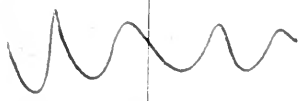

FIELD COLUMBIAN MUSEUM
PUBLICATION 7.
ZOOLOGICAL SERIES. VOL. I, NO. 2.

ON CERTAIN PORTIONS OF THE SKELETON

OF

PROTOSTEGA GIGAS.

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CHICAGO, U. S. A.
November 21, 1895.

ON CERTAIN PORTIONS OF THE SKELETON OF *PROTOSTEGA GIGAS* COPE.—O. P. HAY.

The Dermochelyoid turtle, *Protostega gigas*, was first described by Professor E. D. Cope in Proc. Amer. Phil. Soc., 1871, page 172, and again in the same publication in 1872, page 403. In 1875, in his "Cretaceous Vertebrata," pp. 99-113, pls. IX-XIII, the same writer more fully described and illustrated the structure of this remarkable reptile.

The materials which were in Professor Cope's hands consisted of a number of vertebræ, ten ribs, some marginal bones, certain portions of the skull, some limb bones, and some large plates. Of the latter there were what the describer regarded as two entire and parts of one or two others. These plates he considered as belonging to the carapace, and this was supposed to be free from the ribs, as the peculiar carapace of *Dermochelys* is free from the ribs of that turtle. In this conclusion he was undoubtedly wrong, as was later shown by Dr. G. Baur (Biolog. Centralblatt, vol. 9, p. 190). This author pointed out that the plates were components of the plastron, an opinion that finds abundant confirmation in the materials here to be described. These consist of a large portion of the plastron of a large individual whose remains were entombed in the Cretaceous deposits of Butte Creek, Kansas. As shown in Plate IV, there are present the hyoplastron and the hypoplastron of the left side almost complete. There are also portions of the same bones belonging to the right side. These parts of the plastron were also accompanied by the nuchal.

The length of the hyoplastron and the hypoplastron taken together amounts to 1.2 metres, including the estimated length of a piece missing from near the hinder end of the hypoplastron. These two bones are united by suture, which may be seen immediately in front of the fracture produced in excavating the fossil. The relation of these two bones is therefore unmistakably indicated. The suture between the two bones is a very short one, in comparison with that of *Thalassochelys*.

The length of the hyoplastron is 61cm; its width 52.5 cm. The extreme width of the hypoplastron is somewhat less than that of the hyoplastron, but it cannot be accurately determined. The latter bone is thickest just behind and somewhat mesiad of the excavation for the fore limb, and here the thickness amounts to 45mm. The hypoplastron is not so thick, but still quite thick and solid. The corresponding bones in Professor Cope's possession were not more than half an inch in thickness, at the most. This condition was in all probability due to the pressure to which they had been subjected.

As will be observed, the anterior inner angle of the hyoplastron is extensively developed, surpassing in this respect that of *Thalassochelys*, in which again the plastron is more developed than in *Chelonia*. As usual in all the recent marine turtles, this angle extends further forward than does the outer one. To that border of this angle which lies next to the fore limb was attached the hinder end of the epiplastron. Neither of the epiplastra was secured. In *Thalassochelys* the anterior ends of the epiplastra extend in front of a line joining the bottoms of the excavations for the fore limbs a distance equal to that from the bottom of the excavations for the fore limbs to those for the hind limbs. This, in the *Protostega* plastron before me, amounts to 84 cm. The xiphiplastra of *Thalassochelys* extend behind the excavations for the hinder limbs as far as do the epiplastra from the anterior excavations. If these proportions hold good for *Protostega*, the whole length of the plastron would amount to at least 2.4 metres.

As shown by the figure, the hinder end of the hypoplastron is prolonged backward and somewhat inward as a long process. Mesiad of this process there has been another and, judging from the example of *Chelonia* and *Thalassochelys*, a longer process. A portion of this process is missing, but the bone, where the fracture has occurred is still 21 mm. thick. This missing process was also evidently directed somewhat toward the middle line of the body, as well as backward. Between the two processes has been received the forked end of the xiphiplastron of that side. The upper end of the inner border of the outer process has been chamfered off where it forms a suture with the xiphiplastron. This chamfering of the bone continues beyond the point of union of the two processes and is then carried backward on the inner process as far as this remains. The upper side of the outer border of the outer process has also entered into sutural union with the xiphiplastron. The whole structure is here extremely similar to that seen in *Chelonia* and *Thalassochelys*.

Had the breadth of the body of *Protostega* possessed the same ratio to the length that we find existing in *Thalassochelys*, the lower side of the animal would have been about 2.2 metres wide. The positions of the surfaces for union with the epiplastra and xiphiplastra, and the location of the axis of strongest development of the two plastral bones of each side make it evident that the outer border of the bony plastron was at a considerable distance from the outer edge of the body. This is shown too by measuring outward from the excavation for the arm a distance proportional to that found in *Thalassochelys*. The tips of the digitations of the plastral bones must have lacked as much as 30 cm. of reaching the marginal bones. This will leave a space of about 120 cm. from the bottom of the excavation for one arm to that for the other. When we come to compare the distance from the hinder to the front excavations, in the restoration of *Protosphargis* by Capellini (Mem. Ac. dei Lincei, 1884, 3 ser., vol. 18), with the distance of the two anterior excavations apart, I find that the two measurements have almost exactly the same ratio that I have given them in *Protostega*.

If we have placed the plastral bones aright, there is left between them a great fontanelle. Where the hyoplastra are widest this is about 43 cm. in width; and opposite the union of the hyo- and hypoplastron, about 90 cm. This is somewhat smaller, however, than the fontanelle found in *Protosphargis*, and much smaller than that of *Dermochelys*.

The nearest relative of *Protostega* is undoubtedly *Protosphargis*; but when we come to compare the two plastra, we find abundant differences. That of *Protosphargis* is considerably less developed than that of *Protostega*. Notwithstanding this, there was on the front of the hyoplastron of *Protosphargis* a long slender process which ran forward and inward to connect with the epiplastron. In *Protostega* the corresponding angle of the hyoplastron is broad, rounded off, and digitated. In *Protosphargis* again there is a broad notch in the anterior and outer border of the hypoplastron, but none in *Protostega*.

It appears to be quite evident that Capellini's restoration of *Protosphargis* is in one respect not wholly accurate. The epiplastra appear to be too short and to converge too rapidly, thus making the plastron too short.

Accompanying the plastral bones here described is another bone which must he regarded as the nuchal. Considerable portions of it are wanting at each lateral extremity; and the tip of the process which projects backward toward the first dorsal neural arch is also broken away. The portion of the bone remaining projects outward on each

side of the middle line less than 18 cm. If the length of the bone had the same ratio to the remainder of the carapace of *Protostega* that we find in *Chelonia*, it should extend laterally about 40 cm. That it had this length so as to reach the first marginal, is quite probable. If the anterio-posterior extent of the bone were equal to that of *Chelonia*, it would be about 30 cm. at the narrowest part; but it is only 6 cm. Indeed, the portion remaining appears to represent little more than the median, backwardly projecting process and the anterior thickened border of the nuchal of *Chelonia*. The reduction in the anterio-posterior direction really appears to have gone further than in *Dermochelys* even. In the latter, however, the anterior border of the bone has been removed, so that it, as well as the other borders, are jagged and thin. In *Protostega* it is the hinder border of the bone which has been removed.

The anterior border of the bone is relatively thick, 3 cm., and is somewhat bevelled, so as to look downward and forward. On the upper surface, near the anterior border on each side, is a broad shallow groove. The process which is seen to extend backward from the body of the nuchal probably reached the first neural. It must then have had a length of about 28 cm.

As in the case of other Cretaceous marine turtles, there is found on the under surface of the nuchal no tubercle for articulation with the last cervical vertebra.

As regards the presence of a dermal carapace of mosaic-like plates, such as is found in *Dermochelys*, the remains here described afford no light. No evidence of its presence has been furnished by any of the specimens of *Protostega* so far produced. It is nevertheless too early to assure ourselve that there was no such a structure, considering how easily it could become detached from a carcass which was being tumbled about by the waves and dragged by carnivorous lizards.

Professor Cope has described some of the vertebræ and ribs of *Protostega*. The vertebræ, like the remainder of the skeleton, had been greatly flattened by pressure, and probably to this circumstance is to be attributed their relatively great width. The true relationships to the vertebral axis were thus rendered obscure. Notwithstanding the possession of ball and socket articulatory surfaces, it was thought that some of these vertebræ belonged to the dorsal region. Others were regarded as appertaining to the neck.

The length of the shortest cervical vertebra, the first behind the axis, in a specimen of *Chelonia* with carapace 790 mm. long is 35 mm. Professor Cope's specimen of *Protostega* had apparently close to three

times this length, and we might therefore infer that the shortest cervical would have a length of about 110 mm. The longest vertebra in his possession was only 60 mm. long and had at least one plane surface. It is quite improbable therefore that it belonged to the animal's neck. The longest neck vertebra, the last but one, of a specimen as large as the one described by Professor Cope should have a length of about 142 mm., and the longest dorsal vertebra, the third, should have a length of near 270 mm. Professor Cope's account of the longest vertebra in his possesion makes it not improbable that it was the first sacral. The other vertebræ almost certainly belonged to the tail. Their size and the form of their articular surfaces both support this interpretation.

Ten ribs were in Professor Cope's hands. Each had a proximal expansion, and it was evident that these ribs did not unite suturally so as to form a carapace. But since the dorsal vertebræ were regarded as being so small, the conclusion was reached that either the expanded proximal ends interfered with each other in the middle line or the ribs must have been articulated to diapophyses. Since, however, the dorsal vertebræ would have varied in length from 108 to 275 mm., and would have been proportionally wide, while the widest rib described is 140 mm. at the proximal end, there is no necessity for believing that any rib touched either its fellow or its neighbors. The second, third, fourth, and fifth vertebræ probably ranged from 250 to 275 mm., and the next two or three were not much shorter. In *Dermochelys* and *Protosphargis* the ribs in front of the fifth from the last are little, if any, broader than this fifth. Hence we may safely conclude that there were wide spaces between the ribs even near the vertebral column. The ribs certainly lacked little of having reached as advanced a stage of reduction as they have in *Dermoehelys*. Their condition was probably much like that seen in Capellini's restoration of *Protosphargis*.

Professor Cope estimated that the head of the individual which he described had a length of 24⅝ inches. However, basing my estimate on the length of the maxillary bone as figured on plate X of "Cretaceous Vertebrata," and making the ratio of this maxillary to the length of the skull the same as that found in *Thalassochelys*, I can make the whole length of the skull, including the supraoccipital spine, only about 18 inches, or 45 cm. The distance from the snout to the condyle would be close to 13 inches, or 32 cm. Professor Cope's specimen, judging from the size of the plastral bones in his possession, was not much smaller than my own. Hence if we estimate at 32 cm the head, measured to the condyle, we shall probably not make it too great.

On the other hand, a study of the figures of the parts of the skull on plates X and XI of the work cited renders it highly probable that the bone figured on plate X as the maxillary is not such, but the postfrontal; while the figure on plate XI, said to represent the postfrontal, really portrays the maxillary, prefrontal, vomer, and palatine. In such case, the length of the skull would be about a fourth greater, or 40 cm.

The length of the carapace of *Chelonia* has a ratio to the plastron of about 31 to 24. Hence the length of the carapace of my specimen must have been close to 3.1 metres. The neck of our living marine turtles projects beyond the front of the carapace a distance equal to at least one-sixth of the length of the carapace. Hence, we are safe in allowing 50 cm. for the neck outside of the shell. We have therefore for the length of this turtle the following figures:

Head	.32	metres.
Neck beyond carapace	.50	"
Carapace	3.10	"
Total	3.92	metres.

PLATE VII.

Skull of Cervus ——— ♀ female.

Fig. 1. View from above.

2. " " side.

3. " " below.

...ity of the figures of the parts of the ...ected renders it highly probable ... the maxillary is not such, but the ... plate XI, said to represent the post- ... maxillary, prefrontal, vomer, and palа- ...th of the skull would be about a fourth ...

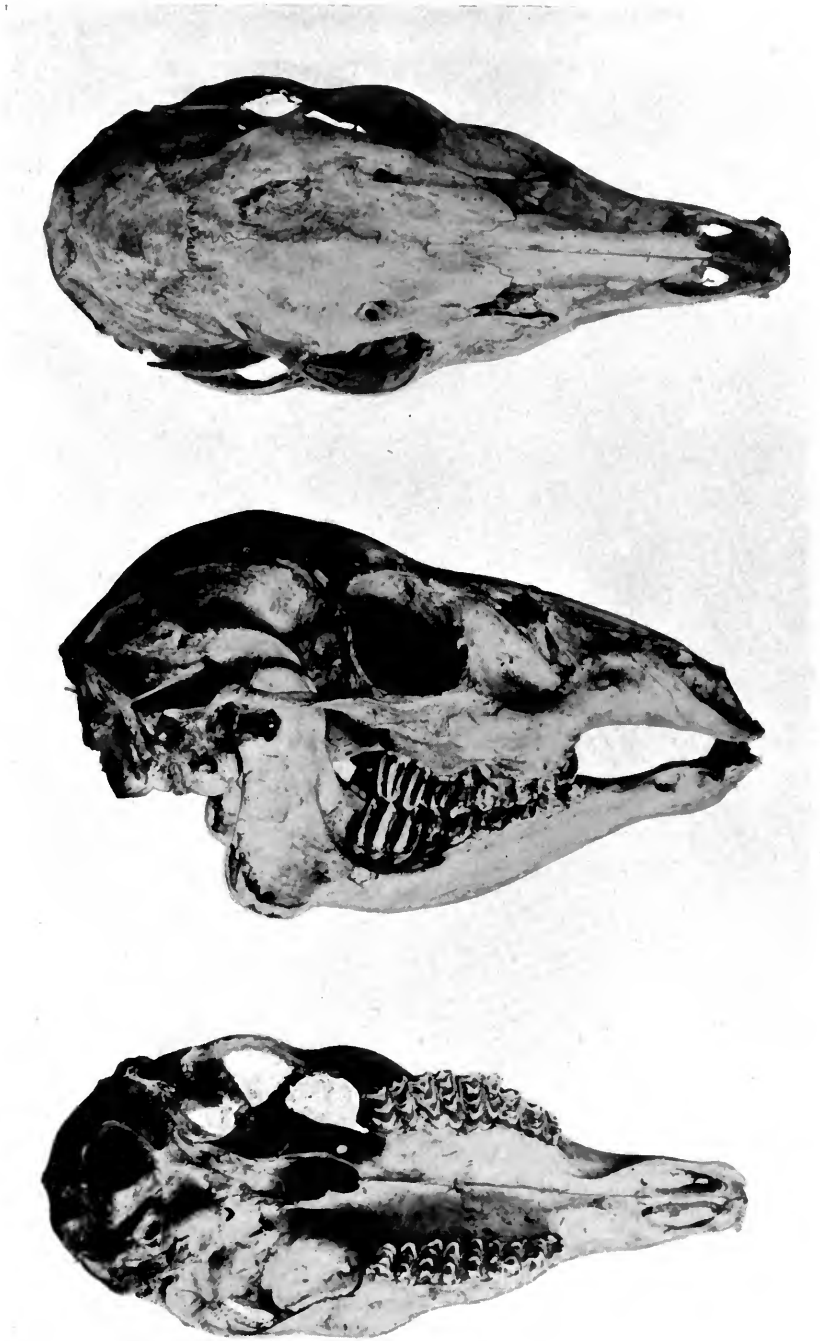
... of *Chelonia* has a ratio to the plastron ... the length of the carapace of my specimen ... metres. The neck of our living marine ... of the carapace a distance equal to ... the carapace. Hence, we are safe ... outside of the shell. We have there- ... the following ratios:

...	...32 metres.
Neck beyond carapace	.56 "
Carapace	.10 "
...	...98 metres.

PLATE VII.

Skull of Cervus ————?—Female.

Fig. 1. View from above.
2. " " side.
3. " " below.



SKULL OF CERVUS———?—FEMALE.

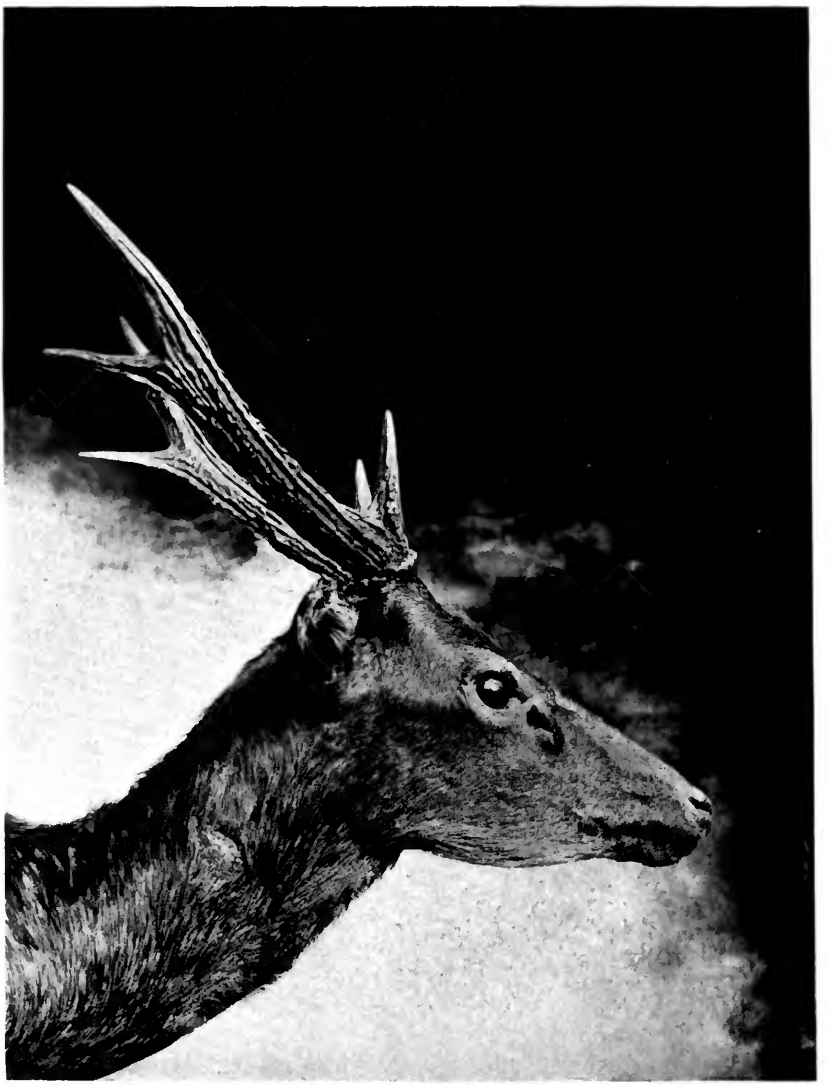
PLATE VIII.

Head of Cervus sheerii.—Male.

HEAD OF CERVUS SHEERII.—MALE

PLATE VIII.

Head of Cervus steerii.—Male.



HEAD OF CERVUS STEERII.—MALE.

PLATE IX.

Skull of Cervus sterni.—Male.

Fig. 1. View from above.

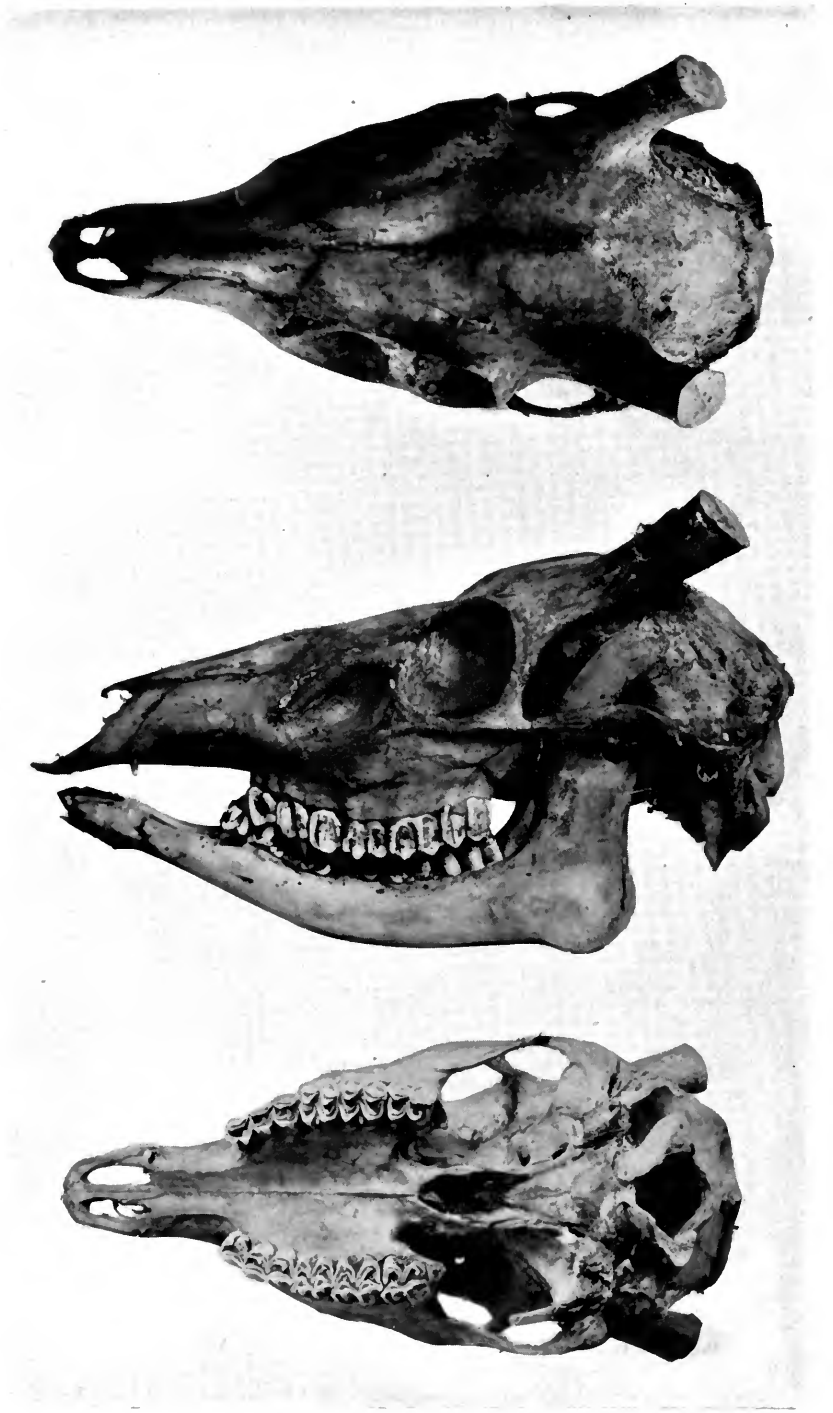
" 2. " " side.

" 3. " " below.

PLATE IX.

Skull of Cervus steerii.—Male.

Fig. 1. View from above.
2. " " side.
3. " " below.



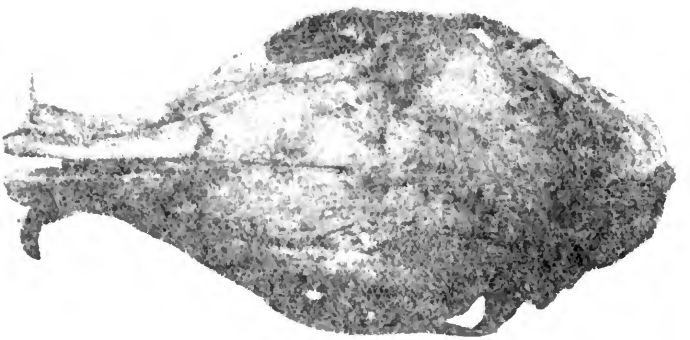
SKULL OF CERVUS STEERII.—MALE.

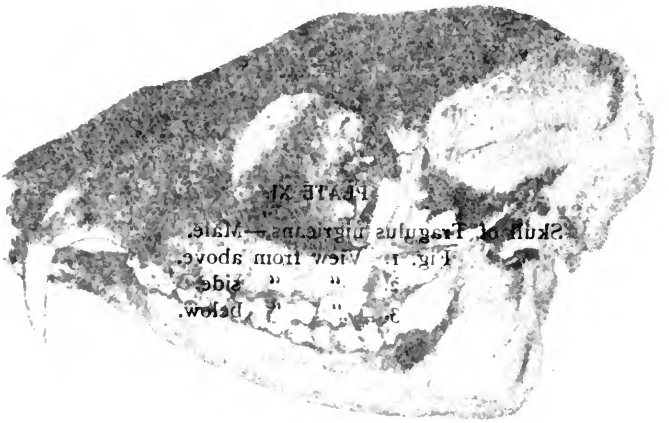
PLATE X.

Skull of Cervus steerii.—Female.

Fig. 1. View from above.
2. " " side.
3. " " below.

SKULL OF CERVUS STEERII.—FEMALE.





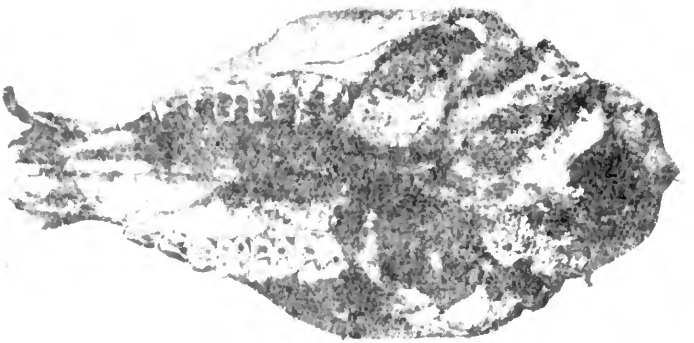


PLATE XI.

Skull of Tragulus nigricans.—Male.

Fig. 1. View from above.
2. " " side.
3. " " below.

SKULL OF TRAGULUS NIGRICANS.—MALE.

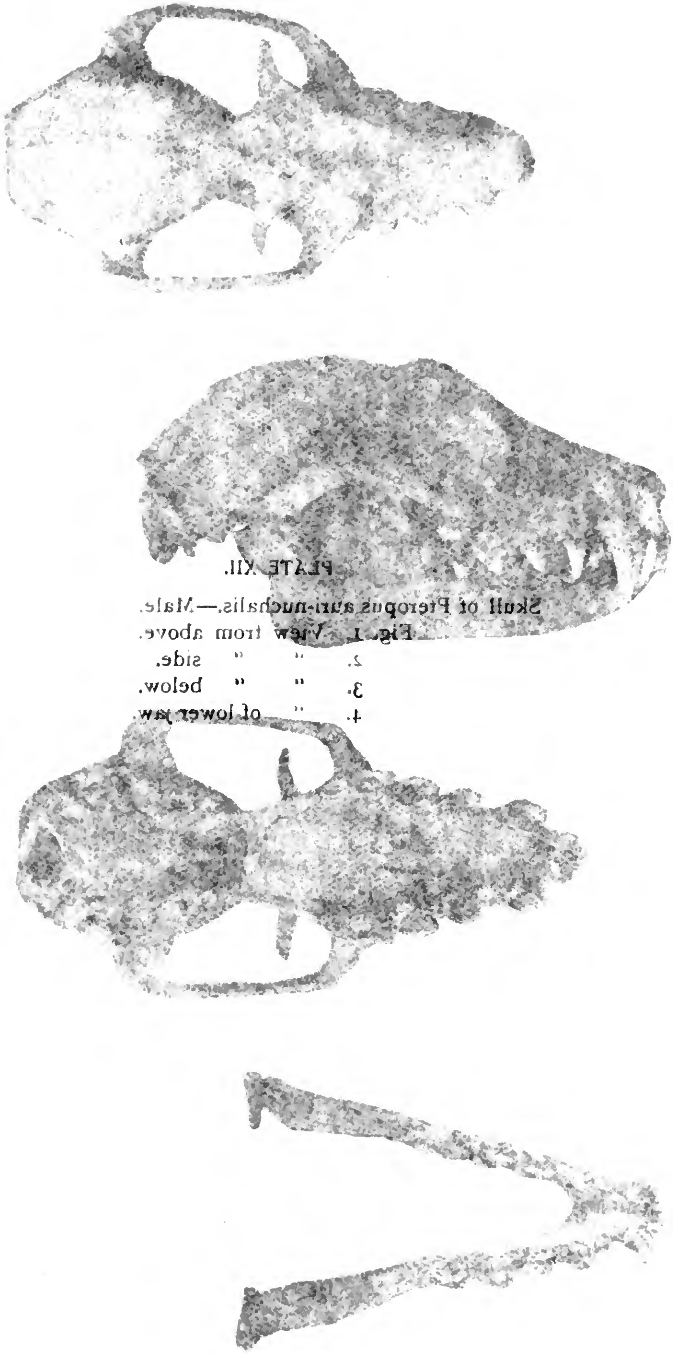
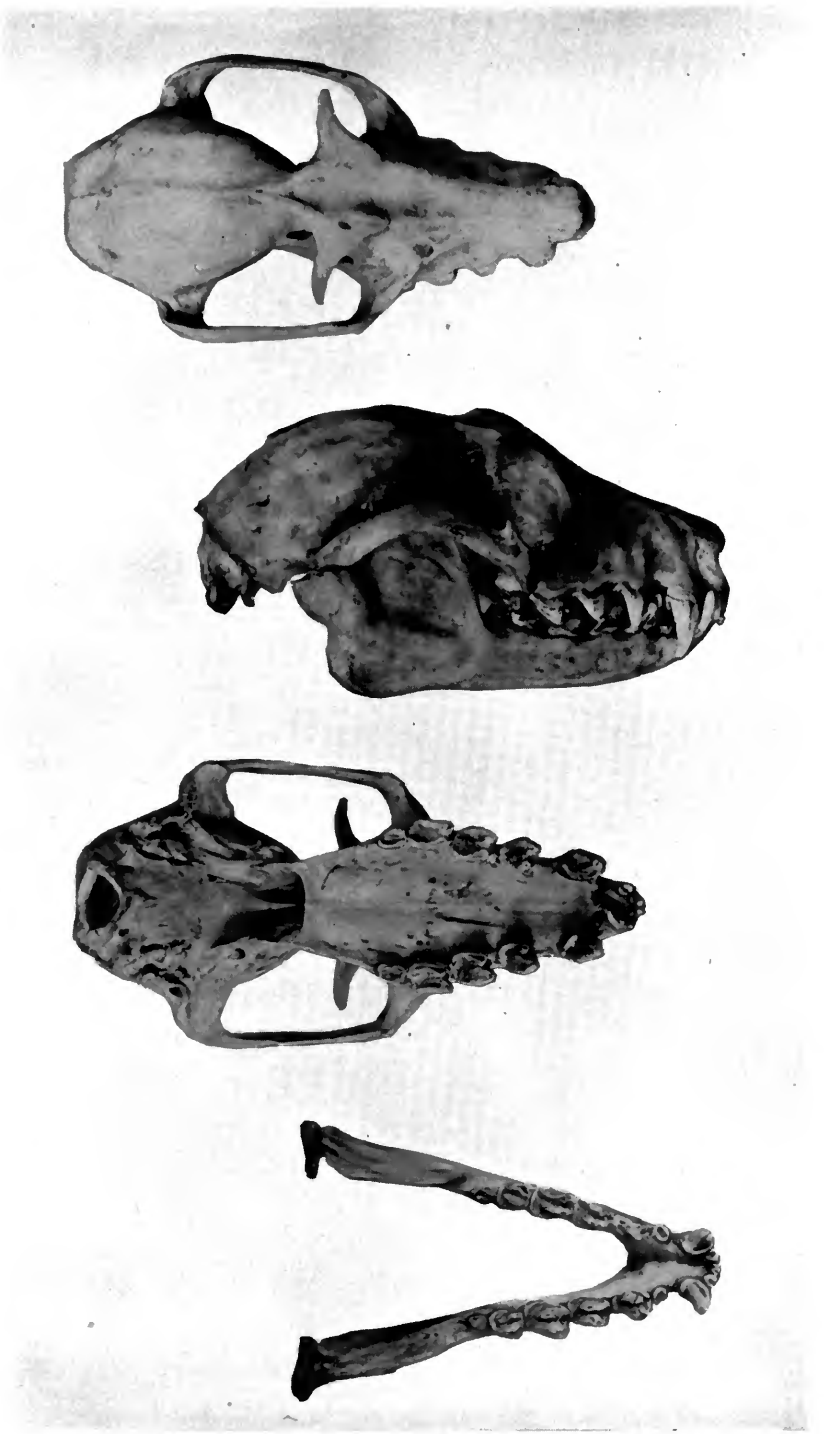


PLATE XII.

Skull of Pteropus auri-nuchalis.—Male.

Fig. 1. View from above.
2. " " side.
3. " " below.
4. " of lower jaw.



SKULL OF PTEROPUS AURI-NUCHALIS.—MALE.

PLATE XIII.

Skull of Pteropus lucifer.—Male.

Fig. 1. View from above.
2. " " side.
3. " " below.

SKULL OF PTEROPUS LUCIFER.—MALE.