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PROFESSOR MACLAGAN, M.D., Vice-President,
in the Chair.

The following Communications were read:—

1. On a Specimen of *Balænoptera borealis* or *laticeps* captured in the Firth of Forth. By Professor Turner.

In September 1872 a whale of some magnitude was seen floundering in shallow water at Snab, Kinneil, about a mile from Bo'ness, on the Firth of Forth. Some men proceeded to the spot and fastening a rope round its tail, hauled it closer to the shore, and then killed it. I was not at home at the time, but on reading a notice of its capture in the *Scotsman* of September 26, I wrote to my assistant, the late Mr A. B. Stirling, to go and see the animal. He reported to me that it was a whalebone whale, ribbed and grooved on the belly, and he was able to make the following notes on its colour and dimensions:—

The animal was black on the back of the head and body and dorsum of the tail. The belly was pinkish white, with a shade of yellow, from chin to anus. Behind the anus it was patched with white to three feet from the tail. Behind this again the colour varied from lead grey to black, and the under as well as the upper surface of the tail was black. The breadth of the dorsum of the head at the tip of the upper lip was 2 inches; one foot further back it was 9 inches; two feet back 18 inches; and at the blowholes, 3 feet. The dorsal fin had a falcate posterior border, and its long

diameter along the anterior border to the tip was 1 foot 8 inches, whilst its height was 11 inches. The flipper, when disarticulated at the shoulder, was 4 feet 10 inches in length. The breadth of the tail was 8 feet 8 inches : its anterior border was convex, its posterior border festooned. From the root of the tail to the mesial notch was 2 feet 5 inches, and the depth of the notch was 5 inches. The lower jaw projected both in front of and to the sides of the upper jaw. The length of the animal, from the tip of the beak to the end of the tail, was about 37 feet, and the girth round the belly about 15 feet.

The whale was taken possession of by the Custom House officials, and was then sold by public auction.

When I saw it a few days afterwards the blubber and baleen had been removed from the animal. The baleen consisted of numerous plates, the biggest of which were about 1 foot 3 inches in length and about 6 inches wide. They were black, striped with grey and white, and the hairs projecting from the lower free border were greyish-white.

The fluted state of the belly and the presence of a dorsal fin proved it to be one of the *Balænoptera*, or Finner whales. It was evident, both from the colour of the whalebone and the shape of the upper jaw, the lateral borders of which were straight, that the animal was not the *Balænoptera sibbaldii*, a magnificent example of which had been stranded at Longniddry only three years before.* Its size and the colour of its baleen distinguished it also from the lesser piked whale, *Balænoptera rostrata*. The absence of yellowish and greenish tints in the plates of the whalebone threw some doubt on its being *Balænoptera musculus*, but I was not in a position, in the condition the animal then was, to discriminate between *Balænoptera musculus* and *B. borealis*. I decided, therefore, to buy the carcass, and to have the skeleton prepared for the Anatomical Museum of the University. Accordingly men were engaged to take the flesh off the bones, and to separate it into pieces of convenient size for transport into Edinburgh. I regret to say that the sternum and pelvic bones were lost amidst the masses of flesh, and could not be recovered ; but with these exceptions, and that of a carpal bone, some of the smallest phalanges, and perhaps one or two chevrons, the skeleton is, I believe, perfect. As the bones of the large cetacea are, from the quantity of oil which they contain,

* See my account of this animal in *Trans. Roy. Soc. Edin.*, 1870, vol. xxvi.

difficult to clean, I obtained permission from my colleague, Professor Balfour, to bury them in the Botanic Gardens in a mixture of leaves and earth. They remained there until the summer of last year, when they were disinterred, clean and free from grease and smell. The examination which I have subsequently made of the skeleton has satisfied me that the animal was the cetacean named by zoologists *Balænoptera borealis* or *laticeps*.

The only specimen captured in the British seas, which has been referred to this species by some zoologists, is one stranded at Charmouth, Dorsetshire, in 1840. From the colour of its baleen and the number of its vertebræ (60), it was much more likely to have been *Balænoptera musculus*. But as the skeleton has not been preserved, its identification is now rendered difficult. As no properly authenticated specimen of *B. borealis* had therefore previously been captured in the seas of our islands, I have the satisfaction of adding this mammal to the British Fauna.

In the Museum of the Royal College of Surgeons of England are some vertebræ and other bones of this species, but nothing is known of their history. In the University Museum, Cambridge, are the skull and one scapula of a whale cast ashore on the island of Islay, in 1866, which Professor Van Beneden referred at one time to this species.* Mr. J. W. Clark has, however, pointed out† that it is the skull of a very fine *Balænoptera rostrata*, and Professor Flower tells me that he is of the same opinion. Skeletons of *B. borealis* are preserved in the Museums at Leyden, Berlin, Bergen, Brussels, and Bayonne. The Leyden specimen was taken in 1811, near to Moniken Dam, in the Zuider Zee, and the characters of the skeleton have been given by Professor Flower.‡ The Berlin specimen, figured and described by Rudolphi,§ was taken in 1819 on the coast of Holstein, near to Gromitz. Two skeletons are at Bergen, the one was described by Lilljeborg,|| from a young animal captured on the Norwegian coast; the other came from the Loffoden Islands,¶ and

* *Ostéographie des Cétacés*, p. 202.

† See reference in *The Fauna of Scotland*, "Mammalia," by E. R. Alston, Glasgow, 1870. Also, in a letter to myself, in reply to a communication on the subject.

‡ *Proc. Zool. Soc. London*, Nov. 8, 1864.

§ Rudolphi named this animal *Balæna rostrata*. *Abhand. der Akad. der Wissensch. zu Berlin*, 1820, 1821.

|| Translation of Lilljeborg's *Memoir on the Scandinavian Cetacea*, in publications of Ray Society.

¶ *Ostéographie des Cétacés*, p. 201.

has apparently not yet been described. The Brussels skeleton was obtained by Eschricht from the North Cape, and has been described by Van Beneden.* The skeleton in the Museum at Bayonne is a young male specimen, which M. P. Fischer states was stranded near Biarritz in July 1874.† The animal was 7·83 mètres long (about 26 feet). *B. borealis* is therefore a denizen of the North Atlantic Ocean.‡

It is not my intention on this occasion to enter in detail into the description of the skeleton of this whale stranded near Bo'ness, but it will be necessary to refer to such points in its anatomy as will give certainty to the identification of the species. The bones of this animal were less massive, smoother on their surface, and less porous than the bones of either *B. musculus* or *B. sibbaldii*. The vertebral plates were not ankylosed to their respective bodies, and the epiphyses of the radius, ulna, and humerus were not united to the shafts of their respective bones.

The entire length of the skull and spine was 35 feet 2½ inches, viz., the skull, 8 feet 1½ inches; the spine, without the intervertebral discs, 26 feet 7 inches. If to this be added 2 feet for the probable thickness of the intervertebral discs, and 8 or 10 inches for the projection of the lower jaw beyond the upper and the thickness of the skin, the length of the animal would have been about 38 feet, which closely approximates with what was reported

* *Ostéographie des Cétacés*, p. 302.

† *Comptes Rendus*, 27th Dec. 1876, p. 1298, vol. lxxxiii.; and *Journal de Zoologie*, vol. v. p. 462, 1876.

‡ In *Nature*, 12th Oct. 1876, is a reference to the *Schriften der naturforschenden Gesellschaft in Dantzig*, which contains photographs of the skeleton of a whale, said to be *Pterobalæna laticeps* (Gray), stranded in Dantzig Bay in 1874, but as I have not been able to obtain a copy of the Dantzig publication, can make no further reference to it. I observe that in the *Archiv für Naturgeschichte*, 1875, 41st year, third part, p. 338, is an elaborate description, by Professor Zaddach of Königsberg, of a female fin whale, stranded in August 1874, between Neufährwasser, the harbour of Dantzig, and the village of Heubude. He names it *Balænoptera musculus*. Its vertebral formula is $C_7D_{14}L_{15}Cd_{24} = 60$, and the baleen is described as yellow like horn, with bluish-green or blackish spots at the outer border. Its length was 10·98 mètres (about 36 feet English). Professor Zaddach states that he does not give a detailed description of the skeleton, as the Dantzig Society of Natural History had decided to publish a description of it, with drawings and photographs, in their *Schriften*, from the pen of Professor Menge. Can this be the specimen referred to in *Nature*? The colour of the baleen and the vertebral formula (probably the last two caudals had not been ossified and preserved) show its affinity to *B. musculus* rather than to *B. laticeps*.

as its length before being flensed. Although the condition of the epiphyses proved that the animal had not reached adult life, or probably attained its full dimensions, yet this skeleton is larger and more advanced in its ossification than the other skeletons which have been described. The Leyden specimen is said to have been 32 feet long, and Professor Flower gives its skeleton as 29 feet 7 inches, without the intervertebral discs, for the thickness of which an additional 2 feet should be allowed. Professor Rudolphi states that the Berlin skeleton is 31 feet 1 inch Rhenish measurement. The young skeleton in Bergen described by Lilljeborg is 30 feet 2 inches; and Professor Van Beneden names 32 feet as the length of the specimen in the Brussels Museum. From these measurements, M. Van Beneden concludes that this species of whale does not appear to exceed 35 feet in length. But the dimensions of the specimen now before us, which is obviously not an adult, would lead one to say that this animal may attain a length of 40 feet, or even more. Whilst larger than *B. rostrata*, it is considerably smaller than *B. musculus*, and still more than *B. sibbaldii*.

Spine.—The vertebræ numbered in this specimen fifty-six; and as the last caudal was only $1\frac{1}{2}$ inch in its transverse and $1\frac{1}{4}$ in its antero-posterior diameter, it is probable that all the vertebræ were secured. The formula was as follows:— $C_7D_{14}L_{14}Cd_{21}=56$. In the Leyden specimen there were also fifty-six vertebræ, the two last caudals being fused together, viz., C_7D_{13} or $_{14}$, L_{16} or $_{15}$, Cd_{20} . Rudolphi states that the Berlin skeleton had fifty-four vertebræ, though Eschricht says fifty-five, and one was probably missing. Lilljeborg states that the young skeleton in Bergen had fifty-five vertebræ, viz., $C_7D_{13}L_{14}Cd_{21}$. In the Brussels specimen the terminal caudals were lost, but the vertebræ present were $C_7D_{14}L_{15}$, and fifteen caudals. The Bayonne skeleton had only fifty-four vertebræ, but the animal was young, and the two terminal caudals were probably not ossified. Fifty-six is probably, therefore, the normal number of vertebræ, and of these fourteen are dorsal, so that there are fourteen pairs of ribs, which is the number present in my specimen. The vertebral formula, therefore at once distinguishes *B. borealis* from the other species of the genus; for in *B. rostrata* the formula is $C_7D_{11}L_{13}Cd_{17}=48$, and there are only eleven pairs of ribs. In *B. musculus* the formula is $C_7D_{15}L_{15}Cd_{25}=62$, and there are, as a rule, fifteen pairs of ribs. In *B. sibbaldii* the vertebræ are sixty-

three or sixty-four, and the formula is C_7D_{15} or $_{16}$, $L_{15}Cd_{26}$, and there are fifteen or sixteen pairs of ribs. *Balænoptera borealis* is, therefore, intermediate in length, in the number of its vertebræ and of its ribs to *B. rostrata* on the one hand, and to *B. musculus* and *B. sibbaldii* on the other.

The seven cervical vertebræ of my specimen are all separate bones, except that the right lateral mass of the atlas is ankylosed to the body of the axis. This is an exceptional arrangement in the fin whales, and has not apparently been seen in any of the other skeletons of *borealis*. The atlas has a transverse process, short, twisted, and compressed from before backwards, and a median backward-projecting ventral process corresponding with Professor Flower's description of the Leyden specimen. The ring is markedly divided into an inferior part for the rudimentary odontoid, and a superior rachidian part by a process projecting inwards on each side. This character is also well seen in the atlas in the Museum of the College of Surgeons, London. The height of the atlas is $10\frac{1}{2}$ inches; that of the axis 13 inches. The extreme transverse diameter of the atlas is $14\frac{1}{2}$ inches; that of the axis $21\frac{3}{4}$ inches. The axis has a thick spine. The transverse process has a slender upper and a plate-like lower limb, which unite externally to form a broad plate-like process directed backwards and outwards. The vertebrarterial foramen is only $1\frac{3}{4}$ by $2\frac{1}{2}$ inches, and is placed near the upper border of the process. The rachidian ring is $4\frac{1}{4}$ by $3\frac{1}{2}$ inches. In the 3rd and 4th vertebræ the vertebrarterial foramen is completed by the junction externally of the superior and inferior limbs of the transverse process. In the 5th vertebra these processes are separated externally by an interval of $\frac{1}{2}$ inch; in the 6th, by an interval of $1\frac{1}{2}$ inch; in the 7th, whilst the superior limb is long and curved downwards and outwards, the inferior limb is represented by a mere tubercle. In the Leyden specimen the vertebrarterial foramen is incompletely bounded in the 2nd to the 7th inclusive. In the Berlin and Bergen skeletons only the axis has the foramen completely bounded by bone. In the Brussels skeleton only the axis and 3rd vertebræ. The ossification is therefore more advanced in this region in my specimen than in these other skeletons.

The flat surfaces of the upper transverse processes are almost vertical; those of the lower transverse process of the 6th cervical are

almost horizontal. From the root of the lower transverse process of the 4th, 5th, and 6th a stout conical process projects forwards.

The dorsal vertebræ increased in magnitude from before backwards. The 1st had a vertical diameter to the summit of the spine of $13\frac{1}{2}$ inches, and a transverse, between the tips of the transverse processes, of $19\frac{1}{2}$ inches. The last dorsal had a vertical diameter of $22\frac{3}{4}$ inches, and a transverse of 30 inches. All the dorsal vertebræ were marked by an articular surface for a rib at the free end of the transverse process. They were not keeled on the ventral surface of the body.

The lumbar vertebræ were, as a rule, somewhat bigger than the hinder dorsal, and reached their maximum at the 8th, 9th, and 10th. The 9th lumbar had a vertical diameter of $24\frac{1}{2}$ inches, and a transverse of 31 inches. Behind the 10th the transverse and spinous processes gradually diminished in their amount of projection as they passed back into the caudal region, and in the 12th vertebra from the end of the tail the transverse process was represented by a faint ridge on the side of the body, and the spine was rudimentary. In the 9th vertebra from the end of the tail the spine and laminæ had disappeared, and the neural canal was represented by a groove, which was faintly seen on the two vertebræ next behind, and then disappeared. In the 12th vertebra from the end of the tail a foramen, directed vertically, was situated at the root of the rudimentary transverse process, and a similar foramen was found in the caudals up to and including the 18th from the end of the tail. This arrangement closely resembles that figured by Rudolphi in the Berlin skeleton. The lumbar were all keeled on the ventral surface of the body, though, as a rule, the keel was slight in relation to the size of the bone.

Eleven chevron bones were present. The articulations for the chevron bones began on the 15th vertebra of the lumbo-caudal series (counting from the front) in a pair of surfaces situated at the posterior border of the ventral surface of the body of that vertebra; and distinct articulations for these bones could be seen as far back as the 27th lumbo-caudal vertebra. Hence I have regarded all the vertebræ behind the 14th lumbar as caudal vertebræ. In the 1st caudal the ventral keel was very slight, and a shallow groove was seen posteriorly between the articulations for the 1st chevron bone.

The caudals behind the first were all grooved on the ventral surface, and the groove in many instances possessed considerable depth. The spines of some of the lumbar and the more anterior caudals had sharp bony outgrowths projecting from the posterior border.

Ribs.—There were fourteen pairs of ribs. The 1st was flattened, and measured in a straight line $25\frac{1}{4}$ inches on the left side and 25 inches on the right; the breadth of the sternal end of the 1st left was $4\frac{3}{4}$ inches. The 2nd rib was $37\frac{3}{4}$ inches long on the left side and $33\frac{1}{4}$ inches on the right side. The ribs increased in length, as far back as the 6th rib, which measured 4 feet 3 inches in a straight line; from the 7th to the 14th they diminished in size, and the last rib was 2 feet 3 inches in length; they were slender rod-like bones. All the left ribs were separate bones, but the right 1st rib was fused with the 2nd at the sternal end, where they formed a plate of bone $13\frac{3}{4}$ inches broad. The breadth was partly due to a broadening of the sternal end of the 2nd rib, and partly to the formation of bone in the 1st intercostal space, for a distance of 6 inches from the sternal end, which was fused with the borders of both the 1st and 2nd ribs, and, together with them, formed the broad plate above referred to. On the 3rd and 4th ribs well-marked capitular processes extended from the vertebral articular surface towards the body of the vertebra. Rudimentary capitular processes were present on the 2nd and 5th, but were absent on all the other ribs.

In all the skeletons of *B. borealis* which have previously been described, the 1st rib had the peculiarity of possessing two heads. In the Leyden specimen the cleft which separated these heads from each other had a depth of 5 inches (Flower). From the figure given by Rudolphi of this rib in the Berlin skeleton, it is probable that the cleft had a similar depth. In Lilljeborg's Bergen skeleton the 1st pair are considerably wider than the others, with the upper end forked or "biceps," and the lower rather dilated and much wider than the upper. In the Brussels skeleton, as figured by Van Beneden, one of the first ribs has the same character, and in the Museum of the Royal College of Surgeons of England are the first ribs of two individuals of this species, which are also bicipital. M. Fischer does not describe the skeleton of the Bayonne specimen, but notes that the spinal end of the 1st rib is bicipital. M. Van Beneden had the

advantage of seeing the ribs in place before the flesh was removed. He states that on the right side an elongated, compressed movable bone, curved like a rib, was applied to and articulated with the anterior surface of the 1st true rib, and on the left side a similar rudimentary rib was present, which was fused with the body of the first true rib, so as to give it a bicipital appearance. Both Professors Flower and Van Beneden regard this supplementary part of the 1st rib as a cervical rib, so that the double vertebral end of this rib articulates with both the 7th cervical and 1st dorsal vertebræ. In my skeleton no supplementary cervical rib was present. The two ribs which were fused together on the right side, at the sternal end, were the 1st and 2nd thoracic ribs, and differed therefore from the condition described in the other skeletons. The constancy with which the bicipital form of the 1st rib had been seen, in the skeletons of this animal previously described, had given rise to the impression that it might almost be regarded as a specific character, and the late Dr. J. E. Gray even went so far as to give it generic importance, and named Rudolphi's whale *Rudolphius laticeps*.¹ In a criticism which I made some years ago on the value of this character for purposes of classification,² I argued that the presence of a cervical rib, whether blended or not with the 1st thoracic rib, was only an individual variation, and, as cervical ribs occasionally occur in men as well as in whales, that one should as little think of classifying men who possess cervical ribs as distinct from those who do not possess them, as found a genus of whales on the presence of these bones. The absence of a cervical rib in the skeleton now described, which is an undoubted specimen of *B. borealis* or *laticeps*, shows that the bicipital form of the 1st rib is not constant in this species; but as the majority of the skeletons which have been examined have two heads to this rib, its bicipital character would seem in this animal to be the rule, and not, as in man, the exception.

Skull.—The skull resembled, both in its general configuration and in detail, the figures of the skulls of this animal published by Rudolphi and Van Beneden. The sides of the beak were straight;

¹ *Catalogue of Seals and Whales, and Supplement*.

² The so-called two-headed ribs in Whales and in Man, *Jour. of Anat. and Phys.* vol. v.

the premaxillaries projected 6 inches beyond the superior maxillaries. The upper surface of each nasal bone was $8\frac{1}{4}$ inches long, flattened in the posterior third, but slightly concave in the anterior two-thirds, owing to the inner border of that part of the bone being raised into a low longitudinal ridge. The anterior borders of the two bones were truncated, and formed together almost a straight line. The breadth of each bone at its posterior end was 1 inch, and at its anterior end $2\frac{1}{2}$ inches. The premaxilla passed back as a thin plate between the nasal and superior maxilla, as far as the posterior end of the nasal. The superior maxilla passed back for 3 inches beyond the posterior end of the nasal.

The orbital border of the frontal bone was 14 inches in length; the antero-posterior diameter of the inner part of this bone was 16 inches. The anterior borders of this bone sloped outwards and slightly backwards, whilst the posterior border was almost transverse.

The anterior border of the occipital bone was $10\frac{1}{2}$ inches wide, and almost transverse; the posterior border was $31\frac{3}{4}$ inches, and presented on each side from the foramen magnum outwards two concavities separated by an intermediate convexity.

The malar was 12 inches long, inclusive of the thin plate between the lachrymal and superior maxilla; the part which formed the proper lower boundary of the orbit was 8 inches. The lachrymal, $8\frac{1}{2}$ inches long, was a thin plate of bone except at the anterior end, which was tuberculated.

The beak arched in the antero-posterior direction from base to tip, and the highest point of this arch was 5 inches above the chord of the arc.

The mandible was not strongly curved. The length of the lower jaw in a straight line was 8 feet $5\frac{1}{4}$ inches; and along the outer convex surface 8 feet 8 inches. The superior border was 11 inches at its farthest point from the chord of the arc. The coronoid process was low and triangular, its base was $8\frac{1}{2}$ inches long, and its height from the base line was $3\frac{1}{2}$ inches. The depth of the mandible, including the coronoid process, was $11\frac{3}{4}$ inches.

The hyoid closely resembles Rudolphi's figure, and, as it has not hitherto been properly described, and is so characteristic of this species, I shall give an account of it. The inferior surface of the

middle of the body was slightly concave from side to side, and slightly convex from before backwards. The posterior border of the body was convex, and projected backwards considerably behind a line drawn across between the posterior border of the two great cornua. In this character it differed very markedly from both *B. sibbaldii* and *B. musculus*. The great cornu was flattened on its upper and slightly convex on its under surface, with the anterior border a little more rounded than the posterior; its antero-posterior diameter was almost uniform until near the tip. In *B. sibbaldii*, again, the great cornu swelled out so as to assume a remarkable fusiform shape, and to a less degree this is also seen in *B. musculus*. The stylo-hyals were flattened on both surfaces and $13\frac{1}{2}$ inches long. The hyoid measured between the tips of the great cornua 21 inches.

The following table gives, in feet and inches, the principal dimensions of the skull:—

	FT.	IN.
From anterior border of foramen magnum over vertex to tip of beak,	8	$9\frac{1}{4}$
From nasal end of superior maxilla to tip of beak,	6	9
From anterior border of foramen magnum to nasal end of superior maxilla,	2	$0\frac{1}{2}$
Breadth across posterior ends of superior maxillæ,	0	$8\frac{3}{4}$
Greatest breadth of skull,	3	$10\frac{1}{4}$
Breadth of skull at base of beak,	2	6
Breadth of skull at middle of beak,	1	$5\frac{1}{2}$
Breadth of skull between middle of orbital borders of frontals,	3	$7\frac{1}{2}$
Length of skull in a straight line (condylo-premaxillary),	8	$7\frac{1}{4}$
Length of beak,	5	9
Length of superior maxilla,	6	3
Length of premaxilla,	6	$6\frac{1}{2}$
Greatest breadth of superior maxilla behind base of beak,	3	7
Greatest breadth between outer borders of both premaxillæ,	0	10
Greatest breadth of space between both premaxillæ,	0	8
From foramen magnum to upper border of occiput,	2	0

I have compared the tympanic bones with those of *B. rostrata*—the smallest—and *B. sibbaldii*—the largest—of the fin whales. Their dimensions expressed in inches were as follows:—

	Immature. <i>B. rostrata.</i>	Adolescent. <i>B. borealis.</i>	Immature. <i>B. Sibbaldii.</i>	Adolescent. <i>B. Sibbaldii.</i>
Length,	3·5	4·8	4·7	5·3
Breadth,	1·8	2·2	2·5	2·6

In *B. rostrata* the breadth index was 51, in *borealis* 46. The

greater relative breadth of *rostrata* was due to both the outer and inner surfaces being generally more convex; but the anterior part of the outer surface of *rostrata* possessed a concave area more distinctly marked than in *borealis*. In *rostrata* the superior border between the two attachments of the petrosal was more horizontal than in *borealis*, and in the same specimen the posterior attachment of the petrosal was nearer the hinder end of the bone, which was more rounded in *rostrata* than in *borealis*. In *rostrata* the entrance to the tympanic cavity was relatively wider, with the rounded border relatively thicker; whilst the inferior border was less distinctly keeled than in *borealis*. In the adolescent *B. sibbaldii* the tympanic was broader in relation to the length than in *borealis*, and this greater relative breadth was still more strongly marked in the immature *sibbaldii*, the breadth indices in the two specimens being respectively 49 and 53. The greater breadth of *sibbaldii* was especially seen in the posterior third of the bone, which bulged considerably on the inner surface in *sibbaldii*, and was almost flat in *borealis*. This bulging caused a broadish concave surface at the root of the posterior attachment of the petrous bone in *sibbaldii*, whilst the corresponding area in *borealis* was a narrow groove. In *sibbaldii* the entrance to the tympanic hollow was more sinuous, and the rounded border of the bone much thicker than in *borealis*. In *sibbaldii* the anterior and posterior ends were less attenuated than in *borealis*. Through these characters there was no difficulty in distinguishing between the tympanics of these species, and the character which most impressed me in making this comparison was the relative want of breadth of *borealis*. I have not a tympanic bone of *B. musculus* at hand with which to compare my specimen, but from my recollection of a specimen I saw in the Royal Museum, Brussels, in May of last year, I should say that in *musculus* the tympanic had a greater breadth than in *borealis*.

Pectoral Limb.—The scapula was a triangular plate, measuring 29 inches between its superior and inferior angles, and $17\frac{1}{2}$ inches in its glenoido-vertebral diameter. The coracoid was $\frac{3}{4}$ inch long, and $2\frac{1}{4}$ in its greatest breadth. The acromion was $6\frac{3}{4}$ inches long, and 4 in its greatest breadth. The humerus was only 11 inches long, and 1 foot $2\frac{1}{4}$ inches in circumference at the middle of the shaft, the surfaces of which were somewhat flattened. The

ulna was 11 inches long, $5\frac{3}{4}$ broad at the upper end, measured across the olecranon, $3\frac{1}{4}$ at the lower end, and only $2\frac{1}{4}$ in breadth in the middle of the shaft. The radius was $20\frac{1}{2}$ inches in length, and with much less difference in breadth between the upper and lower ends and the middle of the shaft than was seen in the ulna.

Thirteen carpal bones were present, and one was probably missing. Five pairs of these bones were nodular, in part tuberculated on the surface, and in part with flattened articular-looking surfaces, well marked in four pairs, very imperfect in one pair. One pair and the single bone were flattened, elongated, and uniformly tuberculated, without any appearance of an articular surface.

Thirty-three finger bones were present, and some of the smaller phalanges were either unossified or probably missing.

The comparison which I have so far made of the Bo'ness whale with other specimens has been with skeletons admittedly those of *B. borealis*, and obtained in the North Atlantic. But in the Leyden Museum is a skeleton brought from the north-west coast of Java, named, after Professor Schlegel, *Balænoptera Schlegelii*, which Professor Flower, who first described it, regarded as closely allied to, if not specifically identical with, *B. borealis*, though, on account of its *habitat*, he had a difficulty in placing it with *borealis*.¹ This skeleton was more perfectly ossified than in my specimen, and belonged to an animal probably about 45 feet long. I have compared my skeleton with Professor Flower's description and figures, and with the additional description and illustrations of its skeleton in Pls. XIV. and XV., and on p. 221 of the *Ostéographie des Cétacés*, and without doubt the resemblance is in many particulars very striking.

The mandible with its low coronoid process, the profile outline of the skull, the flattened stylo-hyals, the general form of the tympanic, the cervical vertebræ, the general form of the dorsals and lumbar (the latter with their spiculated spines), the scapula, the humerus, radius, and ulna, all closely corresponded. The Java specimen possessed also fourteen pairs of ribs and fifty-four vertebræ, C₇ D₁₄ L₁₄ Cd₁₉. Professor Flower thinks that three or four caudals are wanting, but Professor Van Beneden considers only one or two are missing.

¹ *Proc. Zool. Soc.*, London, Nov. 8, 1864.

On the other hand, the nasal bones are obviously flatter and longer; the antero-posterior diameter of the orbital border of the frontal is relatively not so long; the double curve of the posterior border of the occipital is not so marked, and its base is wider (Van Beneden) in *Schlegelii* than in *borealis*. Again, my specimen does not have a pair of strong tubercles projecting from the posterior border of the body of the hyoid, as in the Java specimen, and the first rib is not bicipital.

Some of these differences may be due to the more advanced ossification of the Java skeleton, and the longer and stronger spines of the dorsal and lumbar vertebræ, which M. Van Beneden refers to, are obviously due to the same cause. The greater length of the Java skeleton has not the importance which Van Beneden attaches to it, as I have already maintained that *borealis* may attain a length of 40 feet or upwards, and the ribs in the Java specimen corresponded in number with those in my skeleton.

At the time when Professor Flower wrote his description, there was a greater tendency, on the part of cetologists, to limit the area of distribution of the individual species of cetacea, than now exists, and to confer specific value upon specimens which, though in many respects similar in characters, yet came from distant seas. The wider range of distribution of some of the species of the marine mammals is now more generally recognised, and the remoteness of the *habitat* of Schlegel's *Balænoptera* ought not, if the anatomical arrangements correspond, to bar its association with *B. borealis*.

2. On Minding's Theorem. By G. Plarr.

In treating, by the method of quaternions, the question which forms the basis of *Minding's Theorem*, I had the advantage of being guided by Professor Tait's paper on that subject (*T. R. S. E.*, 1880), and it is only by varying his method that I could hope to present the question under a new aspect.

§ 1.

Let us apply the operator

$$p(\)q$$

of a conical rotation, where $q = p^{-1}$, to a system of given vector-