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IV. *Description of the Skeleton of the Chinese White Dolphin* (*Delphinus sinensis*, Osbeck). By WILLIAM HENRY FLOWER, F.R.S., F.R.C.S., F.Z.S., Conservator of the Museum of the Royal College of Surgeons of England.

Read June 10th, 1869.

[PLATES XVII. & XVIII.]

THE Swedish missionary and naturalist, Peter Osbeck, writing in 1751, says that, while lying at anchor in the Canton River, "Snow-white Dolphins (*Delphinus chinensis*) tumbled about the ship; but at a distance they seemed in nothing different from the common species, except in the white colour"<sup>1</sup>. Upon the strength of this brief description *Delphinus chinensis* is introduced by Desmarest into the list of species of the genus, though with the asterisk indicating "les espèces douteuses ou trop peu connues."<sup>2</sup>

Fred. Cuvier sums up as follows the opinion of the zoologists of his time upon the White Dolphin of Osbeck (whose name he modifies into the more classical *sinensis*):—"Quelques auteurs distinguent ce dauphin comme espèce, et M. Desmarest est du nombre. D'autres, tels que Bonnaterre (Cétologie, p. 21), n'en font qu'une variété du dauphin commun, prenant à la lettre les premiers mots d'Osbeck; et mon frère était disposé à réunir ce dauphin blanc au delphinaptère de Péron (Ossem. Foss. t. v. p. 289). Le fait est que la phrase d'Osbeck est insuffisante pour caractériser aujourd'hui une espèce du genre dauphin."<sup>3</sup>

In Dr. Gray's 'Catalogue of Seals and Whales in the British Museum,' 2nd edit. (1866), "*D. chinensis*, Desm., from Osbeck's Voy.," is admitted among the species "requiring further examination" (p. 266). In the more recent 'Synopsis' of the same zoologist, which is confined to the species which he has "been able to examine, compare, and characterize," it is omitted altogether<sup>4</sup>.

As far as I can ascertain, no portion of this striking and well-marked species has ever been examined by any naturalist, and, but for the passing allusion of the Swedish traveller more than a hundred years ago, nothing would be known even of its existence.

Under these circumstances it is a subject of congratulation that our zealous member, Mr. Robert Swinhoe, H. B. M. Consul at Amoy, has succeeded in obtaining a fine

<sup>1</sup> 'A Voyage to China and the East Indies' (in 1751), by Peter Osbeck. Translated by J. R. Forster, Lond. 1771, vol. ii. p. 27.

<sup>2</sup> Desmarest, 'Mammalogie,' Encyclop. Méthod. (1822), p. 514.

<sup>3</sup> F. Cuvier, 'Histoire naturelle des Cétacés' (1836), p. 213.

<sup>4</sup> 'Synopsis of the Species of Whales and Dolphins in the Collection of the British Museum.' By J. E. Gray, 1865.

skeleton of this Dolphin, and has most liberally presented it to the Museum of the Royal College of Surgeons.

In a letter dated "British Consulate, Amoy, 23rd September, 1867," Mr. Swinhoe says, "I have managed during my incumbency here to procure the skeleton of the White Porpoise that rolls in the harbour of Amoy. The live animal is of a milky white, with pinkish fins and black eyes. I desire to present this skeleton to the Royal College of Surgeons, and beg that you will undertake a full description of it in the Zoological Society's Transactions. The weather was very hot when the present specimen was acquired, it being midsummer; and its capture having taken place at Quemoy (a large island to seaward of Amoy) it was found impossible to bring it to me in a fresh condition; my hunter, therefore, had the bones partially cleaned and brought them to me. I had them well dried before I packed them up. I regret that I was unable to see the entire animal, as I would in such case have taken a drawing and a full description of it. I have striven in vain to get another specimen. The animals are of daily occurrence in the harbour; but the Chinese are not adepts at catching them. I have often watched their gambols and have seen them wounded. When wounded they make seaward, the wounded beast generally pursued by his fellows. They appear to occur in this harbour through the greater part of the year. In the box you will find a few bones of a second individual, which I procured from a fisherman here. These seem to differ somewhat from the corresponding bones in the first specimen."

In a subsequent letter, dated "Hongkong, 28th January, 1868," in reply to my inquiries as to the geographical range of the animal, Mr. Swinhoe wrote, "I think I have seen this white species in the Canton river and in the Forchow river, but I have no idea how far it extends north and south. In Formosa I have never seen Porpoises; but the coast there is too exposed and the rivers too barred, I should think, for regular visits of Porpoises."

The specimens received from Mr. Swinhoe consist of:—1. An almost complete skeleton of a perfectly adult individual, all the epiphyses being united to the bodies of the vertebrae. The caudal and pectoral fins were sent entire and dried, thus allowing of a description of their form, as well as preserving the bones of the manus and termination of the vertebral column in a perfect condition. The missing portions of the skeleton are the sternum, some of the sternal ribs, the body of the hyoid, and the pelvic bones. The skeleton as now mounted measures, in a straight line, from tip of lower jaw to end of last caudal vertebra, 7 feet  $4\frac{1}{2}$  inches; but as the intervertebral substances which still connect the bodies of the vertebrae have contracted somewhat in drying, the animal during life would probably have been upwards of eight feet in length.

2. Portions of the skeleton of another and slightly smaller individual, viz. a fragment of the cranium, the lower jaw with teeth complete, one lumbar vertebra, two ribs, and two scapulae.

The genus *Delphinus*, as restricted by F. Cuvier and Rapp, contains numerous species, presenting great diversity of anatomical characters. Unfortunately the requisite materials are still wanting for making a satisfactory arrangement of the group, as complete skeletons of but very few species are preserved in museums, and fewer still have been fully described. Dr. Gray has arranged the species in numerous genera and sections, founded on variations in the characters of the cranium, the only part at present available for the purpose. Although this arrangement is very convenient for the purposes of practical zoology, it is necessarily provisional, and awaits a knowledge of the remainder of the organization to determine its scientific status. On comparing the skull of the present specimen with the description in Dr. Gray's last 'Synopsis' (1868), aided by an examination of the originals in the British Museum, it is perfectly evident that it belongs to a species there undescribed. Its exact position among the numerous divisions of the family can, however, be clearly determined. It belongs to the Tribe *Stenonina*, and genus *Steno* (*loc. cit.* p. 5), characterized by having the "beak of the skull compressed, higher than broad. Symphysis of the lower jaw long." In size and other characters the skull corresponds with Section A of that genus, comprising *S. frontalis* and *S. compressus*; but in the number and size of the teeth it is intermediate between this section and the next, as it has exactly three teeth in each inch of the alveolar margin, whereas in Dr. Gray's first section there are two, in his second (comprising *S. capensis* and *S. lentiginosus*) four in each inch.

This determination of the position of the Chinese White Dolphin, according to its cranial characters, makes an account of its complete osteology particularly important, as no skeleton of any member of this well-marked group (genus *Steno*, Gray) has hitherto been described or figured.

The Cranium (as seen in Plates XVII. and XVIII.) presents the well-known general characters of the allied forms. It closely agrees with *S. frontatus* and *S. compressus* of the British Museum in size, but differs from them in the rostrum being broader at the base and tapering gradually towards the middle, and especially in the form of the pterygoid bones and in the greater number and smaller size of the teeth. In the form of the rostrum and number of teeth it approaches to *S. lentiginosus*, Ow., from the Indian seas, but differs from this species in its superior size, and also in the form of the pterygoids.

The principal dimensions of the skull are as follows:—

	inches.
Entire length . . . . .	20·7
Length of rostrum . . . . .	12·8
Breadth of occipital foramen . . . . .	1·7
Greatest height of occipital foramen . . . . .	1·8
Breadth of occipital condyles . . . . .	4·1
Greatest breadth of cranium at parietal region . . . . .	6·4

	inches.
Greatest breadth at postorbital processes of frontals . . . . .	8·8
Breadth of anterior narial apertures . . . . .	2·4
Breadth of rostrum at base . . . . .	4·7
Breadth of rostrum at a quarter of its length from base . . . . .	2·9
Breadth of rostrum at the middle . . . . .	1·85
Breadth of rostrum at three-quarters of its length from base . . . . .	1·4
Length of upper tooth-line . . . . .	11·2
Mandible. Length of ramus . . . . .	18·
Length of symphysis . . . . .	5·5
Length of tooth-line . . . . .	11·
Breadth at condyles . . . . .	8·
Height at coronoid process . . . . .	3·6

The occipital foramen is subcircular, slightly higher than broad. The tentorium is largely ossified. The temporal fossæ are bounded by very prominent ridges. The postorbital processes of the frontals do not meet the squamosals by a space of 2 inches. The anteorbital process is well marked, its depressed outer extremity is formed by the jugal. The styliiform portion of the jugal is 4 inches long. The median postnarial prominence of the frontal is strongly marked, and rises slightly higher than the supra-occipital or the nasals; the latter are ankylosed both to the frontals and the ethmoid. The narial apertures exhibit the usual want of symmetry, inclining to the left. The upper extremity of the left præmaxilla is shorter and much more attenuated than that of the right. The rostrum is rather broad at the base, and gradually tapers towards the middle; it then becomes much compressed, and retains very nearly the same breadth to its termination. Correspondingly the palate is broad and flat behind, but narrow and with a deep median groove in its anterior two-thirds; a narrow strip of the vomer appears for a space of  $2\frac{1}{2}$  inches in the hinder part of this groove; as in the allied forms, there are no lateral grooves.

The palate-bones are of larger extent than in most Dolphins; and the form of the pterygoids is quite peculiar (see Pl. XVIII. fig. 1, *pt*): instead of meeting in the middle line and concealing the hinder edge of the palatines, they are widely separated throughout their whole extent, and gradually recede from each other till their hinder apices are 2 inches apart. In the other large Stenos, as in nearly all other Dolphins, the pterygoids are in contact in the median line for a distance of 2 inches. In *Steno lentiginosus*, Ow., the inner edges of the pterygoids do not meet, though they are parallel for the greater part of their extent. In *D. gadamu*, which Owen places in this section, and Gray in the genus *Clymenia*<sup>1</sup>, the pterygoids appear to resemble those of the present species; the skull, however, cannot be confounded with it, as it is much smaller, has a broader and shorter rostrum, and less numerous teeth.

<sup>1</sup> Synopsis, p. 6.

The petrotympanic bones resemble those of other members of the genus. The greatest length of the scroll-like tympanic is 1".45, its greatest breadth 0".85.

The numbers of the teeth of the adult specimen of *D. sinensis*, as indicated by the alveoli, are  $\frac{33-32}{32-31}$ , total 128. In the second lower jaw there are 32—33. In the former they are unfortunately very incomplete; and as those that remain have mostly fallen from their sockets, and been artificially replaced, absolute reliance cannot be placed upon their present position in the jaws. Many of them, both in the maxilla and mandible, are worn down to flat-topped stumps, which can have scarcely projected above the level of the gum, all of the crown and a portion even of the root having disappeared. Such a mode of wear occurs habitually in *D. tursio*, but I have never observed it in any other of the numerous species of Dolphins. The amount of truncation varies in extent in different parts of the jaw; it affects the lower more than the upper teeth. Those in the posterior part of the maxilla have entirely escaped. Besides the truncation of the apex, many of the upper teeth, especially near the hinder part of the series, have the neck, or that part of the root immediately adjoining the enamelled crown, suddenly contracted for a space of about  $\frac{1}{10}$ ", apparently by erosion or absorption of the surface.

The characters of the mandibular teeth are well shown in the detached jaw of the younger specimen, as they are nearly all perfect and *in situ*. Truncation of the apex has commenced in nearly all; but the greater number are but slightly affected, and in none is so much as half the crown worn away. The roots of the teeth are much thicker than the crowns, they are slightly flattened from before backwards, and taper upwards to a sufficiently well-marked "neck," above which is the smooth, enamelled, conical, slightly compressed (from before backwards) and incurved crown. In the posterior fourth of the ramus the teeth are placed vertically, but in the remaining portion they incline considerably outwards; the three or four most anterior are again more vertical. Except those at the extreme ends of the series, which, as usual, are somewhat smaller than the others, the teeth of the lower jaw do not differ materially from each other in size. The following are the dimensions of an unworn tooth from near the middle of the series.

	inch.
Entire length . . . . .	1.00
Length of crown . . . . .	0.35
Length of crown and portion of root projecting above alveolar margin of jaw . . . . .	0.50
Greatest (transverse) diameter of root . . . . .	0.20
Greatest (transverse) diameter of crown . . . . .	0.23

The teeth are placed at very regular distances, their roots being completely separated by a very narrow strip of alveolus. As nearly as may be, three teeth occupy each inch of the alveolar border.

The stylo-hyals have the usual form, and are 4''·5 long, and 0''·6 in greatest diameter.

The spinal column, which is quite complete, consists of fifty-one vertebræ, seven belonging to the cervical, twelve to the dorsal, ten to the lumbar, and twenty-two to the caudal region. The respective lengths of these four regions in the articulated skeleton are 3 inches, 17½ inches, 16½ inches, and 30 inches.

In the cervical region, the atlas and axis are united, and the remaining vertebræ are free, as appears to be the rule in the genus *Delphinus*. The component parts of the conjoined mass formed of the first two vertebræ can be readily defined. The bodies are thoroughly confluent, though a superficial groove marks the limit of each with tolerable certainty. The arches in their first part, or pedicle, are distinct, and have between them a considerable oval aperture for the transmission of the second spinal nerve. Above this, opposite the zygapophysis, they are firmly united; the laminae are then separated on either side for a space of half an inch by a linear fissure; and, finally, the spines are completely confluent. This conjoined spinous process is high, massive, sloping backwards, strongly ridged on its median upper or anterior border, and with a rounded and somewhat depressed and truncated apex. The pedicle of the arch of the atlas is very much thicker than that of the axis, and on its anterior border has a deep notch, almost converted into a foramen on the left side, for the passage of the first (the suboccipital) spinal nerve. Both atlas and axis have a single transverse process on each side, that of the former long, stout, rugged, rounded at the end, and directed slightly downwards and backwards. The transverse process of the axis is a small, rough, and rather compressed tubercle, placed nearly on a level with the root of the last, and directed somewhat upwards as well as backwards. The dimensions of these vertebræ are:—

	inches.
Breadth of articular surfaces on atlas for condyles . . . . .	4·0
Breadth between tips of transverse processes of atlas . . . . .	5·7
Breadth between tips of transverse processes of axis . . . . .	3·6
Greatest breadth of spinal canal, inside arch of atlas . . . . .	1·8
Greatest breadth of spinal canal, inside arch of axis . . . . .	1·5
Height of spinal canal, inside atlas . . . . .	1·5
Height of spinal canal, inside axis . . . . .	1·5
Breadth of body of axis at posterior end . . . . .	1·7
Height of body of axis at posterior end . . . . .	1·5
Height from lower surface of body of axis to apex of spinous process . . . . .	4·0
Length of upper or anterior edge of conjoined spinous process . . . . .	2·1

The remaining cervical vertebræ have greatly compressed subcircular bodies. The under surface of each has a fringe of rough exostoses growing on each side of the middle line, and leaving (as seen in the figures, Pl. XVIII.) a deep notch at this part.

The arches of all are very similar, and terminate in a very short compressed spine of nearly equal height in all. In the third this spine can scarcely be said to be developed; in the seventh it is very slightly larger than in the others, and the laminae of the arch are slightly broader. The zygapophyses of all are well developed, and accurately coadapted; the third, fourth, fifth, and sixth have very short superior and inferior transverse processes on each side. In the third these are united together at their extremities on one side only—in the fourth and fifth on both sides, forming complete rings; in the sixth they are not united, and the lower process is greatly developed in the antero-posterior direction; in the seventh vertebra the upper process is alone developed, and the body has on its hinder margin an articular surface for the head of the first rib.

The dorsal vertebræ generally resemble those of other Dolphins. The bodies of the first four only bear articular surfaces for the attachment of the heads of the ribs. The spines are moderately high, compressed, and broad from before backwards. They increase slightly in length from the first. In the posterior part of the region they have a curve forwards. Distinct contiguous articular surfaces to the arches (zygapophyses) cease after the fourth vertebra. The transverse processes have broad concave articular ends for the tubercles of the ribs; they gradually increase in length, but the last two disproportionately so. Tubercles (superior accessory processes or metapophyses), which are first seen on the anterior edge of the transverse process of the third dorsal vertebra, increase in size, and rise up, being transferred to the sides of the arch, and form the characteristic "clasping" processes, which are strongly developed in the hinder dorsal region.

The ten lumbar vertebræ have bodies of nearly equal length, hollowed at the side, and keeled below. The transverse processes are long, flat, broad, and directed nearly horizontally outwards, though the hinder ones are bent down at their extremity, and very rough on their upper surface. The spines are moderately high, broad, and nearly vertical, though curving forwards at their extremities. The clasping processes are less developed at the middle of the region than either before or behind.

The caudal vertebræ present the usual division into two distinct sets—those in front of, and those contained within the expansion of the tail-lobes. The former are twelve in number; they have (especially towards the end of the series) compressed, vertically extended, comparatively long bodies. There is one vertebra which may be called transitional (the thirteenth caudal, see figure); then follow the nine terminal or fin vertebræ, with depressed, transversely extended, and extremely short bodies. The last vertebra is very small, depressed, and triangular when seen from above. The transverse processes of the caudal vertebræ gradually diminish in length to the tenth, where they are mere rough longitudinal ridges: in the eleventh all traces of them have disappeared. The neural arches cease in the thirteenth. The vertical arterial foramina pierce the sides of the first caudal, and are continued throughout the series to the penultimate.

There are fourteen pairs of hæmapophyses (chevron bones), all comparatively short

and broad (from before backwards). The first pair are only united for a small space at their backward-directed pointed apex. The others are all firmly united, except the fourteenth pair, which are very minute, flattened, and subcircular. The fifth are the longest. All these bones, as shown in the figure, are exactly in their natural position, as they have never been separated from the bodies of the vertebræ.

The form of the caudal appendage is shown in outline at fig. 2, Pl. XVII., drawn from the dried specimen sent by Mr. Swinhoe, after its natural shape and dimensions had been restored by soaking in water. The length between the extremities of the "flukes" is  $20\frac{1}{2}$  inches.

There are twelve pairs of ribs. The five foremost have necks and heads which reach the bodies of the vertebræ. The sixth has a rudimentary neck, the others none, and are only attached to the ends of the transverse processes. The last rib is nearly as well developed as its predecessor. Some of the sternal ribs are wanting; but those that are present indicate that there were at least seven pairs of these bones.

As before mentioned, the sternum is missing.

The scapula generally resembles that of other Dolphins, but it is rather high in proportion to its breadth, and has its posterior angle obliquely truncated. The acromion is broad, and the coracoid rather small. The characters of the scapulæ of the other individual sent by Mr. Swinhoe are precisely similar.

The humerus, radius, and ulna appear to differ little in the true Dolphins, and in the present specimen they offer nothing worthy of note, except that the olecranon is but slightly developed. These bones are ankylosed together at the elbow-joint.

The manus is broader at the base than in most Dolphins (e. g. *D. delphis* and *D. tursio*), and much resembles in form that of *D. guianensis*, as figured by Professor Van Beneden<sup>1</sup>. This breadth is caused by the considerable development and position of the two outer digits. It is falcate and obtusely pointed at the extremity. Considering the age of the animal, the carpal bones are less developed than in other Dolphins available for comparison, as, instead of being united into a sort of closely fitting mosaic, they have rounded borders and are all separated by cartilaginous intervals. They are, as usual, five in number, and probably represent the scaphoid, lunar, cuneiform, trapezium, and unciform. The scaphoid is the largest and of an oblong form, the cuneiform a very small rounded nodule.

The first digit consists of a single, slender, tapering metacarpal, without any ossified phalanx. The other metacarpals are broad and flat. The second digit has six phalanges; the third, five; the fourth, two; and the fifth, one broad phalanx in addition to a well-developed metacarpal. The size of the last two digits (so often almost aborted in the Delphinide) is the more remarkable, as the ulnar side of the carpus shows such a comparative arrest of ossification.

<sup>1</sup> Mém. de l'Acad. Roy. de Belgique, Coll. in-Svo, tom. xvi. 1863, p. 33.

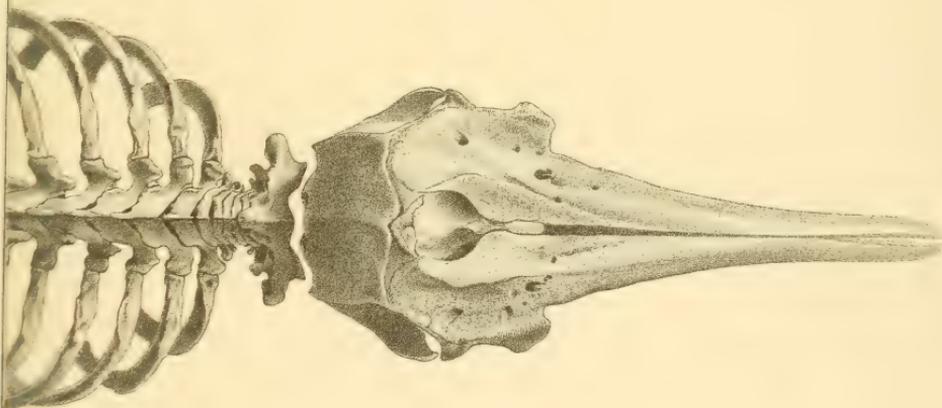
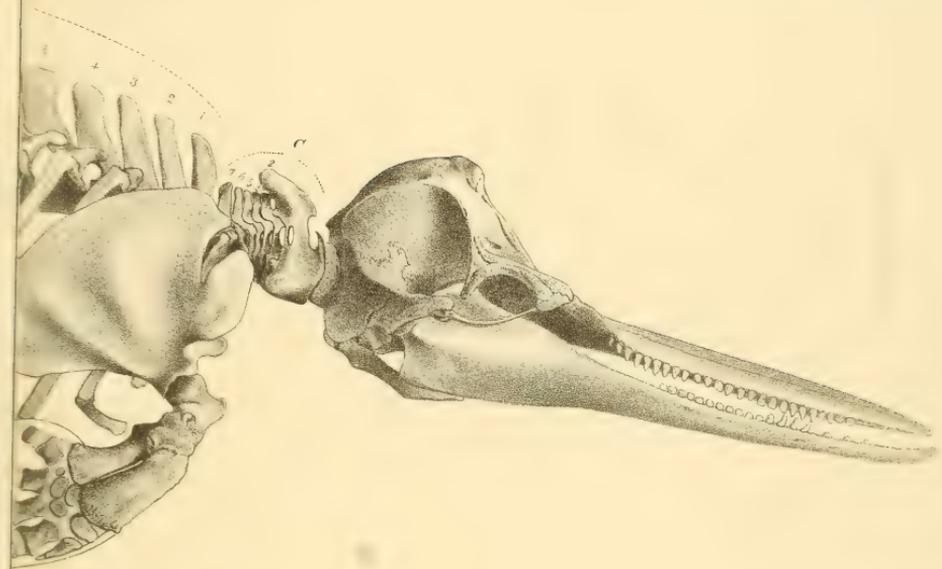
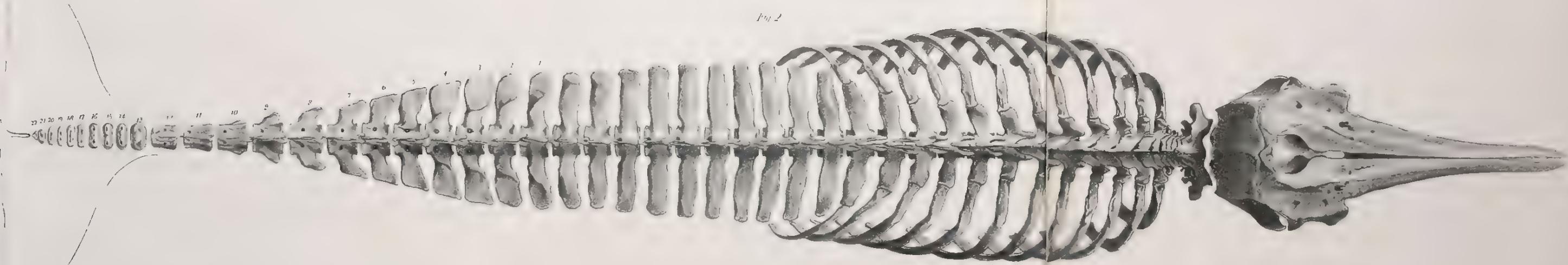




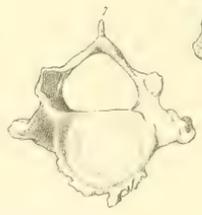
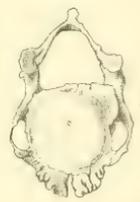
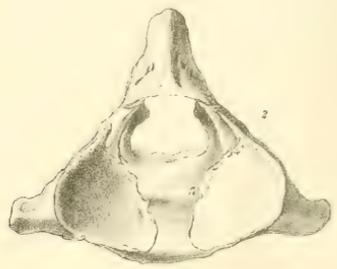
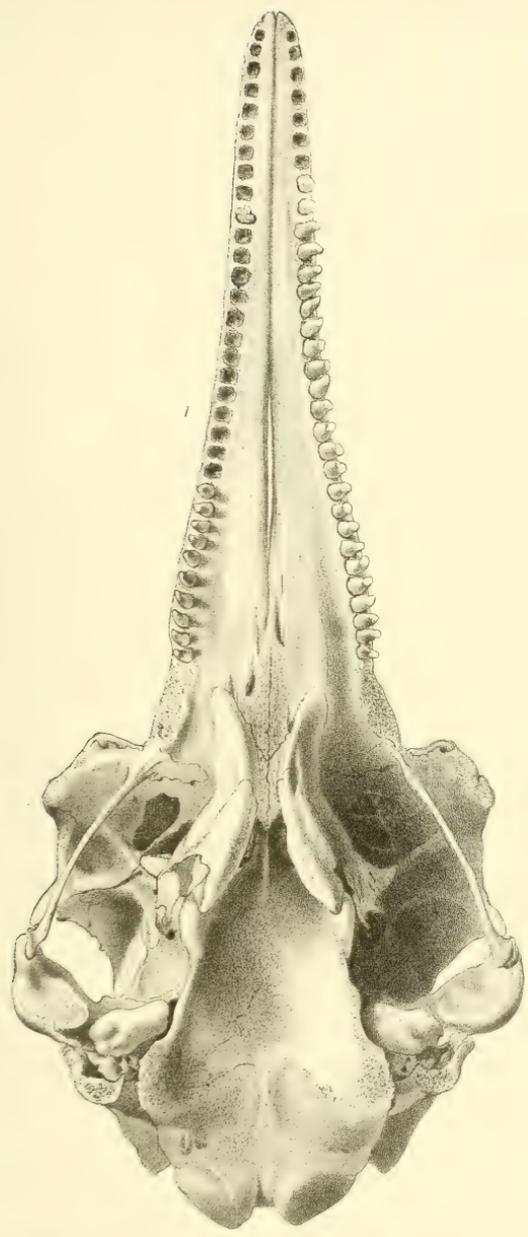
Fig 1



Fig 2









The following are the principal dimensions of the pectoral limb:—

	inches.
Scapula.—Height . . . . .	6·4
Breadth . . . . .	9·0
Length of acromion . . . . .	2·6
Greatest depth of acromion . . . . .	2·1
Length of coracoid process . . . . .	1·4
Length from head of humerus to tip of fin . . . . .	13·0
Greatest breadth of fin . . . . .	5·0
Length of humerus . . . . .	2·9
Length of radius . . . . .	3·4
Length of ulna . . . . .	3·1
Breadth of radius at distal extremity . . . . .	2·0
Breadth of ulna at distal extremity . . . . .	1·3

The principal differences between this skeleton and that of all other known Dolphins lie in the vertebral column. The total number of vertebræ is less, the individual vertebræ are proportionally longer, and their transverse processes are shorter and broader than in any other species. Next to it in these characters stands *D. guianensis* (genus *Sotalia*, Gray), which has the following vertebral formula:—C. 7, D. 12, L. 14, C. 22=55; then *D. tursio*, which has C. 7, D. 13, L. 17, C. 25=62. *D. delphis*, with C. 7, D. 13, L. 24, C. 31=75, is at the other extreme, being only exceeded in number of vertebræ, and length and narrowness of the processes by the *Lagenorhynchi*.

If the osteological characters possessed by this specimen be found to exist in other Dolphins with narrow, compressed beaks and long mandibular symphyses, *Steno* will be established as a natural group of generic value.

## DESCRIPTION OF THE PLATES.

### PLATE XVII.

Fig. 1. Side view of the skeleton of *Delphinus sinensis*, presented by Mr. Swinhoe to the Museum of the Royal College of Surgeons: one-fourth of the natural size.

Fig. 2. Dorsal view of the same skeleton, without the pectoral limbs.

## PLATE XVIII.

Fig. 1. Inferior surface of the cranium of the same: half the natural size.

*vo.* vomer. *pl.* palatine. *pt.* pterygoid. *ty.* tympanic.

Fig. 2. Anterior surface of the conjoined atlas and axis.

Fig. 3. Anterior surface of the third cervical vertebra.

Fig. 4. Anterior surface of the fourth cervical vertebra.

Fig. 5. Anterior surface of the fifth cervical vertebra.

Fig. 6. Anterior surface of the sixth cervical vertebra.

Fig. 7. Anterior surface of the seventh cervical vertebra.

All half the natural size.



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