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On a Skeleton of a Whale in the Provincial Museum, Halifax, Nova Scotia; with Notes on the Fossil Cetacea of North America.

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Skeleton of a Whale from Jacquet River, New Brunswick.

In the *Transactions of the Nova Scotian Institute of Science,* vol. ii., pp. 400-404, 1873, Dr. J. Bernard Gilpin published "Observations on some Fossil Bones found in New Brunswick." In course of a study of the fossil cetacea of North America, the attention of the author was directed to the above article, and learning that the bones described by Dr. Gilpin were preserved in the Provincial Museum of Nova Scotia, at Halifax, enquiries concerning them were sent to Mr. Harry Piers, the curator, and by his courtesy the specimens were sent from Halifax in order that they might be carefully studied and compared with the skeleton of the Vermont specimen with which the Canadian bones had been considered identical.

The account written by Dr. Gilpin is brief and without illustration, and he had no similar bones with which he could

compare those in which he was especially interested. Hence it will not, it is hoped, appear an unnecessary undertaking to give a full description with illustrations of different bones, of this very valuable and interesting specimen.

The bones described by Dr. Gilpin were found in a cutting of the Intercolonial Railway on the Jacquet River, Bay de Chaleurs, New Brunswick. "After cutting through about twelve feet of sand and gravel a bed of clay was reached. In this the bones were bedded." Numerous shells common in Pleistocene deposits, as *Saxicava, Mya, Macoma,* occurred in the clay.

There came to the writer from the Halifax museum twenty-three bones, namely: two fragments of the basioccipital, both scapulas, though considerably broken, one periotic, the sternum, four dorsal vertebræ, five lumbar vertebræ, eight caudal vertebræ. Dr. Gilpin mentions "a small portion of the atlas, twelve fragments of the skull, about one half of a lower jaw, one humerus, radius, ulna, phalanx," in addition to those named above. These bones appear to have been mislaid. At any rate they were not among those which I received. All the bones are chalky, brittle, and more or less broken. Of the total skeleton, the following bones are represented:

The Periotic.—The left periotic is all that was found of the ear bones. This bone has, as the lower figures on plate I show, the usual irregular form. This can be better appreciated by examination of the figures than by any verbal description. It is shown in the figures of natural size.

No other bones of the head, except two fragments from the base of the skull were among those sent. It is especially unfortunate that more of the cranium was not found, for, as will appear later, if we could have the front part of the rostrum it would be easy to determine with absolute certainty at least the genus of this specimen.

Vertebræ.—It should be noticed that plate II shows the vertebræ that were sent, very much reduced, except one, that would have been the last, accidentally omitted by the photographer, arranged as nearly as possible in their natural position; but as more than half of the series are missing, the order must at best be much broken.

As will be seen, all are more or less imperfect as to the processes. The centra are in very good condition. In only two is the neural arch complete, and only one neural spine remains. The transverse processes, though badly broken, have fared somewhat better, and five or six of them are sufficiently whole to indicate fairly well their original form. As would be expected from the different form of the caudals, the above remarks do not apply to the last three or four in the plate. No *cervicals* have been seen and the first four or five dorsals are also wanting.

Dorsal vertebræ.—There are four dorsal vertebræ present. That placed first is undoubtedly one of the anterior bones of the series, but, as indicated, not one of the first. This is shown by the evident carina on the under side.

As shown in the top figure, plate III, the neural arch is complete, but the transverse processes are nearly gone. On plate III, this and other vertebræ are shown about one-third natural size. From comparison with skeletons of recent individuals, it is inferred that this bone was about the fifth or sixth in the dorsal series.

The body, or centrum, is somewhat concave above and distinctly carinated below. It is, measured anteriorly, as are all that follow, 60mm. ($2\frac{3}{8}$ inches) wide, 52mm. (2 inches) high, and 65mm. (2 9-16 inches) long. In this the neural canal is much larger than in any of the vertebræ that follow. It is 48mm. ($1\frac{7}{8}$ inch) high, and 73mm. ($2\frac{7}{8}$ inches) wide. The

ends of the centrum are nearly flat, the posterior slightly concave.

The following vertebræ are probably nearer the end of the series, as it appears that between first and second, in the figure, three or four bones are wanting.

As the figures show, in the second vertebra, the neural arch is quite destroyed, but the left transverse process is in very good condition. The centrum is much heavier than in the first. Its dimensions are:—length 72mm. (2 15-16 inches), width 65mm. ($2\frac{1}{2}$ inches), height 60mm. (2 5-16 inches), neural canal 70mm. ($2\frac{3}{4}$ inches) wide.

The transverse process is stout, much thickened at the end, flat above, convex below. It is nearly perfect, and is 76mm. (3 inches) long, 32mm. ($1\frac{1}{4}$ inches) wide next the centrum, and 51mm. (2 inches) wide and 25mm. (1 inch) thick at the end. This bone is shown in plate IV, upper figure. In the third bone, which is probably the eighth or ninth dorsal, we have perhaps the most complete of the series. The neural arch and transverse processes are fairly complete, as the figures show. The centrum of this vertebra is 61mm. ($2\frac{3}{8}$ inches) high, 70mm. ($2\frac{3}{4}$ inches) wide, and 76 mm. (3 inches) long; the neural canal is 37mm. high, and 57mm. wide. The left transverse process, which is most complete, is 92mm. long. The last dorsal in the specimen, fourth of 1st series of plate II, is perhaps the eleventh. The centrum, especially beneath, has the characters of the lumbars. It is 65mm. ($2\frac{1}{2}$ inches) high, 70mm. ($2\frac{3}{4}$ inches) wide, and 82mm. ($3\frac{1}{4}$ inches) long. The left transverse process is quite complete, and shows all the features of that part of the bone. It is 121mm. ($4\frac{3}{4}$ inches) long.

Lumbar vertebræ.—In the absence of chevrons it is difficult to determine the point where the lumbars pass into the caudals, but five of the bones are considered as lumbar. The bodies lengthen and the vertical diameter increases towards the caudal

end. All have a strong inferior carina, but it decreases towards the caudal end.

The first vertebra of the second set, plate II, appears to belong to the anterior portion of the series, third or fourth. The centrum is 68mm. ($2\frac{5}{8}$ inches) high, 71mm. ($2\frac{3}{4}$ inches) wide, and 85mm. ($3\frac{3}{8}$ nches) long. As in all lumbars, the transverse processes are, compared with the dorsal, thin and flat. All are so broken that it is not possible to ascertain the length with exactness.

The most typical cetacean lumbar is that shown in the third figure from the top in plate IV. This is more perfect than the other lumbars, and the left transverse process is nearly complete. It is the only process that shows the widened ends found normally in all these vertebræ. This was probably the third or fourth in the actual series. The measurements are as follows: height of centrum 69mm. ($2\frac{3}{4}$ inches), width 71mm. (2 13-16 inches), length 87mm. ($3\frac{1}{2}$ inches). The transverse process is 114mm. ($4\frac{1}{2}$ inches) long, and 60mm. ($2\frac{3}{8}$ inches) wide at the end. The length was originally slightly greater, as the end is somewhat broken. In all cetacea the spines of the lumbars are very long, and were these present in this specimen they would give a different aspect to the series. The remaining lumbars do not offer any essential differences. That which appears to be the last, has the centrum rather more nearly circular, the width being only a little more than the height, and the neural canal is considerably less, its width being 35mm. ($1\frac{3}{8}$ inches).

Caudal vertebræ.—The eight remaining vertebræ are considered caudal. As the lower series, plate II, indicates, there is much difference between the first and the last lower right hand figure, plate IV. The whole series of caudals, except one as stated before, is shown in plate II, lower series. If there were originally twenty-six caudals, of course this series must be very incomplete.

As we have them, the changes may be in some measure noted by a study of the bodies which increase in size to the fourth of the series, and then suddenly decrease. There are evidently several vertebræ missing between the third and fourth vertebræ, plate II.

In the third the body is larger than in any other of the whole series. Here also the spine has an entirely different form from that found in the preceding bones. It is not only shorter, and relatively broader, but, as may be seen in plates II and IV, there are short, blunt metapophyses. The centrum here has a height of 87mm. (3½ inches), a width of 83mm. (3¼ inches), and a length of 95mm. (3¾ inches). The neural canal, however, is reduced to a width of only 10mm., or a seventh of that in the first vertebra mentioned. The transverse processes are also reduced to mere ridges, and they soon grow so small as to be hardly noticeable, and in the last have nearly disappeared.

As seen, though not as distinctly as might be desired, there is a backward projection from the spine in *h* so that the whole ridge, rather than process, is as long as the body. In the caudal last on plate IV, the body is nearly circular. None of the button or discoid vertebræ, such as always form the final portion of the tail, are present. Apparently, there should be at least twelve after the last shown in plate II. The caudal that was accidentally left out when the bones were photographed as seen in plate II, is seen in the last plate IV.

As stated, there were probably twenty-six caudals originally. If twelve of the eighteen missing bones should come after the last in plate II, then six should be placed between the third and fourth of the last series in plate II, or at any rate in that region.

Chevrons.—No chevrons were with the bones received from the Halifax museum. In the plate of the skeleton of *Monodon,* Van Beneden and Gervais (*Osteographie des Cetaces*) there are fourteen chevrons.

When laid in continuous series, as in plate II, the vertebræ measure 135 cent. (55 inches) in length. Of course this leaves out all intervertebral cartillages which would add materially to the total length of the column. The whole of the cervicals and the head are also to be added to complete the original length.

As far as it has been possible to determine by comparison with skeletons from recent specimens, the Halifax whale was not far from twelve feet long when living. This corresponds well enough with measurements of recent individuals. If this specimen should be referred to Monodon, as I have little doubt twelve feet would be a fair length for a medium-sized specimen.

The following table of measurements of the different vertebræ will not be without interest to one who may wish to make a thorough examination of the specimen. All the measurements were made at the anterior face of each vertebra:

Measurements of the vertebræ of the Halifax whale.

	Length of body.	Width of body.	Height of body.	Width of neural canal.
		DORSALS.		
a	65mm.	60mm.	52mm.	73mm.
b	72mm.	70mm.	60mm.	70mm.
c	76mm.	70mm.	61mm.	57mm.
d	82mm.	70mm.	65mm.	48mm.
		LUMBARS.		
e	85mm.	71mm.	68mm.	48mm.
f	87mm.	71mm.	69mm.	43mm.
g	90mm.	73mm.	73mm.	40mm.
h	90mm.	75mm.	74mm.	37mm.
i	93mm.	76mm.	75mm.	35mm.
		CAUDALS.		
j	93mm.	78mm.	76mm.	32mm.
k	93mm.	81mm.	77mm.	25mm.
l	94mm.	83mm.	77mm.	22mm.
m	95mm.	87mm.	80mm.	10mm.
n	69mm.	85mm.	83mm.	10mm.
o	66mm.	77mm.	83mm.	8mm.
p	56mm.	65mm.	70mm.	5mm.
q	49mm.	62mm.	70mm.	4mm.

In discussing individual vertebræ, many of the resemblances and differences existing between them have been noticed. A few additional points may be mentioned.

The centra vary slightly from vertebra to vertebra. This may be seen in plates III and IV, if different figures are compared. It will be seen that the form changes as we pass from the anterior dorsals back. This is better seen if the table of measurements be examined. Here it will be found that the length of the body increases from the beginning back to the 13th, of the series as given in plate II. The great diminution between the 13th and 14th indicates that several bones are lacking, but from the 13th the length of the body decreases rapidly, and had we the final caudals, the shortening of the bodies would be still more apparent. The width of the centra increase up to the same vertebra, while the height increases beyond to the last but one, and from here is a rapid decrease. That is to say, the centrum of each vertebra is wider than high to and including the 14th of the fossil series. In the next vertebra the width is considerably less than the height, and so remains in the rest of the series.

The neural canal is largest at the beginning, top figure, plate III. Here it is broadly oval, much wider than high, but in *c*, which, unfortunately, is the only other vertebra in which both height and breadth can be measured, until we go back nearly to the end of the caudals, the width is reduced to from 73mm. to 57mm., and the height 73mm. to 38mm., and so on until in the last caudal we have it only 4mm. wide and about the same in height.

Sternum.—This bone is very thick and large, and, in the fossil, spongy in texture. As plate I shows, its general outline is triangular. The segments are entirely anchylosed so that no trace of sutures remains. Although the bone is not perfect, as will readily be seen, still enough remains to supply a fair indication of its complete form. Articular surfaces for

three ribs are plainly seen, but those for the remaining three cannot be well made out. It is reduced one-half in plate I.

While on account of the condition of the bone, exact measurements cannot be made, yet it may be well to notice that as we have it, the total length is 229mm. (9 inches), width across the upper end 191mm. (7½ inches), width across the articular spaces at the lower end, 83mm. (3¼ inches), thickness at the upper part 38mm. (1½ inches), average thickness rather more than 18mm. (¾ inch). The whole bone is somewhat curved longitudinally.

Scapula.—Both scapulas were preserved, but in a much broken condition, so much so that the original form cannot be made out. It is, however, most probable that these bones had the same form as in recent specimens of *Monodon.* They appear to have been thin and thus easily broken. A considerable part of the glenoid cavity is present in each scapula.

Specific position.—In Dr. Gilpin's account of this specimen we find the following, "The fragment of the lower jaw so exactly resembles the cut in Dana's *Geology,* of *Beluga vermontana,* as to hazard the conjecture that they are closely allied if not identical." Students of anatomy do not need to be told that this is very slight foundation for regarding the two specimens as of the same or allied species. Dr. Gilpin's account was published in 1873, and since then, the Halifax specimen has been assumed to be the same as Thompson's Vermont specimen.

After the bones were received from the Halifax museum they were compared with those of the Vermont specimen, and it soon became evident that the two were in important respects unlike. Had the Halifax specimen been as complete as is the Vermont, it is certain that the differences would have been more numerous and more marked.

Very fortunately, there is one periotic with each skeleton, and thus we can compare what is probably the most important

bones of all for specific identification. Plates I and VIII show these, and the dissimilarity must be evident to anyone who examines them with care.

The sternum in the Halifax whale also presents important differences from that of the Vermont one, as plates I and VII show. The various vertebræ in each skeleton present greater or less differences.

It is perhaps unnecessary to go into a detailed comparison of the two sets of bones. It will be sufficient if a few of the more important points are mentioned.

As will be seen by comparing the sternums of the two whales, there is a marked dissimilarity in the form. It should be stated here that the two are not shown in the plates on the same scale, hence this must be taken into account in comparing them. The Halifax sternum is shown on plate I a little less than half, exactly 4-9ths, natural size; while the sternum of the Vermont whale, as shown in plate VII, is one-third natural size. It will be noticed that the Halifax specimen is much wider relatively across the top, and tapers more rapidly from the top down, and it is thicker at the top than is the Vermont specimen. The latter is probably longer; but the lower end of the Halifax bone is broken, so that its actual length cannot be ascertained.

As to the more important bone, the periotic, I am happy to be able to quote the opinions of others who are much better able to decide questions in cetacean anatomy than the author. After examination of photographs of the Halifax periotic, Dr. F. W. True wrote as follows: "As regards the Nova Scotia specimen, I think that there is no doubt that it is not *Delphinapterus,* on account of the shape of the periotic and short lumbar vertebræ. Our skulls of *Monodon,* unfortunately, are without the periotics so that I cannot make comparisons of importance, but Van Beneden's and Gervais' figures indicate a shape similar to that shown in your photographs." Much to my regret I could not

show the actual bone to Dr. True, but at the time of my visit to the American Museum in New York, I had the bone and was able to leave it with Mr. Andrews, who later wrote concerning it: "I have just finished a comparison of the periotic bone which you sent with that of *Delphinapterus leucas* and of *Monodon monoceros*. As soon as I looked at the periotic of this specimen, it seemed to resemble very closely the corresponding bone of *Monodon*. A comparison shows that in size and general shape it agrees very much better with *M. monoceros* than with *D. leucas*. In fact the whole shape of the bone is decidedly unlike *Delphinapterus*. In order to verify my opinion, I showed the specimen to Dr. W. D. Matthews, and he agreed with me that while there are some points of difference between the periotic of this specimen and that of *Monodon*, yet it is certainly closer to that genus than to *Delphinapterus*. Your specimen, on the other hand, agrees well with *Delphinapterus*, consequently it would seem to me unlikely that it and the Halifax whale can be of the same species or even the same genus. . . . . The tympanic and periotic are, so far as I am aware, subject to less individual variation than any other bones in the cetacean skeleton, and the remarkable difference shown in the Halifax whale would seem a pretty good ground for a close examination of the species if it has been referred to *Delphinapterus*. Of course if you could see the rostrum of the Halifax specimen and determine whether or not the upper teeth were present, it would simplify matters very greatly, for *Monodon* has no teeth aside from the tusk." The above is, I think, conclusive as to placing the Halifax specimen in the genus *Monodon*.

Only a single living species of this genus is recognized by any of the authorities. Whether the fossil specimen is to be referred to the living speciese, or should be placed in a species by itself, cannot well be settled from the material in hand. Undoubtedly, the fossil bones are very much like corresponding

bones in the living species. I have compared them with specimens in the American Museum at New York, and, while some differences certainly do appear, yet it seems to me that on the whole it would not be wise to create a new species where there is so close similarity.

Nicholson and Lyddeker, *Manual of Palaeontology*, page 1307, say: "Remains of Narwhal, *Monodon monoceros*, are found in the Norfolk Forest bed and the Pleistocene of Alaska."

At present, *Monodon* has been, though rarely, taken as far south as England. *Monodon* and *Delphinapterus* are closely allied species, and Flower, *Trans. Zoological Society*, London, 1886, placed these two genera in a group, *Belugineæ*, which includes no others.

Notes on fossil cetacea of North America.

It may add to the value of this article if a few notes on other fossil cetaceans are included. This is the more true because nearly all the specimens of this order that have been found have occurred in Canada. One of the most perfect skeletons is that described by Thompson from Vermont, and, with the possible exception of a few isolated bones, this is the only specimen that has been found in the United States. The following is, so far as I can ascertain, a list of all the specimens thus far discovered:

I.—1849. A nearly complete skeleton; Charlotte, Vermont; Professor Z. Thompson. State Museum, Montpelier, Vermont.

II.—1858. Several caudal vertebræ; Mile-end Quarries, Montreal; Sir W. Logan. Museum of the Geological Survey, Ottawa.

III.—1864. A few bones; Riviere du Loup, Ont.; Sir J. W. Dawson. Peter Redpath Museum, Montreal.

IV.—1870. A nearly complete skeleton; Cornwall, Ont.; Mr. E. Billings. Geological Survey Museum, Ottawa.

V.—1874. A considerable portion of a skeleton; Jacquet River, N. B.; Dr. J. B. Gilpin. Provincial Museum, Halifax, N. S.

VI.—1883. A few vertebræ and fragment of a rib; Smith's Falls, Ont.; Sir J. W. Dawson. Redpath Museum.

VII.—1891. A portion of the lower jaw of a large whale; Metis, Quebec; Sir J. W. Dawson. Redpath Museum.

VIII.—1895. A nearly complete skeleton; Smith's brickyard, Montreal; Sir J. W. Dawson, Redpath Museum, Montreal.

IX.—1901. A hyoid, ribs and other bones; Williamstown, Ont.; Mr. E. Ardsley. Redpath Museum.

X.—1901. Several vertebræ, ribs and parts of cranium; Smith's brickyard, Montreal. Redpath Museum.

XI.—1906. Most of the skull, several vertebræ; Pakenham, Ont.; Dr. J. F. Whiteaves. Not in a museum.

The following notes on the above specimens may not be without value to those who have not ready access to the skeletons themselves. With the exception of the Pakenham specimen, the author has examined all the specimens named in the list. Hearty acknowledgments are due Mr. Harry Piers, Provincial Museum, Halifax, N. S.; Mr. Edward Ardsley, of the Peter Redpath Museum; Dr. Whiteaves and Mr. Lambe of the museum of the Geological Survey of Canada, Ottawa, for freely giving all possible aid in the examination of the specimens in those museums.

I.—The Vermont specimen, plates V-VIII, has been longest known and has often been considered as the type to which most of the others since discovered have been referred. For this reason, as well as for the sake of adding completeness to this paper, a somewhat full account of this historic specimen may be given in this connection. Plate V shows this specimen as now mounted in the Vermont museum. Very unfortunately, the mounting was not done by an anatomist, and most of the

vertebræ back of the dorsals are reversed. The cranium was badly shattered when found, and was restored in some respects very satisfactorily, but in others quite erroneously. The mounting was done some fifty or more years ago, and the bones are so easily broken, though much less fragile than those of the Halifax specimen, and the rods used in mounting the separate bones have so rusted that, while the curator hopes at some time to remount the skeleton, he has not as yet ventured to undertake the task.

In the plate the upper figure shows the entire skeleton reduced to about one-fourteenth natural size, and the two lower show most of the vertebræ reduced to about one-third natural size.

Those interested in cetacean anatomy will find it profitable to compare plate V with plate II, which shows the vertebræ of the Halifax specimen. Like most of the remains of cetacea found in pleistocene deposits, the Vermont specimen was discovered in a bed of clay, "between eight and nine feet below the surface," in a railroad cut. They were secured by Professor Z. Thompson, who studied and described them, but with very poor illustrations, and after considerable deliberation placed the animal in a new species, believing, and as recent investigations show rightly, that while very closely allied to the living white whale, *Delphinapterus leucas,* it nevertheless presented differences of sufficient importance to warrant its separation specifically from the living form.

The following named bones were found and are now preserved in this skeleton. The cranium was badly broken, but enough fragments that could be pieced together were found to, as Thompson says, "determine very nearly the form and entire length of the head and of one side of the lower jaw, and of its symphysis with the other side."

From the alveoli it appears that the animal had seven teeth in the lower jaw and eight in the upper on each side, or thirty in all. Only nine of these were found. Forty-one vertebræ

were found, four cervical, eleven dorsal, ten lumbar and sixteen caudal. Five of the chevrons were saved, the right periotic, sternum, hyoid, both of which are large and heavy, the scapulas, one humerus, both ulnas, one radius, more or less complete portions of nine pairs of ribs and fragments of others. Thus while somewhat less complete than either the Smith's brickyard or the Cornwall specimen, a large majority of the bones have been preserved in the Vermont specimen, including some, as the periotics, not found in the others.

II.—The bones discovered in 1858 in the clav near Montreal, are now in the museum of the Geological Survey at Ottawa. They are mostly caudal vertebræ, but there are several lumbars among them. In all there are twenty vertebræ. Thus a considerable portion of the caudal series is present. Probably not more than five or six are wanting. The spines, neural arches and transverse processes in most are present. Of course these are smaller and stouter in the caudals, after the first few, than elsewhere, and would therefore be more likely to withstand unfavorable conditions. These processes are, however, more or less incomplete in all. These vertebræ do not differ essentially in size or form from those in the Cornwall specimen. As now mounted with the intervertebral cartilages supplied by wooden disks, the total length of the series is sixty-five inches.

In "Superficial Geology of Canada," Geological Survey, Canada, page 919, Sir W. Logan says, "At the mile-end quarries, Montreal, upon a slight ridge are found stratified sand and gravel holding boulders and shells in the lower part. The deposit sometimes rests directly on the limestone rock, which is at other times covered with a thin layer of boulder formation. . . . A thick deposit of this clay is seen at the brick-yard of Messrs. Peel and Comte, where it is overlaid by Saxicava sand, and has furnished one of the pelvic bones of a seal, and several of the caudal vertebræ of a cetacean, *Beluga vermontana,* besides fragments of white cedar."

III.—In the Riviere du Loup specimen there are preserved only a portion of the atlas and one caudal vertebra which is one of the posterior portion of the series.

IV.—This is a very fine and nearly complete skeleton. It is well mounted and is in the Ottawa Geological Survey Museum.

For a copy of the following account by Mr. E. Billings, I am indebted to Dr. Whiteaves. "Several months ago, Mr. Charles Poole, of Cornwall, wrote to the secretary of the society that a large skeleton, resembling that of *Ichthyosaurus,* had been found in the neighborhood, by the men engaged in excavating clay for brick. In another letter he stated that Mr. T. S. Scott had procured the lower jaws, and states that Mr. Scott presented the jaws to the geological museum." Mr. Billings then went to Cornwall and obtained from Mr. Poole the bones which were in his possession. "These were discovered in Post-pliocene clay about sixteen feet below the surface. They are those of a small whale closely allied to the white whale, *Beluga leucas,* which lives in the northern seas, and at certain seasons abounds in the Gulf of St. Lawrence. The lower jaws are nearly perfect. The skull and upper jaws are much damaged and some of the parts lost. Thirty-five of the vertebræ, the two shoulder blades, most of the ribs, and a number of small bones were collected. The length of the animal was probably about fifteen feet. The lower jaws have the sockets of eight teeth upon the right side and seven on the left." E. Billings, *Canadian Naturalist and Quarterly Journal of Science,* vol. v., pp. 438-9.

Some of the parts of this skeleton are more perfect than in any other that has been found; but taken all in all, this and the best specimen in the Montreal museum are about equal, and both rather more perfect than the Vermont specimen. However, each has some portions that are lacking in the others.

As mounted in the Ottawa museum the Cornwall whale is twelve feet and one inch long. The cartilages have been sup-

plied by wooden disks. There are present the following parts: The cranium is tolerably complete, but broken at the rostral end and also in the occipital region. Measured in a straight line from the front of lower jaw, which being perfect locates the missing part of the rostrum, the upper jaw being broken at the end, to the lower part of the foramen, the length is twenty-one inches, and nine and a half across the condylar region. There are no teeth, but alveoli for eight on each side of the upper and right side of lower jaw, while on the left side of the latter, there are only seven alveoli. No ear bones were found. The hyoid and one stylohal are present.

There are thirty-eight vertebræ, viz., all the seven cervicals, ten dorsal, ten lumbar, eleven caudal and one chevron. In all but four, the spines are complete, and nearly so in one of these. The neural arch is seen in all but two. The transverse processes are present in all, but in all are more or less broken, though not badly in many. The bodies increase in length from the cervicals backwards to the tenth lumbar. In the cervical behind the axis the length of the body is one-half inch, and in the largest it is four and a quarter inches.

Probably not less than thirteen caudals are wanting from the end of the column.

The scapulas are not only both present, but are in excellent condition. Each is somewhat broken on the border, but as they are not broken in the same part it is possible by taking them together to make out the entire outline. Even the very long and slender coracoids are perfect. Each bone measures from the top border to the glenoid border eight inches, and ten inches across the upper border. The coracoids are nearly ten inches long on the upper border.

The humerus, like all the arm bones, is rather short and stout. It is five and a half inches long; the radius is three and a half, and the ulna four and a quarter inches.

There are ten ribs on the right side and nine on the left. Some of them are considerably broken, but others are nearly perfect. The longest in this skeleton is the fifth, which from vertebra to sternum, is thirty-five inches on the outside curve. This specimen is more perfect than any other in its vertebræ and scapulas.

V.—This is the Halifax specimen, which is described in the first part of this paper.

VI.—In *American Journal of Science,* 3rd series, vol. xxv., p. 200, Dr. Dawson writes: "Bones of large whales are not of infrequent occurrence in the lower St. Lawrence. The bones found on lower and therefore modern terraces are usually in a good state of preservation, and have a very recent appearance." After mentioning several specimens of "Beluga," all of which are discussed in these pages, Dr. Dawson mentions particularly several large bones found in a gravel pit thirty feet below the surface.

In *Canadian Ice Age,* p. 268, Dr. Dawson refers to these bones as follows: "*Megaptera longimana,* Gray. Portions of a skeleton of this species were found in 1882 in a ballast pit of the Canadian Pacific Railroad, three miles north of Smith's Falls, Ontario, 31 miles north of the St. Lawrence River. They were imbedded in gravel along with shells of *Tellina grœnlandica,* apparently on a beach of the Pleistocene period, at an elevation of 440 feet above the sea, which corresponds nearly with one of the principal sea-coast terraces on the Montreal mountain and other parts of the St. Lawrence valley."

These bones, now in the Redpath Museum, consist of a dorsal, a lumbar vertebra, part of the neural arch of another, and a part of a rib. The centrum of the lumbar is ten inches in diameter and from tip to tip of the transverse processes it is thirty inches.

The bones have a much fresher appearance than those of the other fossils here recorded. Dr. Dawson says of these: "I have no doubt that they belong to the Humpback Whale, *Megaptera longimanas* (*boops*).

VII.—In *Canadian Ice Age,* page 269, Dr. Dawson writes: "I secured last summer, 1891, a large jaw-bone found in digging a cellar in the shelly gravel of the lower terrace at Metis." This fragment, for the interior portion is wanting, is over eleven feet long and eighteen inches wide near the articular end.

VIII.—This is one of the finest of our fossil cetacea. It includes nearly all the bones of the skeleton, and most of them are in very good preservation.

The cranium is better in this than in either the Ottawa or the Vermont specimen, although it lacks ear bones. The lower jaw is less perfect. The hyoid, one stylohyal and part of the other are present. Nine teeth are preserved in the upper jaw and two in the lower. Both scapulas and all the arm bones are present, but no phalanges. There is also a considerable part of the sternum.

In all, thirty-six vertebræ are seen in the skeleton. These are all the cervicals, ten dorsals, ten lumbars and nine caudals. There are no chevrons. Most of the vertebræ are essentially complete. All except two have at least a part of the neural arch and spine, and in most these are in good condition. The transverse processes are all, at least partially, present, but most are somewhat fractured. The last of the caudals are missing, and a few which would come in between those mounted in the specimen. The whole are exceedingly well set up and accurately placed. The ribs are in fairly good condition.

The missing cartilages have not been supplied in this specimen. As it is mounted, it is one hundred and twelve inches long.

IX.—A few bones consisting of the hyoid, sternum, nearly complete, several phalanges and some fragments of ribs were found by Mr. Edward Ardsley at Williamstown, Ontario, in 1901. This find is especially interesting as giving the only phalanges we have in the fossil skeletons.

X.—In the same clays in which the complete skeleton was discovered at Smith's brickyard, Montreal, a number of bones of a young individual were found. There are ten vertebræ, apparently mostly caudals, though some are lumbars. In all, the apophyses are separated from the centra of the vertebræ, but were secured with the rest.

All the bones are small, the largest centrum being one and three-fourths inch in diameter. The bones indicate an immature animal, but more than half grown. Besides the vertebræ there are five parts of ribs and portions of the cranium.

XI.—Most of the skull and a number of vertebræ found at Pakenham, Ontario. Not placed in a museum, but presumably in the possession of Mr. Patrick Cannon, of Pakenham. Of this Dr. Whiteaves writes in the *Ottawa Naturalist,* vol. xx, pp. 214-216, as follows: "On the fifth of September, 1906, a skeleton, which is obviously that of a very young individual of white whale, was found by Mr. Patrick Cannon while digging a well on his farm at Pakenham, Ontario. . . . This skeleton was imbedded in blue clay, fourteen feet below the surface, and only a portion was dug out. In digging the well, some depth of clay was first bored through, then a mixture of clay and shells, in which the skeleton was found, was struck, and the excavation ended in blue clay. The bones that have been exhumed so far consist of a nearly perfect skull, with only a few of the teeth missing, and one of the tympanic bones with most of the cervical vertebræ and three of the dorsals with some of their epiphyses. Apart from the obvious immaturity, this Pakenham skull and the vertebræ immediately adjoining

thereto seem to be essentially similar to the corresponding parts of the skeleton of the *Beluga* from Cornwall Pleistocene and that of a recent specimen of the white whale from Metis in the museum of the survey."

In *Bulletin 179, U. S. Geological Survey,* Mr. O. P. Hay enumerates seventy-eight species of fossil cetacea. Most of these species are not now living. Of the whole number, forty-three are found in the Miocene, eleven in the Eocene, seventeen in the Tertiary, epoch not stated, and six in the Pleistocene. There is one species not assigned. Of the six Pleistocene species, one found in Louisiana is a doubtful fossil, *Physeter macrocephalus.* Another, *Physeter vetus,* is from South Carolina, one from Vermont, *Delphinapterus vermontanus,* one from Alaska, *Monodon monoceros,* two from Canada, *Delphinapterus leucas* and *Megaptera boops.* To the above should be added the Halifax specimen, that from Pakenham, and sundry isolated bones found in Canada, all of which are given in the foregoing list.

As many of the references given show, nearly all of the Canadian specimens have been referred, by those geologists who have had occasion to mention them, either to the living *Delphinapterus leucas* or to Thompson's *D. vermontanus,* mostly to the former.

In those specimens which are very imperfect, it is not possible to determine as to the correctness of these identifications, since the resemblances, which always exist in most of the bones of allied species of cetacea, are so close as to render separation useless. This would be emphatically true when only a few vertebræ were found. When the periotic is present it should be possible to come to more satisfactory conclusions.

Dr. Dawson says that the Cornwall specimen was compared by Mr. Billings with recent bones of *D. leucas,* and as a result of this comparison Mr. Billings "concluded that it belonged to the modern species, and I believe extended his conclusion to Mr.

Thompson's specimen." So far as appears, Mr. Billings had never seen the Vermont specimen, at least had not studied it. Dr. Whiteaves writes: "The identification of the Mile-end specimen, and of that from Cornwall, with *Beluga vermontana*, it must be remembered, is solely on the authority of Mr. Billings. It seems to me that the specimens from those two localities and the skull, etc., from Pakenham, which are all that I have seen, are at any rate all referable to the same species. And I do not see how they are to be distinguished from the present *D. leucas*."

The question whether the Vermont specimen is as Thompson decided, a new species or *leucas*, has usually been decided by writers in favor of the living species. Thompson's reasons for separating it from *leucas* were, a difference in dentition, in size of maxillary bones and some minor points. None of these are sufficient, considering the individual variation within the same species of many cetacea. As has been previously noticed, the periotic is less likely to vary in different individuals of the same species than any other bone. After a study of this bone, Mr. Andrews writes, "I have compared the bone with the earbones of several specimens of *Delphinapterus leucas*. The resemblance, except in size, is very close indeed. The bullate portion of the periotic in your specimen is somewhat smaller in proportion to the whole length than in *Delphinapterus leucas*. The internal auditory meatus is also slightly different in shape. However, I believe that these characters are open to a slight individual variation. The difference in size seems to me an important one, as it probably indicates that your animal, if adult, is a smaller animal than *Delphinapterus leucas*. A comparison with the periotic of a very young individual of *Delphinapterus leucas* shows this bone in the latter to be considerably larger than in your specimen."

The author visited the American Museum, New York, twice for the purpose of comparing the fossil bones with those of recent skeletons, and then went to the National Museum, Wash-

ington, for the same purpose. Here Dr. True was most helpful, as has already been noted. A series of photographs of the periotic of the Vermont specimen was examined by him, and he reports as follows: "The periotic of *D. vermontanus* appears to indicate that the species is distinct from *leucas*. The principal differences are that in the former the petrosal is larger, the porus acusticus internus also larger and differently shaped, the posterior process of the petrous portion much longer and more pointed, the anterior process more rounded, the fenestra cochleæ larger. I cannot see that the vertebræ of *vermontanus* present any tangible differences of importance. The neural arch of the axis appears to be differently shaped, but this is probably due to its imperfect condition. The vertical foramina in the sides of the centra of the caudals appear smaller, but there is considerable variation in this character. The coracoid process of the scapula is narrow at the end, but this is also variable. I think the ulna is straighter. It is really necessary in identifying such material to examine the specimens themselves."

As to what Dr. True notices in respect to the neural arch of the axis, it may be well to say that this vertebra in the Vermont specimen does not seem to have been broken to any such extent as to change its form, especially that of the upper border of the spine, from that of *D. leucas* to that which it now has. In all specimens of the recent species which I have seen, the upper portion of the spine slopes rapidly from back down to the front, while in *D. vermontanus* it is nearly horizontal, that is, it has little slant from the back to the front edge.

The hyoid, too, is much more cylindrical in the thyrohyal portion. Of course it may be said that most or all of these characters are subject to individual variation in the cetacea, but allowing for this it seems probable that some at least of these characters are constant and may be regarded as at least varietal if not specific. It appears, then, that Thompson was justified in establishing the species *vermontanus*.

After a somewhat careful study of all the different specimens given in the foregoing list, the following conclusions have been reached by the author as to the specific position which should be occupied by these specimens. Very fortunately, in both the Redpath Museum and that at Ottawa there was a well-mounted skeleton of *D. leucas* close at hand, so that comparisons were readily made. As the measurements show, there is no great difference in the size of the three skeletons, Vermont, Cornwall and Montreal, which are sufficiently complete to make any comparison worth while. The Cornwall skeleton at Ottawa is rather larger, and the Smith's brickyard one at Montreal rather smaller than the Vermont, but as they are somewhat differently set up, and especially, as the Ottawa specimen alone has anything to take the places of the intervertebral cartilages, exact comparison is not possible.

From comparison of separate bones it seems to the author most probable that the Vermont specimen and the most perfect one in the Redpath Museum are identical, and are sufficiently different from the modern *D. leucas* to warrant placing them as at least a distinct variety, if not species. Had not a species been already established by Thompson and long well-known, it might seem best to regard the fossils as belonging to a small variety of *D. leucas* rather than to add a new specific name; but as it is, it seems best to allow Thompson's species *vermontanus* to stand.

The reasons for separating the fossil from the recent forms have already been given.

The Cornwall whale presents greater resemblance to the modern species than either of the others, and I agree fully with those who have considered it identical. If only we had the ear bones, it would probably be possible to speak with more certain conviction as to the above. As it is, the author would state what has been said rather as his opinion than as an indisputable fact.

As to the Mile-end specimen, since there are only vertebræ, it is impossible to do more than suggest the probability that the individual from which they came was of the same kind as the Montreal and Vermont specimens.

Of the smaller portions of skeletons enumerated, I should not wish to express even an opinion, except that they are all of the genus *Delphinapterus.*

Setting aside those specimens which are too incomplete to make any identification possible, we have in accordance with the foregoing, the following species of fossil cetacea:—

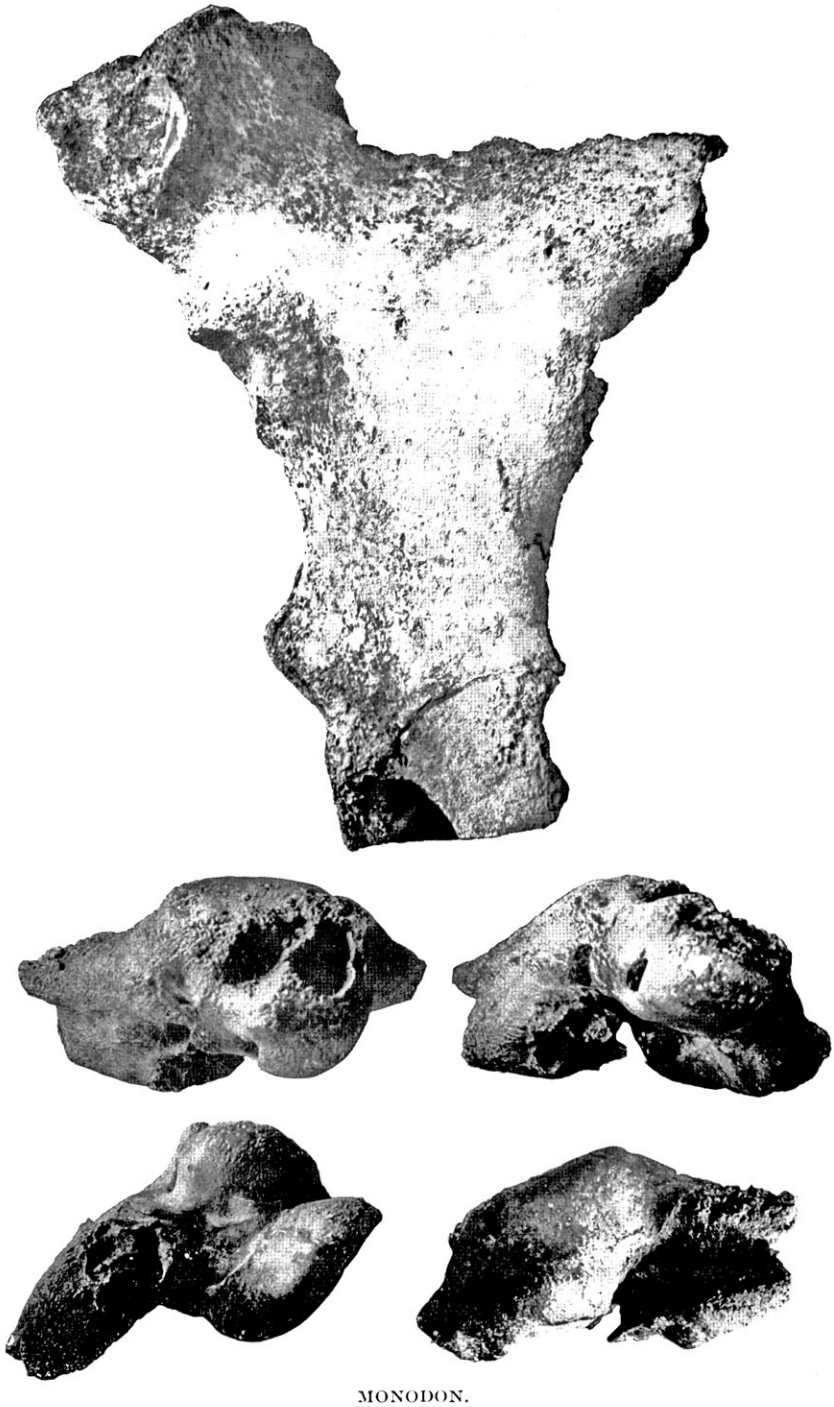
(1) *Delphinapterus leucas,* Gray. Museum of Canadian Geological Survey, Ottawa.

(2) *Delphinapterus vermontanus,* Thompson. Museum of McGill University, Montreal. Vermont State Museum, Montpelier.

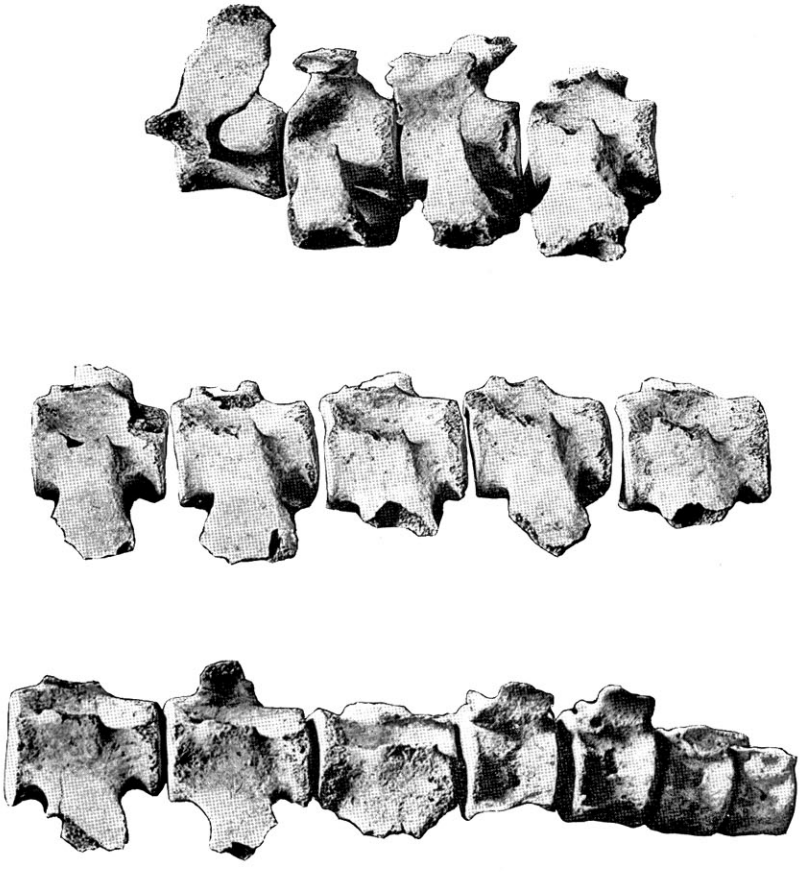
(3) *Monodon monoceros,* Linn. Provincial Museum of Nova Scotia, Halifax.

(4) *Megaptera longimana* (*boops*), Gray. Museum of McGill University, Montreal.

LIST OF PLATES.

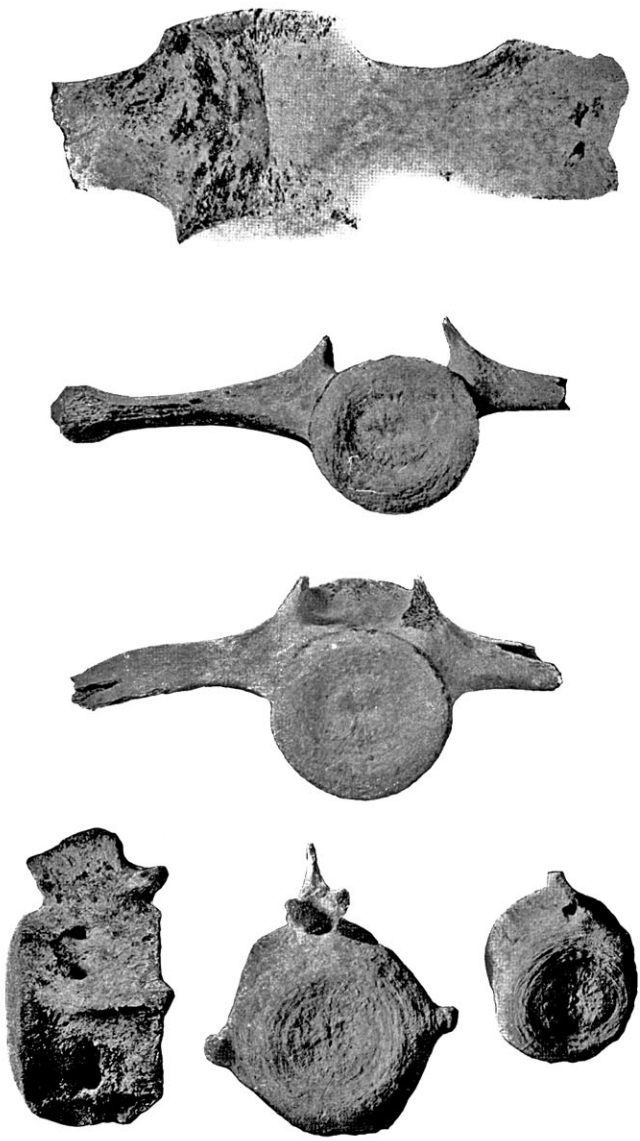


MONODON.
(Provincial Museum, Halifax; from Jacquet River, N. B.)
STERNUM, *one-half natural size.* PERIOTIC, *natural size.*



MONODON.
(Provincial Museum, Halifax; from Jacquet River, N. B.)
VERTEBRÆ, *about one-fifth natural size.*

MONODON.
(Provincial Museum, Halifax; from Jacquet River, N. B.)
DORSAL VERTEBRÆ, *one-third natural size.*



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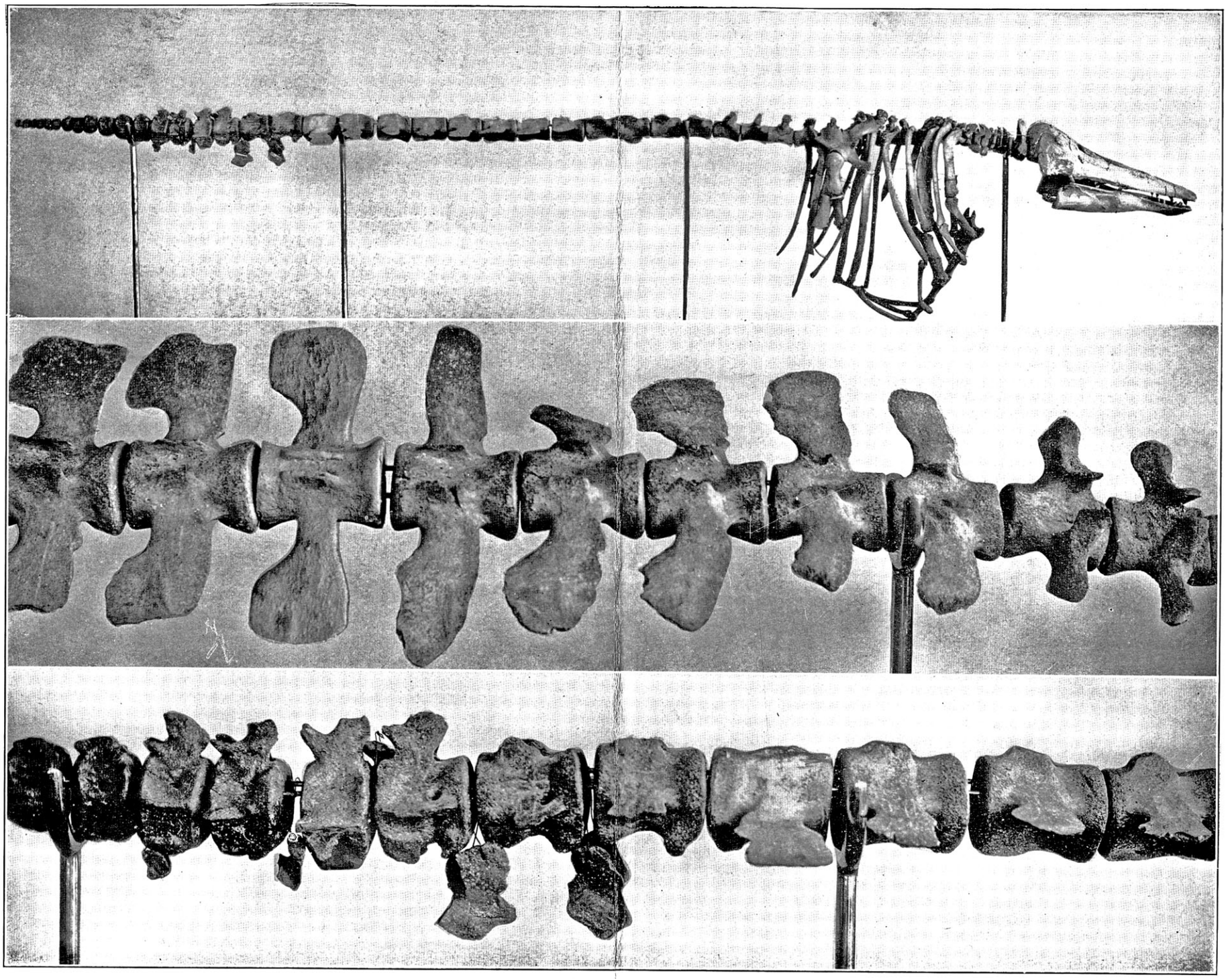
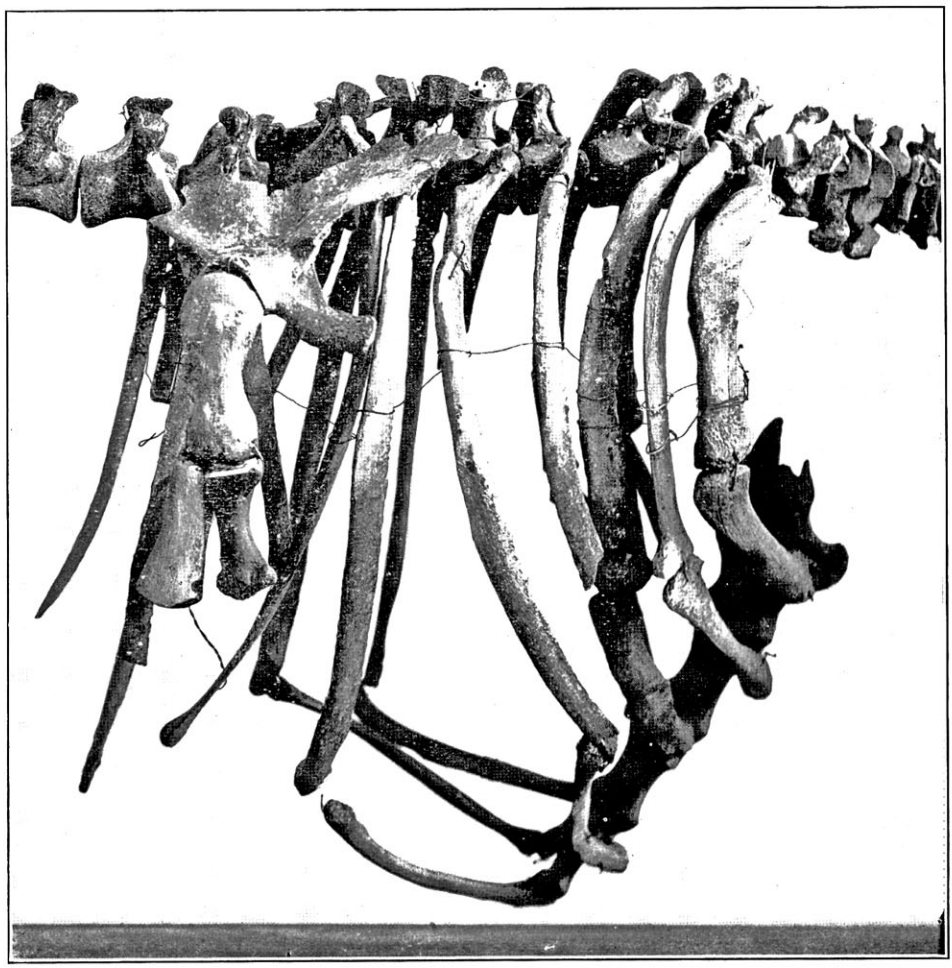
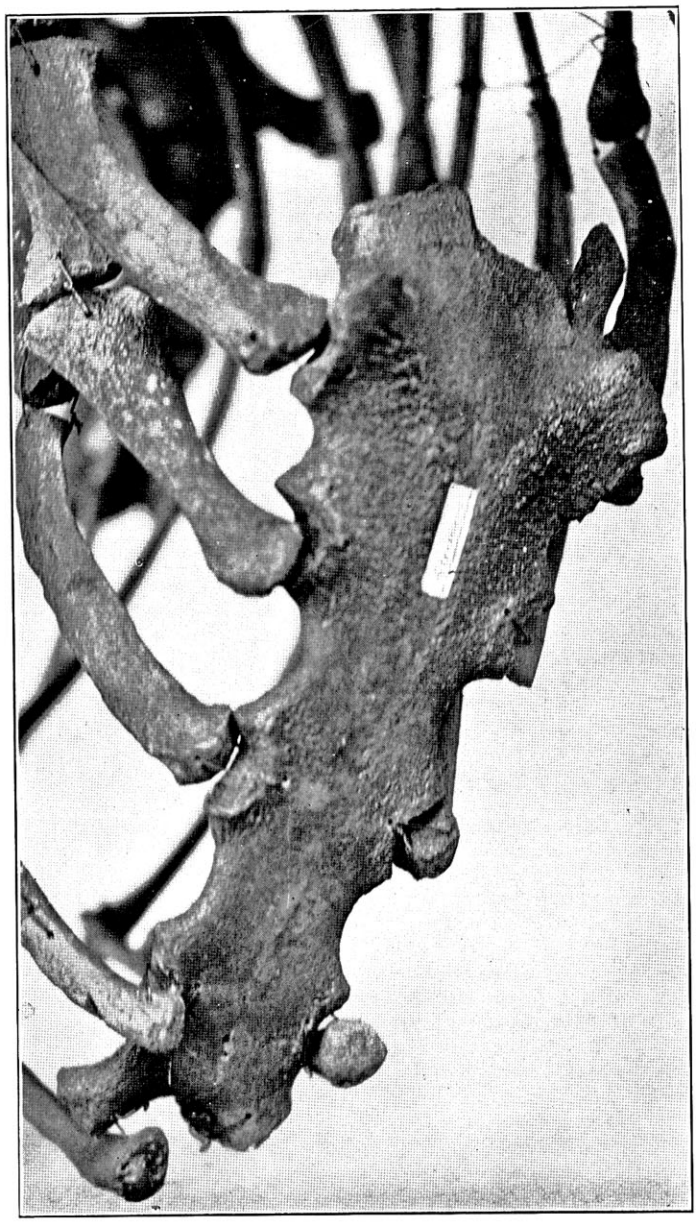
(Provincial Museum, Halifax; from Jacquet River, N. B.)
LUMBAR AND CAUDAL VERTEBRÆ, *one-third natural size*.



DELPHINAPTERUS VERMONTANUS, THOMPSON.
(State Museum, Montpelier, Vt.; from Charlotte, Vt.)
Upper figure one-fourteenth natural size; lower figures about one-fourth natural size.



DELPHINAPTERUS VERMONTANUS, THOMPSON.
(State Museum, Montpelier, Vt.; from Charlotte, Vt.)
ANTERIOR PART OF SKELETON, *about one-seventh natural size.*



DELPHINAPTERUS VERMONTANUS, THOMPSON.
(State Museum, Montpelier, Vt.; from Charlotte, Vt.)
STERNUM AND RIBS, *one-third natural size.*

DELPHINAPTERUS VERMONTANUS, THOMPSON.
(State Museum, Montpelier, Vt.; from Charlotte, Vt.)
PERIOTIC, *natural size*.