XXIII. *Observations to determine the Dentition of the Dugong ; to which are added Observations illustrating the Anatomical Structure and Natural History of certain of the Cetacea.*
By ROBERT KNOX, F. R. S. Ed. and Lecturer on Anatomy.

(Read 18th January 1830.)

THE following observations as to the dentition of the Dugong were made rather more than two years ago, and the inquiry as to the succession and character of the teeth in this interesting animal, and as to the exact composition of its skeleton, was then fully gone into, and all the facts to be now stated proved satisfactorily to myself at least. Notices of these opinions and facts more or less perfect, have been in several ways submitted to the public, both in this country and on the continent ; but, as the whole matter was in some measure controversial, tending to call in question the accuracy of a theory as to the dentition of the dugong, promulgated and supported by an anatomist of the highest reputation *, I hesitated whether or not the matter to be discussed merited being brought before this Society. Recollecting, however, that the opinions and statements opposed to my own views, had found their way into the pages of a work †, of such importance and authority in itself, as to impress readily

* SIR EVERARD HOME, Bart.

† The Philosophical Transactions.

in the minds of most readers an easy credence as to the exactness of whatever researches there find a place, I hesitated no longer as to the course to be adopted.

A considerable time ago, Mr SWINTON, to whom this Society owes so many rare and valuable presents in anatomy and zoology, transmitted to this country the head of an apparently full grown dugong from the Indian Seas, clothed with all the soft parts, and seemingly, in every respect, uninjured. Together with the head, which was preserved in strong spirits, and quite fresh when it reached this country, Mr SWINTON had taken the trouble to forward in like manner to the Society the heart*, stomach, and organs of generation, which appertain to the female, from which one may reasonably conjecture that these preparations belonged to the same individual, and, if so, that the cranium of the dugong, now in the possession of the Society, belonged to the female.

Our Secretary and Treasurer, who do me the honour to consult me as to the disposal and arrangement of the anatomical and zoological presents to the Society, were so kind as to inform me early of the arrival of these, and to put them at my disposal, directing me to dissect and prepare them in whatever way I should deem most fit for the interests of the Museum and of science.

This communication afforded me the greatest pleasure. I knew, indeed, that some coarse dissections of the dugong had been made in this and in other countries, and that a theory as to the

* In the excellent anatomical account of the Lamantin, drawn up by DAUBENTON merely from a foetus, preserved for some time in spirits, and under great disadvantages therefore, that careful observer first discovered and described the bifurcation of the heart, and partial separation of the ventricles of that organ from each other. A similar structure was afterwards found to exist in the dugong.

dentition of the animal had been brought forward and supported with great ingenuity by the eminent anatomist and physiologist already named, whose labours have contributed so much to support the cause of comparative anatomy in England ; but I knew also that something doubtful was mixed up with these results, notwithstanding their seeming ingenuity ; and I was aware also, and was the first to point out, long ago, that the osteology of the dugong, contained in the justly celebrated “ *Ossements Fossiles*,” had been drawn up from an imperfect skeleton, sent to its distinguished author by MM. DIARD and DUVAUCEAL *. I felt, therefore, that any well ascertained fact must be a valuable addition to the history of the animal, and such appeared to me, whatever observations should result from a careful inspection of

* There are no proofs whatever that there now exists any where in Europe, a perfect skeleton of the dugong ; by perfect, I mean a skeleton prepared under the immediate superintendence of an anatomist. The engraving of the skeleton in the *Ossements Fossiles*, from which M. CUVIER drew up his account of the osteology of this interesting animal, represents it to be without a sternum. Now, it matters not whether the bones were sent home in this condition to M. CUVIER by the Naturaliste Voyageur, or whether the animal reached him entire, preserved in spirits, or otherwise, and the bones of the sternum were afterwards lost in preparing the skeleton ; I insist chiefly on the fact, that the skeleton is, from some cause or other, imperfect. Extensive experience as to those matters has convinced me, that no skeleton can be properly prepared and in a way to be entirely depended on, with a view to anatomical and zoological inquiry, which has not been dissected and prepared under the immediate superintendence of a good anatomist. Mr ROBISON, who did me the honour to convey personally to M. CUVIER a memorandum from me, containing an outline of this inquiry, has since informed me that Baron CUVIER assured him that he now possessed five complete skeletons of the dugong ; they must, of course, have come into his possession since the publication of the last edition of the “ *Ossements Fossiles* ” in 1825 ; but it remains to be shewn before we agree to these skeletons being complete, by whom they were prepared, and if the separate bones were sent to Europe, or the entire animals.

the head and cranium, put into my hands by the politeness of this Society.

When Mr SWINTON transmitted the preparations and parts of the dugong, to which I have already alluded, to this country, he at the same time sent the separate bones of another dugong, which had been macerated and prepared in the East Indies. These bones, seemingly an entire skeleton of an adult animal, came accidentally into the hands of the curators of the University Museum, and Professor JAMESON, Keeper of that Museum, very readily granted my request, that he would allow these bones to be articulated by my assistant, Mr F. KNOX, who, being much conversant with these matters, would take every care that the workmen employed by him should in no shape injure the skeleton, as had happened to a deplorable extent to the skeleton of a young dugong, at present deposited in the Museum of the University*.

* The animal to which the young skeleton I now speak of belonged, reached this country several years ago, and, as I have been assured, entire. It was the munificent gift of some patron of science to the Museum of the University. I many years ago pointed out, from a cursory and hasty view of the skeleton, when prepared, that a highly blamable neglect had been shewn in its preparation, inasmuch as the bones of the sternum and rudimentary pelvis had evidently been lost or destroyed. My brother, somewhat more than a year ago, having had occasion to re-examine this skeleton, discovered that the original teeth (probably all milk-teeth, as the skeleton must evidently have been that of a young animal) had been lost, and their place supplied by the workman to whom the articulation of this invaluable skeleton was entrusted, who had substituted for the absent teeth those of a variety of other animals, and even pieces of ivory. So that all that remains of this splendid gift is a mutilated skeleton, which ought not to be exhibited in any museum. I trust that nothing contained in this note will be construed by any one into censure of the Curators of a museum, which is really a private collection; on the contrary, we may regret with them that the person to whom they entrusted the dissection was found to be altogether unfit for real anatomical research. I mentioned these facts, first discovered by my brother, to several persons, and they, somehow or other, have got into the public journals; but this was not originally intended.

I had thus before me the crania of two adult specimens of the dugong, for such I presumed them to be, one prepared by myself, and one by some persons abroad. A little dissection brought to light a most unexpected fact, viz. *that the tusks of the crania before me differed from each other in shape and general appearance*; and that, whilst one of these resembled in all respects the tusk which Sir EVERARD HOME had characterised as belonging to the adult or complete animal, the other resembled entirely the tusk which he considered as a milk-tusk. Here, then, were two crania, evidently adult, possessing differently formed tusks, which difference in form could not possibly depend on age, as had been advanced by Sir E. HOME, but must depend on some other cause. Before we consider what that cause may be, I shall take the liberty of briefly and rapidly reviewing what has been done as to the anatomy of the dugong, by those anatomists who have preceded me in this inquiry, stating in the first place, succinctly and briefly, those facts (and the conclusions drawn from them by myself), which may be verified by the Members of this Society and by others, by simply inspecting the two crania, I have had an opportunity of describing.

The cranium of the skeleton at present in the possession of the University, is somewhat smaller than that now before the Society. The length of the skeleton is fully 7 feet 3 inches English; the bones are extremely hard, and the head dense and heavy. In the crania I observed differences as to the shape of various bones, when compared with each other, which, upon the whole, however, hardly amounted to what I should venture to call specific differences. They do not exactly resemble each other. In the upper jaw there are two tusks in the intermaxillary bones, and three molar teeth on each side, opposed to those occupying a similar situation in the lower jaw-bone. The ante-

rior part of this bone slopes greatly, and is of vast strength, and there are cavities for eight rudimentary teeth, which teeth, however, are not present. It will be quite obvious to every one, that the teeth may have been lost by maceration, or have been intentionally removed, or accidentally dropt out ; to me it seems probable that they occasionally remain in the jaw during the whole period of the animal's existence. Upon the whole I do not reckon this a question of any moment. The right tusk of the narwal (which is an incisive tooth) remains always imbedded in the jaw, and seldom shews itself even beyond the gums, and, were it not for this, I should imagine, by what we see take place in man, that the alveolar cavities would be absorbed and disappear, and thus cause a great loss of depth and strength in this part of the jaw. If we apply this reasoning to the jaws and small rudimentary incisive teeth of the dugong, we shall find the natural conclusion to be, that they probably get entangled in the alveolar cavity, and may possibly thereby prevent its absorption and disappearance, which, according to the physiological laws prevalent in other animals, would most certainly take place, were the teeth entirely removed. Those who talk of the filling up of the alveolar cavities, after the removal of the teeth, either by a natural process or otherwise, employ a language exceedingly incorrect, and at total variance with the whole history of dentition, and the changes which take place in the maxillary bones of animals, from a variety of causes.

Without pretending, therefore, to consider it as a view finally settled, I deem it merely probable that the incisive teeth in a rudimentary state are retained, and lodged in the alveolar cavities of the lower jaw-bone, throughout the life of the animal, for the reasons assigned. Should it be afterwards shewn that an opposite law prevails in the dugong, to what takes place in other animals ; should it hereafter be shewn that the alveolar processes of the maxillary bones can and do retain all their depth and

strength, even after the teeth which were lodged in them have been thrown off by the ordinary processes of dentition, I shall not be in any way surprised at this, knowing as I do the infinite power of Nature, which adapts and modifies all structure according to the wants and habits of the animal.

The cranium now on the table of the Society is somewhat larger, and of a different shape, from the one I have just described, and which I presume is still preserved in the University Museum. The tusks or teeth, supported by the intermaxillary bones, correspond in every respect to those which have been described as milk-tusks by Sir E. HOME, and yet they are not milk-tusks. They are as long as the so-named permanent ones of the other head. To suppose them milk-tusks, we should be forced to have recourse to conjectures totally inadmissible in anatomical inquiry. We might suppose them to be milk-tusks, which, by some extraordinary accident, had not been thrown off at the usual time, but had grown up and taken on the functions of the permanent ones, which, in this individual, had not been developed. Now, conjectures of this kind lead to error, and are altogether unnecessary in the present case. The tusks differ as much in form in the two crania, as the tusks of the Asiatic elephant differ from those of the African one, and, therefore, naturalists would say that these animals must be specifically different*. I hesitate, however, in asserting this positively, and would say rather that it amounts with other data, such as the belief, on the part of the Malays, in whose seas these animals reside, that, to a great probability, there are two distinct species of the dugong now inhabiting the Eastern Ocean. I

* The difference in the tusks of the African and Asiatic Elephants is not confined to mere form; Mr ROBISON informs me that the ivory is much finer and more dense in the former than in the latter.

do not at the present moment remember any facts tending to shew that these very obvious differences may be merely sexual; and that they do not depend on difference as to age, I think has been clearly made out by the preceding observations *.

It may be observed, moreover, with a reference to the tusks of the cranium now on the table, that there are no appearances of permanent or other tusks behind these; no vestiges of the roots, or such other appearances as indicate their probable ultimate replacement by others. The molar teeth correspond in both jaws, and in the lower jaw of this cranium we find the alveoli for the reception of the imperfect rudimentary incisive teeth formerly spoken of. These teeth are mostly present, but not all, a circumstance which may either arise from some of them having been thrown off, or by their having become encrusted with bone. All this part of the jaw was covered with a dense and almost horny semicartilaginous substance. A similar substance was found encrusting the palate above, and these substances seemed to me placed there, to supply the deficiency of incisive teeth †.

The dugong seems then to have originally, and, whilst yet

* I observe, in a late number of the *Annales des Sciences d'Observation* that a new species of fossil *Hyæna* has been established, merely from a slight variety of form occurring in one of the *molar teeth*.

† There is rather a vagueness in what Sir E. HOME says about the *milk-molar teeth in an animal four feet eight inches long*; it seems reasonable to have expected that the molar teeth in such an animal should have been proved to be *milk-molar teeth*, by laying open the jaw and shewing the germs of the *permanent ones below*. The same distinguished anatomist has, besides, from an accidental oversight no doubt, given a representation of the upper jaw of a dugong, which must obviously have been adult, there being two molar teeth on one side, and three on the other, and has described this jaw as belonging to a young one, and has called these teeth *milk-molar teeth*.

young, incisive teeth in both jaws, in addition to the tusks in the upper. Of these incisors, the upper smaller or mesial ones, are thrown off at an early period, and not replaced. The tusks are probably replaced by permanent teeth. No tusks are found in the lower jaw.

As regards the other parts of the skeleton, I found, in the one so often alluded to during the course of this memoir, twenty-six cervical and dorsal vertebræ, and twenty-eight caudal. The sternum is very remarkable; but its appearance cannot be altogether depended on, for this reason, that we know not how the bones were originally prepared, nor what violence, or injury, or loss, they may have sustained. That they are not quite perfect, is obvious from what I discovered had happened to the temporal bone, where, very obviously, the knife or chisel had been at work, to extract the small bones of the ear. Whether this happened previous to the bones being sent from India, or merely prior to their being inspected by me, I shall not take it upon me to determine. The adult sternum, in a perfect state, may not as yet have been seen by any anatomist.

From the hasty glance I had of the soft parts, I will venture to predict, that the arrangement of the hyoid bones, and their connexion with the tongue, have been totally misunderstood; but I am unwilling to bring forward any views as to this part of the animal, until another opportunity shall occur of inspecting these parts.

In the bones of the fore-arm we meet with an unexpected resemblance to the elephant, in a structure hitherto deemed unique. The ulna is the stronger bone at the carpal joint; but it is quite probable that this structure prevails in several pachydermatous marine mammalia.

Zoological Arrangement of the Dugong.

In the inquiry, which, at the Meeting of the 21st December 1829, I had the honour to submit to the Society, the dentition of the dugong was considered. It was shewn in that memoir, that an insuperable objection lay against the views as to the succession of the tusks of the dugong, promulgated first by the distinguished English anatomist, Sir EVERARD HOME, and adopted, so far as I know, by most continental ones. The observations which were then submitted to the Society shewed, that in two *adult* crania of the dugong, there were two kinds of tusks, quite distinct from each other in their form, and that this difference seemed specific, as not being referrible to age. In considering the character I speak of as specific, I do not go beyond the ordinary rule of zoological investigation ; but, whether or not this determination be the correct one, I feel yet assured, *that these differences in the form of the tusks, in the adult crania of the dugong, do not depend on age*, and this is all I contend for at present.

There is a fact to which I beg leave to call the attention of the Society, before I quit this subject. The milk-tusks of the dugong have never been seen by any one ; that is, I have not heard of the existence of any preparation shewing the germs of the milk or permanent teeth, together or in succession, and in such a way as to leave no doubt on the subject. They may exist, inasmuch as there is nothing in the economy of this interesting animal forbidding such a belief ; but I repeat that they never have been seen by any one ; so that it seems to me but right, that, previous to all further speculations as to the natural history of the animal, efforts were made to perfect, in some measure, its anatomy, on which alone can the zoologist found any rational inquiry.

The remarks I have to make as to the zoological arrangement of the dugong, are of less interest than those regarding its dentition, as being a question merely of nomenclature and system. The dugong was first arranged with the walrus. CAMPER, in his natural history work, called in question the propriety of this arrangement. He was followed by others, and, finally, by Baron CUVIER, who determined the dugong, lamantin, and the animal of STELLER, to belong naturally to the Cetacea, and they were accordingly arranged under the head of Herbivorous Cetacea. I confess that, from the time I commenced these inquiries into the anatomy of the dugong, I felt much inclined to question the propriety in their having separated this animal from others to which it seemed naturally allied. The external form, it is true, so far as regards the caudal termination of the body, greatly resembles the dolphin, porpoise, and whales generally; and there are facts in the anatomy of the bones composing the skeleton of this part of the body, such as the form of the bones of the pelvis, the presence of the bones having the form of the letter V, found on the ventral aspect of the caudal vertebræ, which, taken together with the complete enclosure of all the bones of the upper extremity, so as to render the articulations of the limb of probably little use to the animal, are facts, it may be admitted, in favour of its arrangement with the Cetacea; but, when we reflect on the form of the cranium of the dugong, on the structure of the molar teeth and tusks*, on the dentition of the animal generally, on the structure of its stomach, position of the mam-mæ of the female so different from that of the Cetacea, one cannot but be convinced, reflecting without prejudice on these facts, that the dugong may be more naturally grouped with the walrus, than with any of the whale tribe as yet described by na-

* The teeth in the true Cetacea, when present, are uniform.

turalists. The Scapulæ of the dugong, have no resemblance to those of any of the Cetacea I have examined, but they approach those of the walrus. The great strength of the zygomatic arch, and, indeed, the whole anterior part of the body, shews the natural affinity with the tribe of the walrus ; so that here, as in so many other zoological cases, I fear it will be found that considerations, drawn chiefly from external characters, lead only to false conclusions.

True Cetacea.

We owe to Mr JOHN HUNTER most of the best made out anatomical facts in the history of the Cetacea : above all, we owe to him the history of their mode of dentition ; and the facts and observations, together with the conclusions drawn from them, have, so far as I know, never been directly questioned by any one. Mr HUNTER, I think, was the first to prove that, in their mode of dentition, whales do not strictly resemble other mammalia. He shewed, as far at least as the field of his inquiry extended, that nothing that had been made out regarding the succession of the teeth in the other mammalia, was at all applicable to the Cetacea. In them we have no permanent teeth following milk-teeth, but one set only which are at once temporary and permanent, that is to say, the anterior ones, together with the small part of the jaw containing them, are constantly worn away and lost during the life of the animal, and these are replaced by others, which grow up from behind, precisely as in the elephant. Now, I had thought that this mode of dentition described by Mr HUNTER, and which I had myself verified in a very considerable number of the Cetacea, might, without venturing on a rash analogy, be held as applicable to all the Cetacea ; but it would seem some have thought differently, and, among these, the immediate suc-

cessor of Mr HUNTER, Sir EVERARD HOME, who, in a paper published in the Transactions of the Royal Society of London, speaks familiarly of the milk-tusks of the narwals*. That it was possible, I repeat, that the dentition of this animal might really differ from the other Cetacea, in the having temporary teeth followed by permanent ones, was a circumstance which, in so far as regards its possibility, could not be questioned; but still I doubted the fact, and this doubt seemed confirmed by a note subjoined to the history of the narwal, in the *Possil Remains* of Baron CUVIER, which note, though rather obscure in its style, impresses my mind with a belief that that distinguished anatomist holds opinions similar to those I now submit to the Society; and, as the zoology of this remarkable cetaceous animal is as yet extremely imperfect, I shall take the liberty of submitting to the Society a few remarks as to the structure of its skeleton.

Skeleton of the Narwal.

When Baron CUVIER published the last edition of the “*Ossements Fossiles*,” he had not seen a skeleton of this remarkable whale.

* All anatomists will readily admit the possibility that the mode of dentition of the narwal might be found, on inquiry, to differ from that prevailing in the ordinary Cetacea, inasmuch as the anatomical facts, and the inferences from them, cannot, as I had the honour to demonstrate to the Society on a former occasion, be transferred by *à priori* reasoning to any other species, even though that species be strictly congenerous: at least this has been the impression under which I have now, for a very considerable number of years, carried on extensive inquiries into the anatomical structure of animals. And here I may take the liberty of remarking, that this does seem to me to have been the impression under which all anatomists of any reputation have acted, notwithstanding the observations to the contrary which have been lately brought before this Society and the public, by a distinguished British

If any proofs were wanting that natural science requires protection, that it never has, nor ever can, make any progress in the hands of others than strictly scientific men, it will be found that the facts required to demonstrate this may be best drawn from the history of the Cetacea.

Since the period when the commercial nations of Europe first navigated the icy seas of Greenland, to obtain by the capture of the whale, and others of the tribe Cetacea, whalebone and oil, for the purposes of traffic, hundreds of vessels, admirably equipped, commanded by persons not wholly illiterate, and (I regret to make the avowal) provided with surgeons, whose education ought, assuredly, always more or less, to lead to a fondness for natural historical pursuits, have annually visited these frozen coasts; have assisted in the capture of thousands of whales; have been now, for some centuries past, under circumstances the most favourable for the observation of the peculiar history of these most interesting animals, without the addition of a single well ascertained fact, so far as I can learn, to those published nearly a hundred years ago by a gentleman in no way commercial, the Honourable PAUL DUDLEY, who published, in the Philosophical Transactions for 1730, some Observations on the Natural History of several of the larger Cetacea.

There is something, then, in the spirit of trade and commerce hostile to real science, and to the progress of scientific pursuits; nor do I think this hostility limited to the sciences termed Natural merely, but to every kind of knowledge with which I am acquainted. These remarks I do not make with a view to hurt the feelings of any one, but simply to explain the difficulties which anatomists and naturalists have experienced in

naturalist, Dr FLEMING; an erroneous conception of which, without doubt, must have arisen in his mind from his little acquaintance with anatomical science.

completing the history, or rather, I should say, in obtaining facts sufficient for a mere outline of the structure of these animals *, and as an excuse for wishing to record in the Transactions of this learned body a few facts regarding the anatomy and physiology of whales, which, compared with the mass of unexplored inquiry, must be deemed comparatively meagre and scanty, and of which fact I may venture to presume few can be better judges than myself.

Mr HUNTER, in the work I have just alluded to, says, " From my want of knowledge of the different genera of this tribe of animals, an incorrectness in the application of the anatomical account to the proper *genus* may be the consequence ; a tolerably correct anatomical description of each species, with an accurate drawing of the external form, would lead us to a knowledge of the different genera, and the species in each ; and, in order to

* Mr HUNTER, whose position in life enabled him more than any other person to investigate the structure of the Cetacea with advantage, has remarked, in those admirable " Observations on the Structure and Economy of Whales," that he has availed himself as much as possible of all accidental opportunities of ascertaining the anatomical structure of large marine animals ; " and, anxious to get more extensive information, engaged a surgeon, at a considerable expense, to make a voyage to Greenland in one of the ships employed in the whale-fishery, and furnished him with such necessaries as I thought might be requisite for examining and preserving the more interesting parts, and with instructions for making general observations ; but the only return I received for this expense was a piece of whale's skin, with some small animals sticking upon it."—P. 372.

For my own part, I may say that all accidental opportunities of dissecting the larger species of whales in this country have been denied me by a curious arrangement, which I wish I could believe altogether accidental ; for, notwithstanding the fact, very generally known, that all my leisure moments were constantly employed in ascertaining the anatomical structure of various animals, it has uniformly happened that the requisite information as to the stranding of any of the larger whales has been brought to me last. And thus has it happened with almost all the opportunities which have from time to time occurred for the anatomical examination of the rarer animals which have reached this country during the last ten years.

forward so useful a work, I propose at some future period to lay before the Society descriptions and drawings of those which have come under my own observations." Mr HUNTER, by these remarks, means, no doubt, to state that he had in his possession anatomical descriptions or monographs of the various individuals of the whale tribe examined by him. These monographs unhappily, so far as I know, have never been communicated to the public *. This is extremely to be regretted, inasmuch as, until the publication of proper monographs of each species, drawn up from dissections made by experienced anatomists, almost every thing said regarding the Cetacea, or of any other tribe of animals, must be matter of pure conjecture

Delphinus Phocæna.

I am indebted to my brother for certain of the following observations on some parts of the anatomy of the porpoise.

The ribs have always been found to be *thirteen* on each side, when the specimen came uninjured into his hands at first, a fact the more remarkable, I think, that all the artificially articulated skeletons I have seen have twelve only on each side, shewing how easily errors arise when the setting up of a skeleton is entrusted to persons altogether ignorant, or altogether regardless, of anatomical science. In one specimen which is now in the Museum, about the middle of the dorsal vertebræ, there is a

* As I have not the honour of a personal acquaintance with the person into whose hands Mr HUNTER's Papers came on the demise of that great man, I here take the liberty of suggesting to him the propriety of publishing those Memoirs of the Cetacea spoken of by Mr HUNTER, which assuredly will be found to contain highly important facts and observations.

vertebra which carries no rib, and this fact is undoubted, inasmuch as the skeleton was prepared as a natural skeleton; but this is seemingly only an individual variety, since in the skeleton of several others, and more particularly in that of the foetus of the porpoise, no such appearance is met with.

The skeletons of several specimens, of various ages, of the *Delphinus Phocæna*, prepared with great care by my brother, and whose skeletons are still in the Museum, shew that there are seven cervical vertebræ.

Other specimens of the genus Delphinus.

The want of symmetry in the bones of the cranium of the narwal does not extend to all the Cetacea. We have seen that it scarcely exists in the *Delphinus Phocæna* and *Delphis*. There is in the Barclayan Museum the skeleton of a grampus, which was stranded in the Frith.

Cervical vertebræ, . . .	7
Dorsal and caudal, . . .	56
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	63

Cranium very nearly symmetrical.

Teeth $\frac{22.22}{21.21}$: the two anterior teeth slope much forward; they are small, and solid.

There are twelve ribs on each side: and of these, eight are articulated with the transverse processes of the vertebræ only.

There is the cranium of a large description of grampus in the same museum, in which the want of symmetry is very re-

markable. There are alveolar cavities for six teeth in the upper jaw on each side, and a similar appearance in the lower jaw; these teeth may once have been conical, but, by use, they are much flattened above, and sloped. These anatomical differences, found to exist in animals so greatly resembling each other, are remarkable.

Of the Size of the Fœtus of the Cetacea at the time of Birth.

Naturalists, I presume, must have few well authenticated facts on this point, otherwise it would not happen that so able a naturalist as the author of the British Zoology should have described the foetus of the *Delphinus Phocæna* as being only seven inches in length shortly before birth *. I have put on the table of the Society the skin of the foetus of a common porpoise, of the usual length (about five feet two inches), and which was caught in the Frith of Forth. It was removed from the uterus, together with its membranes, in presence of a numerous class. The length, even in its present dried state, is two feet six inches, and I see no reason, from the state of the parts, to suppose that the birth of the young was about to happen at the moment of the capture of the mother. The foetus of the seal is, in like manner, of a disproportionate size to its parent †. Its birth is provided for by a remarkable mechanism connected with the fibro-cartilaginous and ligamentous structure of the symphysis of the pubis, which, previous to, and during parturition, elongates to the extent of nearly two inches. The effects of this, in enlarging

* British Animals.

† The foetus of a seal shortly before birth was found to be about 2 feet 6 inches in length, that of the mother being about 5 feet 2 inches.

the capacity of the pelvic apertures, may be readily judged of by reflecting on the elongated square form of the pelvis of the seal; but it is equally obvious, that the artificial separation of the bones of the human pelvis, by a section of the ligamentous symphysis, cannot produce the same results, by reason of the circular form of the cavity of the human pelvis. The pretended reasoning from analogy, then, on the part of those who have proposed imitating a process of nature, in dividing the human symphysis pubis during laborious or difficult parturition in women, argues merely a want of accurate observation on their part, and is an attempt to supply one animal with a mechanism, which Nature exclusively intended for another, whose structure was originally entirely different*.

The total length of the skeleton of the narwal, apparently that of an adult animal, in the Barclayan Museum, as now articulated, and which is said to have been presented to Dr BARCLAY by Captain SCORESBY, is 16 feet 3 inches. Length of the head 2 feet; of the tusk 6 feet 1½ inches, being that remarkable single tooth which has in all ages characterized this animal; it being also well known that, in the male, the left tusk only is developed so as to protrude beyond the gums, whilst the right remains imbedded in the jaw for life; in the female both tusks remain in this latter state; the part imbedded within the socket

* In an Essay on the History of Whales, by the Honourable P. DUDLEY, Phil. Trans. 1725, the following observations occur as to the bulk of the fœtus of the Whale.

“ WHALEBONE WHALE.—This fish, when first brought forth, is about 20 feet long, and of little value: the full-grown animal is 60 or 70; say as 1 to 3.

“ SPERMACETI WHALE.—The calf, or young whale, has been found perfectly formed in the cow when not above 17 inches long, and white; yet, when brought forth, it is usually 20 feet, and of a black colour.”

10 inches. The tusk is rolled spirally throughout its whole extent, with the exception of about $5\frac{1}{2}$ inches at the point where the tusk is smooth, and resembles strongly the young teeth. On looking into the cavity for the reception of the pulp, we perceive the spiral twisting to be as well marked as on the outside, and we find the tooth to be hollow throughout the whole extent of the cavity for its reception in the jaw. With the exception of a small space in the centre, we are sure that the remaining part is solid.

The animal has a distinct *vertebra dentata*, almost as large as the atlas, and, in this respect, differs much from the common porpoise of the coast, which has the *dentata* united to the atlas by bone, and not to be distinguished from it; and the spinous process, which is distinct, is a mere plate of bone. With reference, then, to these two *vertebræ*, the narwal differs from all the Cetacea I have examined; and of whom it may be said generally, that the *vertebræ* of the neck run much together, and are so united as not to admit of any motion in this part of the vertebral column. The neck of the narwal is therefore somewhat longer proportionally than in the other whales; and the flexibility of its neck must enable it to be much more agile than others of its kind. In short, we find moveable *vertebræ* with distinct or peculiar surfaces, appearances which do not exist in this part of the column in any of the other true Cetacea I have seen or read of.

There is no opening for the vertebral artery. The junction of the first and second *vertebræ* is by two surfaces, as in man and other animals. In looking into the vertebral canal, *no* *processus dentatus* is seen, so that it presents an appearance as if the *processus dentatus* had been cut slopingly off on its superior surface, leaving only its articulating surface, as seen in other animals. The *dentata* and atlas are equal as to breadth, viz. 8 inches. They are almost equal as to strength. The third

vertebra is remarkably thin and anchylosed to the second. There are no openings in the transverse processes. The fourth, fifth, sixth, and seventh cervical vertebræ are distinct, having intervertebral cartilages interposed, and none of these is so weak as the third. There are characters in which the narwal differs from other Cete. No vestiges of openings for the vertebral arteries in any of them. There are eleven dorsal vertebræ, and eleven ribs on each side. But Captain SCORESBY, whose authority in these matters is unquestionable, says, that there are twelve dorsal vertebræ, and, of course, twelve ribs, so that these bones, in the skeleton now under consideration, may have been lost.

In the Cetacea, apparently, the transverse processes of the vertebræ undergo a sudden elongation, about the termination of the dorsal ones, *that is the thirteenth vertebra*. This we find to be the case in the narwal under consideration.

There are thirty-two remaining vertebræ in the Barclayan narwal, and twelve bones in the form of the letter V, which bones may be considered as spinous processes on the ventral aspect of the vertebræ. They are, however, placed upon the vertebral substances, which renders their presence altogether anomalous. There are then in the narwal,

Cervical vertebræ,	7
Dorsal, carrying ribs,	11
Lumbar and caudal,	32
	<hr/>
	50

The caudal may not be all present; and as Mr SCORESBY says that there are in the narwal he examined fifty-four vertebræ, it is more than probable that four bones of the Barclayan specimen have been lost.

The length of each pectoral extremity is 17 inches; these are imperfect, however, inasmuch as few of the fingers are present. The bones of the pelvis are entirely wanting; that is, I presume, they have been lost in the original preparation of the animal.

	Feet.	Inches.
Length of head,	2	0
Breadth,	0	17

The tusks are carried in the maxillary bone. The summit at the top of the head is removed to the left side to the distance of about an inch from the mesial plane, so that, looking at the head from behind, it has a singular unsymmetrical appearance, the right side of the occipital bone appearing so much broader than the left side; whilst looking at the face on the upper surface, the left side again preponderates over the right, in consequence of the much greater size of the left maxillary bone, as it requires to carry the fully developed tooth. This difference in breadth and depth does not extend to the inter-maxillary bones, or very slightly; and indeed, superiorly, the inter-maxillary bone of the right side is the larger of the two; so that the want of symmetry follows a different law in the cranium and upper part of the face from what it does in the lower part of the face. The distance between the orbit of the right side and the anterior margin of the blow hole of the same side, being nearly an inch greater than on the left. The law, therefore, seems to be, that the greater development with regard to the cranium is on the right side, and with regard to the face, on the left side, and the head has altogether a twisted appearance. This singular want of symmetry in the bones of the cranium and face has not been remarked by M. CUVIER, though in the engraving of the cranium of the narwal the appearance I speak of has been very accurately represented by the engraver. The capacity of the cranium is large,

analogous to what we find in the porpoise and dolphin, and the squamous or ascending plate of the occipital bone is imperfectly ossified, and very thin. The jaw where the developed tooth is contained is slightly reticulated on the upper surface. The symphysis of the lower jaw has been originally united by syndroses, and a shallow groove runs along, for a short distance, the upper margin of the lower jaw, obviously analogous to the deep groove in the porpoise, dolphin, and many other Cetacea, containing in them the sharp conical teeth, but, as is well known, there are no teeth of this kind in the narwal. The maxillary bones are loose and spongy; the inter-maxillary firmer and denser, more resembling in structure the inferior maxillary bones.

Mr HUNTER's admirable account of the dentition of the ordinary Cetacea may be corrected apparently in one point; the groove, or elongated cavity for the reception of the young teeth, cannot be formed by the sinking down of the teeth in it, for the teeth are already deeply imbedded in it in the foetus. In many species of animals, moreover, the osseous partitions of the alveolar cavities are by no means complete. It is probable, therefore, that the germs of the teeth are developed in this elongated alveolar cavity, much in the same way as they are in other Mammalia; but, as Mr HUNTER remarks, they do not succeed each other by germs placed above or below each other in the jaw (according to the jaw spoken of), but rather from behind forwards, the anterior ones, together with the portion of the maxillary bone carrying them, gradually wasting away by a law in the economy of the animal. The inter-maxillary bones carry $\frac{1}{1}$ teeth apparently in many of the Cetacea, as in all the porpoises.

In the adult animal, and no doubt in many others of the Cetacea, this elongated groove for the reception of the teeth may,

and does actually become, partially divided into a number of compartments by osseous division or ridges*.

It is, moreover, probable that the inferior dentar canal, which more resembles a great cavity, contains numerous blood-vessels and nerves, calculated to allow of, and supply, the waste of the jaw, and the succession and loss of teeth; and the same structure may prevail even in the narwal, since being of an analogous nature with the other Cetacea, the jaws may waste away in it although there be no teeth present, with the exception of the left tusk and the aborted tooth † of the right side.

Since the period of the earliest voyages to the Arctic Seas, the narwal, from the remarkable projecting and single tooth, carried in the upper jaw, has attracted the attention even of those least interested in zoological inquiries. The facts, that it is the left tooth only which is developed in general—that sometimes the right is also found to extend, more or less, beyond the gums, but more usually remains in the socket, imbedded in the jaw, probably for the whole life of the animal—and that, in the female, both these teeth remain in the jaw, and never shew themselves external to the gums;—these are facts known to every one. But I do not believe that these aborted teeth, which remain imbedded in the jaw, viz. the right tooth in the male and both in the female, are *milk tusks*, or merely temporary teeth; neither is there a single observation in the history of the narwal to shew that there really exists any true succes-

* There is a species of Rhinoceros in which two incisive teeth remain below the gum during the whole period of the natural life of the animal: they are not to be seen then so long as the head is covered with soft parts. Thus the permanent residence of teeth within the alveolar cavities, or not visible beyond the gums, as assuredly happens in the narwal, and, as I supposed, might also occur in the case of the lower incisives in the dugong, is a fact not confined to the Cetacea.

† An expression employed by M. CUVIER.

sion of the teeth as in most of the Mammalia. The crania of two foetuses of the narwhale now before me show no such appearances. On each side of the upper jaw, and in the usual place, there are two hollow teeth, obviously the extremities of the spiral permanent tooth of the male. These teeth are completely imbedded in the jaw in the young narwhale; observation tells us, that if the animal be a male the left tooth continues to grow, the right, after a time, fills up, its central cavity for containing the pulp disappears, and, after attaining a growth of 5 or 6 inches, the jaw elongates, to correspond with the growth of the animal and of the other tooth, and the aborted tooth remains imbedded in the jaw for life.

Digestive Organs *.

Inquiries into this system of organs are by no means so complete as they ought to be. My own very limited field of inquiry has presented but few novel facts, if any; but I feel inclined to view differently from those who have preceded me in this inquiry, that structure in the second stomach of the porpoise and dolphin, which many have considered as glandular merely. That it bears a considerable resemblance to the tubular portion of the kidney of some animals cannot be overlooked, but this, for obvious reasons, does not seem to remove the difficulty we have in considering the whole structure as merely glandular. The

* I have not observed the muscles in any of the whale tribe or Cetacea to stiffen, nor the blood to coagulate after death. Others, however, whose opportunities for observation may have been more extensive, may have noticed these phenomena. The muscles are, compared with other Mammalia, soft and easily lacerated. The anterior filaments of the spinal nerves are greatly more numerous or larger than the posterior.

following are the few brief remarks I have been able to make regarding it.

In accordance with the language of all or most anatomists, I shall speak of this species of the Cetacea as having four stomachs, this being the usual language held with reference to the stomachs termed complex. My own opinion, as explained more fully in a memoir I had the honour to submit to the Royal Society of Edinburgh, on the Structure of the Stomach of the Lama, is, that no animal possesses more than one stomach, divided more or less by compartments, and thus assuming the appearance of one or more cavities, which anatomists have unhappily spoken of as being one or more stomachs. Now, in accordance with this language, which, however inaccurate, demands respect from its universality, I shall speak of the second cavity in the stomach of the porpoise as being the second stomach.

The gullet of the porpoise, composed of the usual membranes or tunics common to it with other Mammalia, terminates in a somewhat elongated, tolerably capacious pyramidal-shaped bag, known by the name of the first stomach. In this we find, externally, and immediately invested by the peritoneal tunic, a strong coat of muscular fibres, spread uniformly over the surface, continuous upwards with the muscular layers of the gullet, and downwards with those which, in a similar fashion, envelope the second stomach, occupying the same situation relatively to the peritoneal tunic in it as in the first. This muscular tunic of the first stomach is composed of two layers, separated from each other by a layer of cellular membrane; the fibres are chiefly longitudinal and circular. Within these there is the usual vasculo-cellular layer, and it has within it a mucous membrane, covered by a strong epidermic covering. By maceration a double epidermic covering may be separated from the mucous surface of the gullet, but one only seems to invest the first stomach.

To this cavity the branches of the *nervi vagi* (which are large and distinct) do not proceed in any great abundance, their course is rather towards the second cavity or stomach, whose structure I shall now endeavour to describe. The capacity of the second stomachal cavity is less than that of the first, and its structure differs remarkably from it. The aperture of communication betwixt these cavities admits readily enough the forefinger, and here the internal textures of the first stomach suddenly cease; the epidermic covering and subjacent mucous membrane cease, and there is substituted for them a perfectly smooth membrane, without villousities or glandular structures; it has a good deal the appearance of a serous membrane. This closely invests a series of fibres, which externally are covered by an extremely vascular and cellular tunic. These fibres are placed perpendicularly betwixt the two membranes I have spoken of, and quite close to each other. They may be considered, then, as placed on the outer surface of the internal membrane of the stomach like a pile of velvet enclosed by thin laminæ or plates*. Outside the vasculo-cellular layer, muscular layers exist, continu-

* I here take the liberty of subjoining a microscopical examination of the structure by Dr BREWSTER. "I have examined the piece of stomach you have sent me of one of the Cetacea. It seems, in its wet state, to consist of tubes or fibres, perpendicular to the two membranes which enclose them, thus: and the upper surface of one of the membranes is covered with hollows or depressions, corresponding with the extremities of the tubes or fibres. A more minute examination, conducted in a different way, proves these perpendicular portions to be tubes. In order to dry it, I pressed it between folds of paper, and the effect of the compression was, to press together nearly all the tubes, and make the whole one dense mass of a dark brown colour; but when it became dry, and slightly indurated, I drew it out as if it had been India rubber, and the tubes opened and the mass became white, thus* :

* See Edin. Phil. Journal by Dr BREWSTER.

ous, as I have already said, with those of the first stomach, and transmitted over the second, which they, in like manner invest, to the third. The interior of this second cavity, when laid open, presents a series of longitudinal and transverse elevations, which resemble the interlocking of the fingers with each other. To this stomach most of the branches of the nervi vagi are distributed.

The third and fourth cavities have been very carefully described by Baron CUVIER, and by most systematic writers on comparative anatomy. The questions raised by CAMPER as to the *number* of the stomachs in this animal, do not merit notice. The accompanying sketch will perhaps explain in an easier way than I have done, to the non-professional reader, the structures in question. I forbear for the present all speculation as to the nature of these fibres, which are obviously not muscular, and can hardly be considered merely glandular; future observation and experiment will, no doubt, one day determine whether or not I am correct in supposing them analogous to the electric organs of certain fishes.

Fig. 1.

Fig. 2.

Fig. 4.

Fig. 3.

Fig. 7.

Fig. 6.

Fig. 5.

Fig. 8.

EXPLANATION OF PLATE XV.

- Fig. 1. Cranium of the adult narwal seen from the upper surface.
- Fig. 2. The same cranium seen from below. These sketches were made with great care.
- Fig. 3. The same cranium seen from behind. The want of symmetry is remarkable.
- Fig. 4. The atlas, dentata, and third cervical vertebra of the same narwal.
- Fig. 5. Cranium of a young narwal (supposed to be a fœtus), seen from above.
- Fig. 6. One of the teeth withdrawn from the socket. The young narwal seems uniformly to have two such, of nearly equal length; one only comes to perfection in the male; neither in the female.
- Fig. 7. Inner surface of one of the compartments of the porpoise, in which there prevails a peculiar structure, tubular or fibrous, and perhaps electrical.
- Fig. 8. Figure shewing the remarkable regularity of the tubes or fibres placed between two tunics of the stomach.