc. Zool. Soc., March 12, 1868. ‡ Memoir, cited above.

portions of these parts to the length of the entire body; in the form of the beak; and in the curve of the lower jaw, the resemblances are very striking. The osteological characters have also much in common; but the consideration of these I shall not enter into on this occasion.

The comparison I have now made between these different specimens of Finners, leads me to the conclusion that the following should be referred to the *Balænoptera Sibbaldii*:—

The North Berwick whale.

The Hull skeleton.

The Utrecht skeleton, now in the British Museum.

The Gothenburg whale.

The Steypireythr.

The Longniddry whale.

And, in all probability, the Ostend whale, and Sibbald's "Balæna tripinnis quæ maxillam inferiorem rotundam, et superiore multo latiorem habuit."

EXPLANATION OF THE PLATES.

With the exception of fig. 1 Plate V., of figs. 19, 20, 21, 22, 23, 24, 25, 27, 28, Plate VII., and of fig. 29 Plate VIII., the illustrations have been very carefully drawn, under my superintendence, by Mr J. B. Abercrombie, from nature. Fig. 27 was drawn by Mr Coughtrey, fig. 28 by Mr Foulis, and figs. 19 to 25 inclusive, and fig. 29, were sketched by myself from microscopic preparations. As far as possible, the specimens from which the drawings were taken have been preserved in the Anatomical Museum of the University of Edinburgh. When not otherwise stated, the drawings represent portions of the adolescent animal.

Plate V.

Figure 1. Side view of the Longniddry Whale. This drawing was constructed from photographs, from pencil sketches, and from a water-colour sketch by Mr Sam. Bough. The lower jaw is represented somewhat out of position so as to give a side view of the baleen and of the dorsum of the tongue.

Figure 2. The falcate dorsal fin of the fœtus.

Figure 3. The horizontal tail of the fœtus.

Figure 4. The abdominal plicæ of the fœtus, showing bifurcations of the ridges.

Figure 5. Supero-anterior surface of the left flipper of the fœtus. The outlines of the bones of the antibrachium and of the four digits are represented. The posterior edge of the flipper was much thinner than the anterior.

Plate VI.

Figure 6. The clitoris, below which is the opening of the urethra, and the folds of mucous membrane, on the floor of the vestibule. The labia majora have been drawn asunder to expose these parts.

Figure 7. The orifice of the nipple fossa, displaying the nipple with the pedunculated papillæ at its summit.

Figure 8. The anal orifice, with the rugæ of the integument converging to it.

Figure 9. The ventral wall of the fœtus, displaying the penis with the crescentic folds of skin at its root, the median perineal raphé, with a rudimentary nipple fossa on each side, and, more posteriorly, the anal orifice.

Figure 10. Dorsum of the beak of the fœtus. The curved outline of the beak; the dorsal median ridge; the form and direction of the blow-holes, which are partially open, and the intermediate groove are all represented.

Figure 11. A portion of the mammary gland to show the rugose character of the mucous lining of the duct, one-half the size of nature.

Figure 12. One of the large, irregularly quadrilateral, labial, baleen plates, much reduced in size.

Figure 13. A vertical section through the intermediate substance of the baleen, displaying its laminated appearance. The subsidiary blades are shown, two of which have been cut short. On the upper or palatal surface, the clefts between the laminæ of the plates, into which the palatal folds of mucous membrane fit, may be seen.

Figure 14. The baleen plates and intermediate substance of the fœtus, the size of nature. One of the plates, with the thin layer of intermediate substance on each side, has been partially separated from the others.

Figure 15. Portion of the palatal mucous membrane of the fœtus. At the upper end of the figure is the lip; lower down the elongated folds for the larger labial baleen plates, and at the lower end the subconical papillæ from which the bristle-like subsidiary plates arise. The tubular papillæ are not represented in the drawing, as they had all been broken off before the drawing was made.

Figure 16. Palatal surface of a part of the fœtal baleen wreath, with a side view of one of the plates. The elongated clefts between the laminæ of the labial plates and the polygonal pits for the sub-conical papillæ are shown; as the tubular papillæ are still within the blades, their broken ends may be seen in part occupying the clefts and pits.

Plate VII.

Figure 17. Portion of the fœtal membranes; *a*, the non-villous surface of the chorion; *b*, villous surface. Between *a* and *b* the elongated marginal folds of the chorion may be seen. *c*, Divided end of one of the arteries of the chorion.

Figure 18. A large triangular fold of the chorion, displaying the reticulated arrangement of the villi on its surface.

Figure 19. Vertical section through a portion of a baleen plate to show the tubes, with the lamellæ and black pigment granules. × 40 diam.

Figure 20. Transverse section through a portion of a baleen plate. The entire antero-posterior diameter is represented. The tubes are divided transversely. Some are empty, others contain the tubular papillæ, and in some of these the transversely divided ends of the contained blood-vessels may be seen. Both the tubular and cortical lamellæ, with numerous black pigment granules, are represented in the drawing. × 40 diam.

Figure 21. Epithelial cells from the outer layers of two adjacent tubular systems. At the lower part of the drawing some interstitial cells are represented. × 200 diam.

Figure 22. Transverse section through one of the setæ of a baleen plate. The shaded central portion represents the soft papilla, in which a transversely divided blood-vessel is represented. × 40 diam.

Figure 23. Vertical section through a portion of the intermediate substance; the clefts extending into its substance, in which the intermediate papillæ are lodged, are seen at the upper part of the section. × 40 diam.

Figure 24. Epithelial cells from the intermediate substance. × 200 diam.

Figure 25. Red blood corpuscles from the blood in the vessels of the baleen plate of the *B. rostrata*. × 1200 diam.

Figure 26. Portion of one of the elongated folds (pulp-blades) of the palatal mucous membrane. The tubular papillæ are dependent from the lower edge of the fold. Size of nature.

Figure 27. Vertical transverse section through the pulp-blades, intermediate substance, and imbedded parts of the baleen plates of *B. rostrata*, the blood-vessels of which have been injected; *i*, the vessels of the intermediate papillæ; *c*, the vessels of the cortical papilla; *t*, the elongated vessels of the tubular papillæ.

Figure 28. Arch of the aorta and great vessels of the fœtus. *x*, the ductus arteriosus; *a*, right coronary artery; *b*, brachio-cephalic; *c*, left carotid; *d*, left subclavian; *e*, right carotid; *f*, right subclavian; *g*, right posterior thoracic; *h*, right axillary; *i*, right internal mammary; *k*, right cervico-facial; and *l*, right internal carotid; *m*, left cervico-facial; and *n*, left internal carotid; *o*, left posterior thoracic; *p* and *q*, left axillary and internal mammary arteries.

PLATE VIII.

Figure 29. Vertical section through the integument. It shows the elongated papillæ, the comparatively thin cuticle containing a quantity of black pigment, and the subcutaneous tissue, with the small arteries entering the bases of the papillæ. × 20 diam.

Figure 30. Dorsal surface of the pharynx and commencement of the œsophagus of the fœtus; *p h*, the pharynx displaying the fibres of the constrictors and the longitudinal raphé. The upper part of the pharynx has been cut across, and the soft palate *v* is displayed; passing under it is an arrow lying in the bucco-pharyngeal canal. Immediately behind the velum a portion of the epiglottis is visible.

Figure 31. The interior of the cavity of the pharynx of the fœtus opened into by a posterior median incision; *v*, the velum; *e*, the epiglottis, the letter is placed on the cushion, which corresponds in position to the bar-like rod of fibro-cartilage; *l*, the lappet-like fold of mucous membrane which invests the superior horn of the arytenoid cartilage, the outline of which may be seen in the figure. The upper arrow is in the bucco-pharyngeal canal, the lower is in the windpipe.

Figure 32. Portion of the intestinal tube. *v*, the superior mesenteric vein which receives numerous rootlets from the gut; *m*, the moniliform tube, giving off numerous small arteries to the wall of the intestine; *n*, the sympathetic nerve, also sending branches to the gut; *p*, the peritoneal coat turned down. At the right cut edge of the intestine the valvulæ conniventes of the mucous coat are shown.

Figure 33. A portion of the beaded mesenteric vessel, displaying the series of dilatations and constrictions. At the right side the tube has been opened, and the corrugated folds of the inner wall may be seen.

Figure 34. One of the dilated portions of the beaded vessel. The lacunary system on its surface is represented. The darkly shaded, elongated, and globular bodies, *l l*, are the small lymphatic glands.

Figure 35. Annular and spirally arranged plate of cartilage from a bronchial tube.

Figure 36. Front view of the larynx and hyoid apparatus; *h*, the body of the hyoid with the stylohyal and great cornu on each side. Immediately above the hyoid body is the orifice of the bucco-pharyngeal canal, the arrow lying in which has emerged below through the œsophagus; *th*, the thyro-hyoid muscle; *sh*, the stylo-hyoid muscle; *t*, the thyroid cartilage; *c*, the cricoid; *cm*, the constrictor muscle of *p*, the laryngeal pouch. The bifurcation of the trachea and the supplementary right bronchus are seen, and the arrow passed through the left bronchus emerges superiorly, immediately behind the posterior horn of the left arytenoid cartilage.

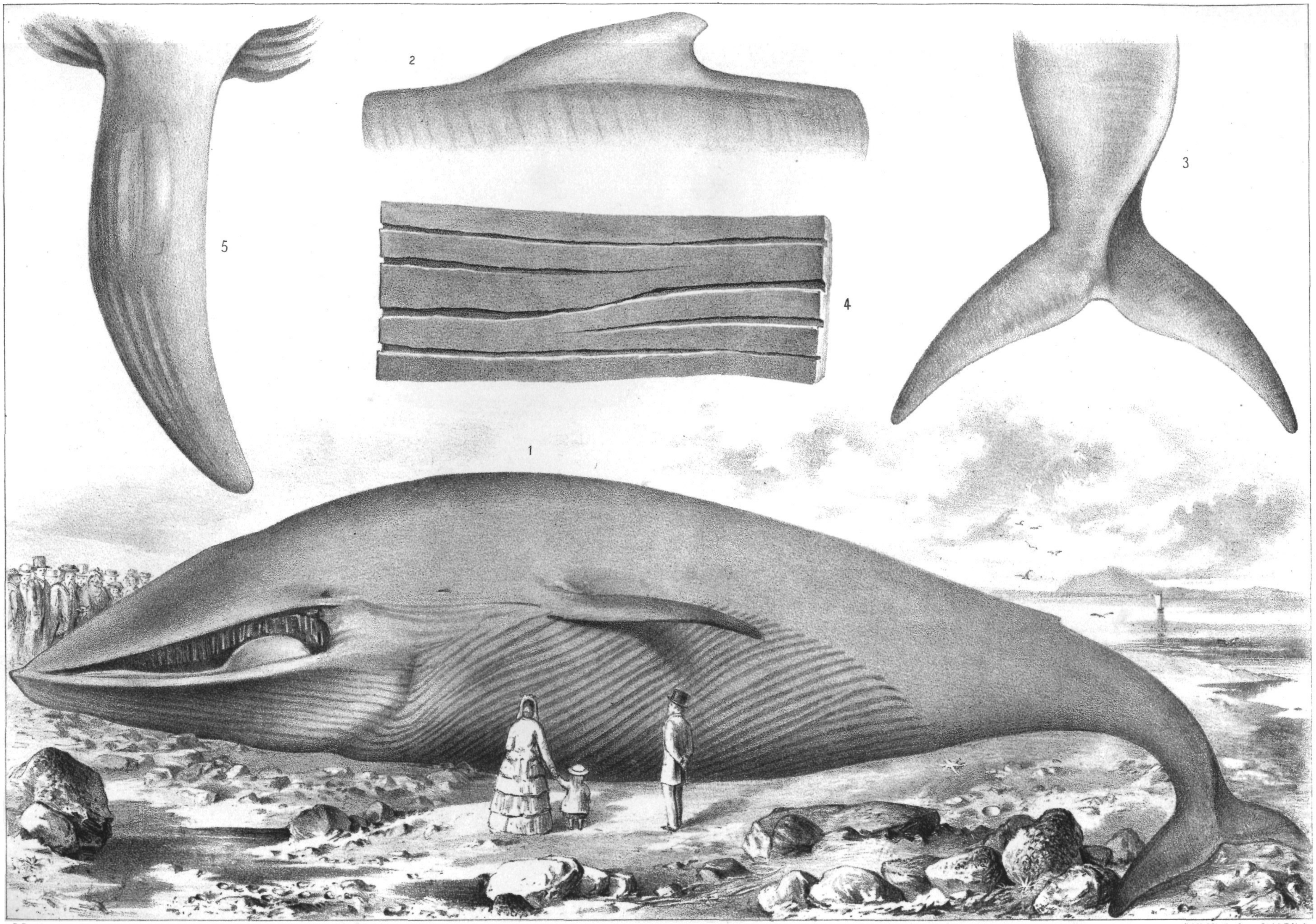
Figure 37. Front view of the larynx and trachea; the laryngeal pouch has been removed and the cartilages dissected, *t*, the thyroid cartilage; *c*, the cricoid with its plate-like processes; *a*, the body; *s*, the anterior, and *i*, the posterior cornu of the arytenoid cartilage; *ct*, the inferior crico-thyroid membrane. The barb of the arrow passed through the left bronchus, lies immediately behind the posterior horn of the left arytenoid cartilage, and in front of the body of the cricoid, which is in deep shadow.

Figure 38. View of the interior of the larynx from behind, obtained by cutting through and turning outwards the body of the cricoid, and the membrane connecting the anterior horns of the two arytenoid cartilages; *e*, the epiglottis; *c*, the cricoid; *l*, the lappet of mucous membrane enclosing *s*, the anterior horn of the arytenoid; *i*, the posterior horn. To the inner side of the anterior horn is the fold of mucous membrane, which may represent a false vocal cord.

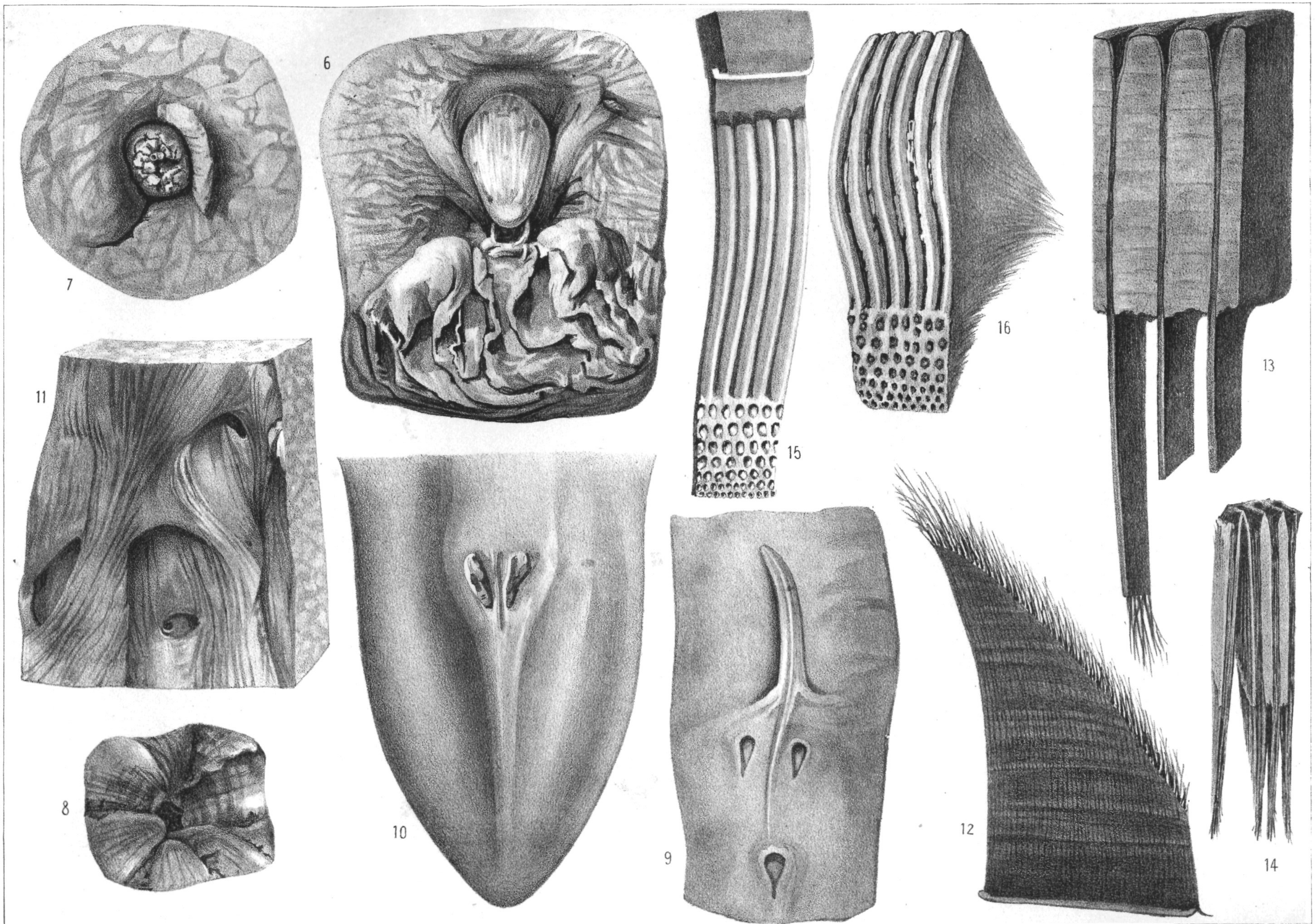
Figure 39. The posterior nares viewed from below.

Figure 40. The anterior nares or blow-holes viewed from above; the walls are separated to show the internal foldings.

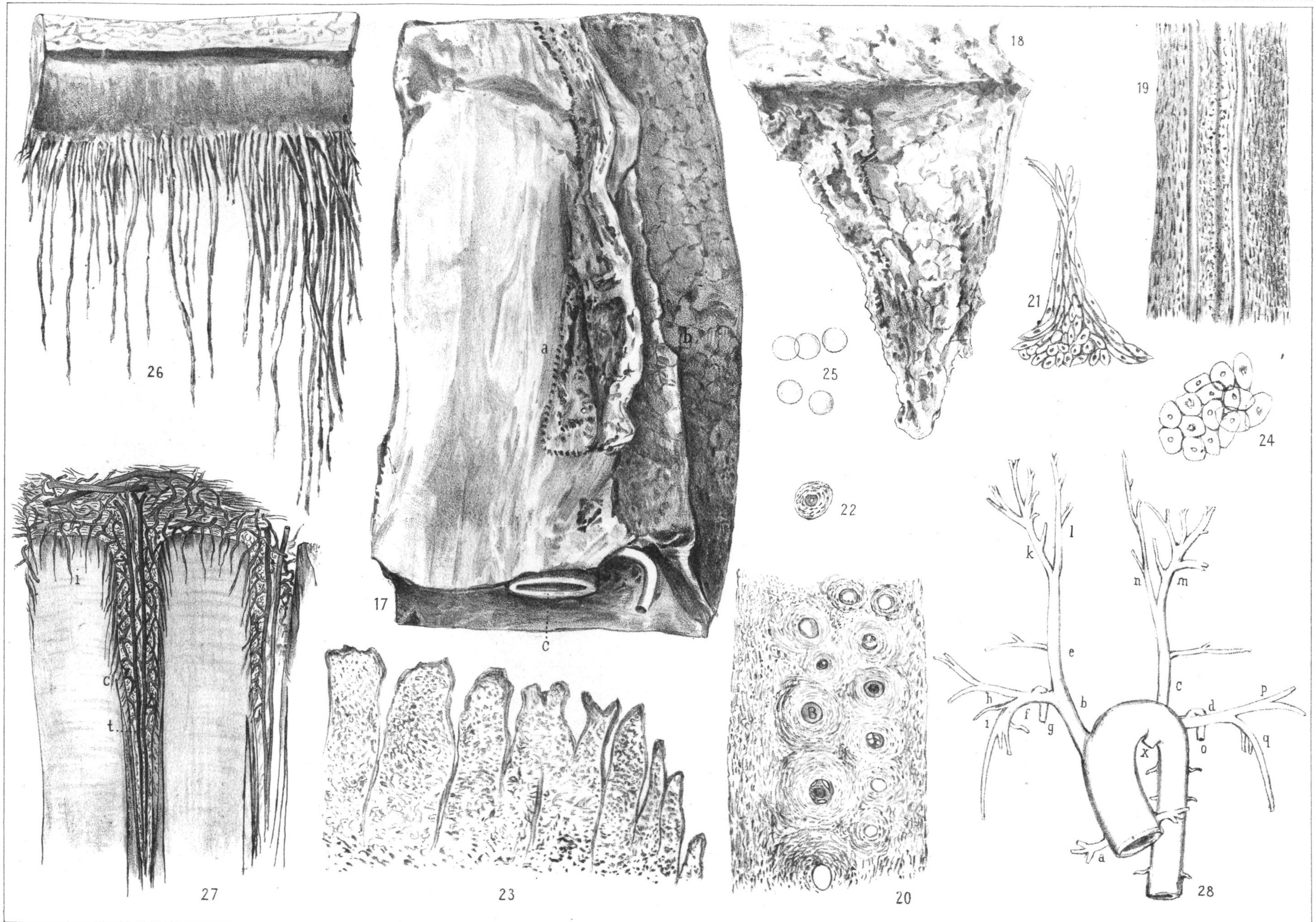
Figures 35 to 40 inclusive are from the fœtus.



J.B. Abercrombie del.t W.H. M.c Farlane Lith.r Edin.r

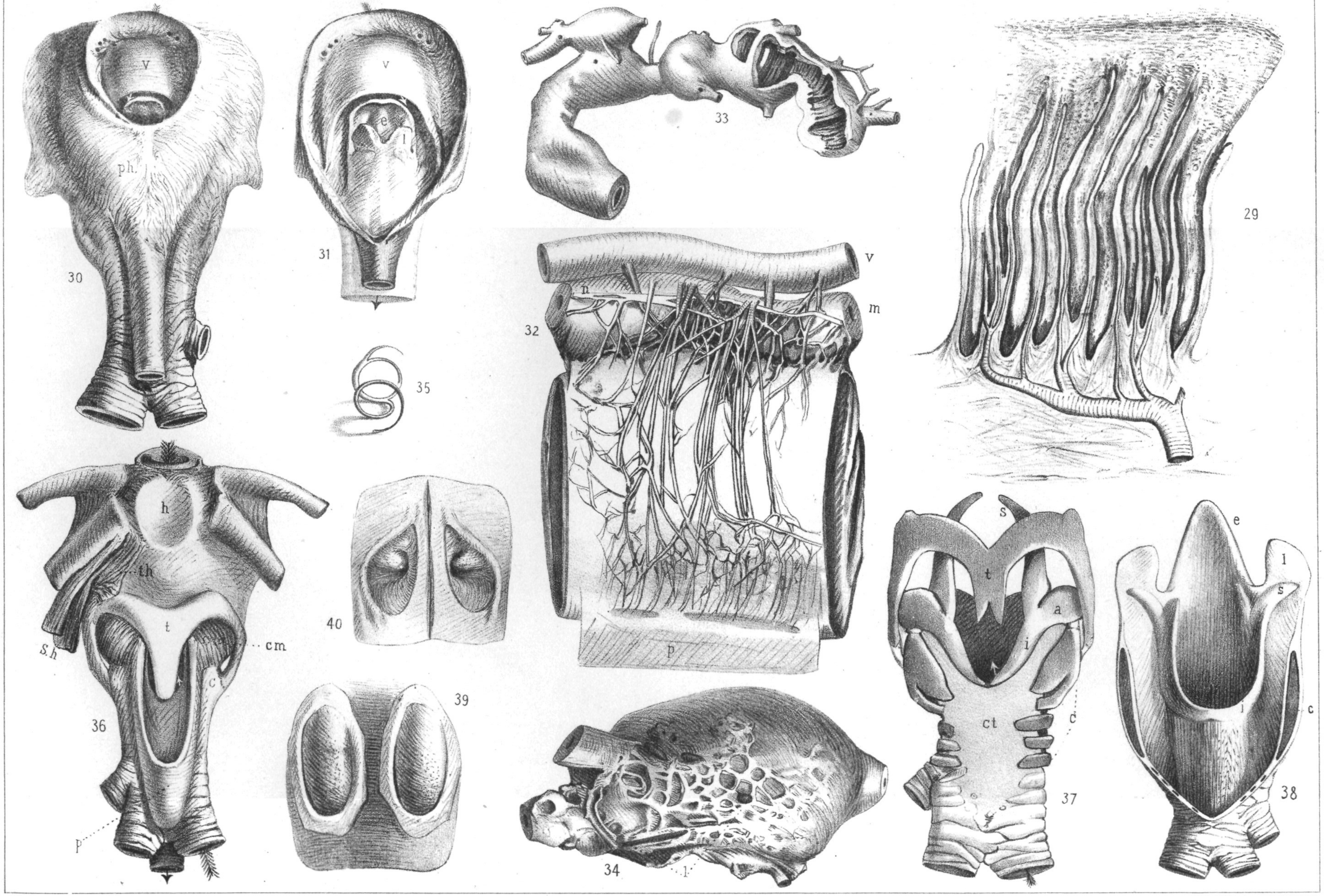


J. B. Abercrombie del.t W. H. Mc Farlane, Lith.r Edin.r



J.B.A. & W.T. del^t.

W.H. M^c Farlane, Lith^r. Edin^r.



J.B. Abercrombie delt.

W.H. McFarlane, Lithr. Edinr.