9. Remarks on the supposed Clavicle of the Sauropodous Dinosaur *Diplodocus*. By Francis, Baron Nopcsa, Ph.D.*

[Received June 6, 1905.]

(Text-figures 46–49.)

It is still uncertain whether the extinct Dinosauria possessed clavicles.

Considering the close relationship existing between these reptiles, the Rhynchocephalians, Parasuchians, and Birds—this last relationship being shown by the continuous tendency of Dinosaurs to specialize on most different occasions in bird-like manner—one is at first naturally induced to believe that in Dinosaurs clavicles were present; but, as a matter of fact, bone after bone supposed to represent this element has had to be removed from this position.

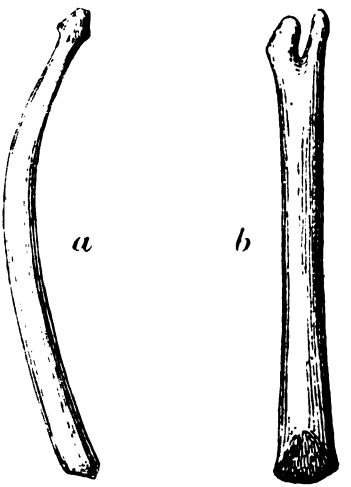
Hitherto only the family Ornithopodidæ is known to possess, in addition to scapula and coracoid, a curious further element in the shoulder-girdle, which was called clavicula, but may quite as well form only a part of the sternum (this double element being in one case united in the middle by bony matter). No other Saurischian or Orthopodous Dinosaur shows a clavicular ossification. It is true that in the Sauropoda, besides scapula and coracoid, one or two flat bones are always present in the scapular region of the body: these, however, do not represent claviculæ, but may with certainty be determined as ossifications of the sternum. The discovery, therefore, of what may be called a supernumerary bone besides the sternal plates in two of the several *Diplodocus* skeletons known to science proves to be of quite exceptional interest.

Hatcher, in his important Monographs of the *Diplodocus* skeletons Nos. 84 and 662 of the Carnegie Museum, describes this element as follows:—"Throughout the greater portion of its length it is circular in cross-section, it is bifid at one extremity and slightly expanded at the other. It is strongly curved, especially toward the bifid extremity. It is asymmetrical." In a more complete specimen (No. 662) than the former (84) it is "somewhat expanded and spatulate; the flattened extremity presents a slightly rugose surface, as though it had been imbedded in cartilaginous or muscular tissue, and this together with the bifid nature of the other extremity has suggested the possibility that the bone might be an os penis." After the description of this bone, however, its asymmetry is regarded by this eminent palæontologist as a weighty argument against its being an os penis, and therefore its identification with the clavicula is advocated.

* Communicated by Dr. A. Smith Woodward, F.R.S., F.Z.S.

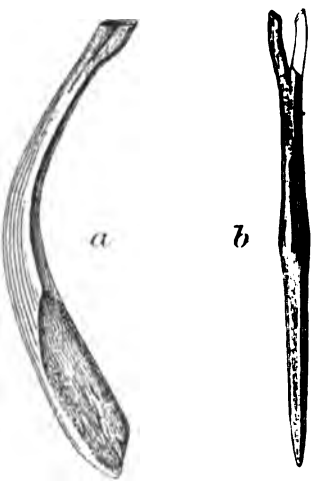
According to the figures given by Hatcher and reproduced here (text-figs. 46 & 47) the bone in question seems to present a great deal of what might be termed individual variation.

Text-fig. 46.



Supposed clavicula of *Diplodocus*, No. 84.

Text-fig. 47.



Same bone of *Diplodocus*, No. 662.

It seems to fit fairly well into the shoulder-girdle, but still

there are several points to be brought forward against the theory of its clavicular nature.

Firstly, it must be remembered that in one case this problematical bone, like the greater part of the skeleton, was displaced and that in the second skeleton, as pointed out by Dr. Holland, the femur bears tooth-marks of carnivorous Dinosaurs. In consequence of this the relative position of the bone cannot prove anything for or against its being an os penis; for the penis would be one of the first parts of the body to become displaced by decomposition and the first part that would be torn away if carnivorous animals were gnawing at the dead body.

Text-fig. 48.

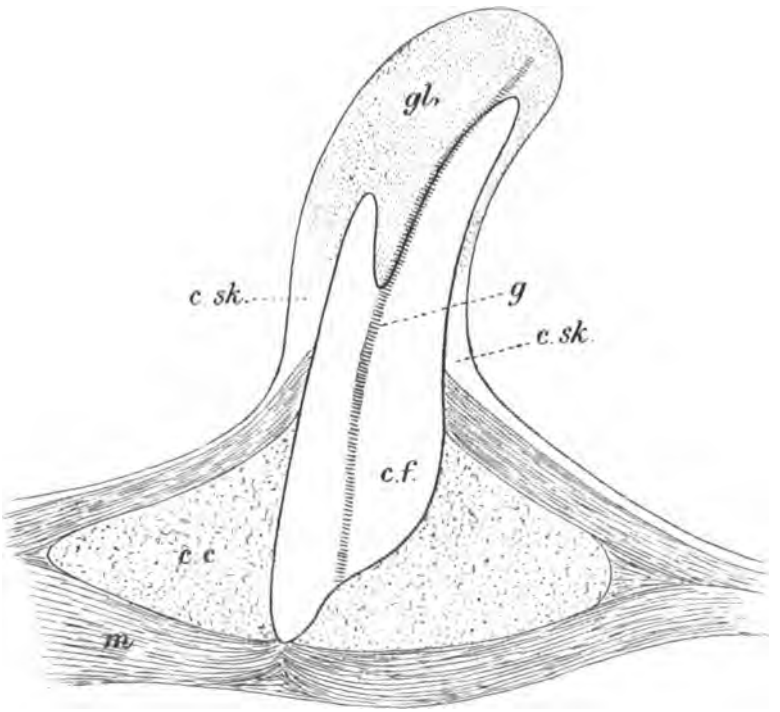


Diagram of penis of *Struthio*.

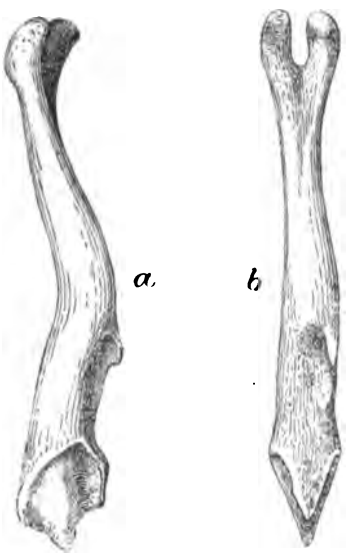
Explanation of letters:—*c.c.*, corpus cavernosum; *c.f.*, corpus fibrosum; *c.sk.*, coarse skin; *g.*, gutter; *gl.*, glans-like part; *m.*, muscles.

Secondly, in each of the two pretty complete skeletons that comprised this bone, only one example was present, and this one appeared to belong to the same side of the body. In other specimens of *Diplodocus* the element was altogether wanting.

This highly remarkable coincidence suggests the probability that the bone in question represents an asymmetrical but nevertheless unpaired organ.

So far as I am aware there is no known reptile, living or extinct, in which the clavicle is bifurcated at one end. Moreover, in most terrestrial and aquatic reptiles, when clavicles are present there is also an interclavicle, which has never been found in Sauropoda. It must also be remembered that these large herbivorous Dinosaurs were probably descended from the carnivorous Theropoda, which are always destitute of a clavicular arch.

Text-fig. 49.



Os penis of European Otter.

I am therefore of opinion that the problematical bone of *Diplodocus* in question cannot be a clavicle, and it is necessary to consider Hatcher's alternative suggestion that it is an os penis.

The fact that existing birds and reptiles are destitute of an os penis does not necessarily imply that gigantic reptiles like *Diplodocus* similarly lacked the bone. Among Mammalia it is well known that the element occurs only sporadically, being present, for instance, in the Anthropoid Apes and absent in Man.

Among the living reptiles we know two types of genital organs. The Squamata show what may be called a bifid penis, while the Crocodilia and Chelonia have the penis simple exteriorly, with a corpus fibrosum and frequently even a glans penis well developed.

In Chelonia the penis sometimes exhibits internally a partially bifid structure.

For the purpose of this paper the penis of birds is of quite exceptional interest. In its origin it is not only traceable to the Crocodilian type, but shows a very great amount of asymmetry, and besides in the Ratitæ a distal bifurcation of the corpus fibrosum (text-fig. 48, p. 291). In *Struthio* the distal part of the penis is changed into a glans-like organ, while in *Rhea* the corpus fibrosum consists of an exceedingly hard and nearly cartilaginous substance.

A bifurcation like that observable in the problematical bone of *Diplodocus* is also frequently to be met with at the distal end of the mammalian os penis, which is often asymmetrical. The os penis of mammals always shows quite remarkable variability. For comparison with the bone of *Diplodocus*, side and hind views of the os penis of the European Otter (*Lutra lutra*) are given (in text-fig. 49, p. 292), and one can see at a glance the well-rounded, smooth, condyle-like, distal ends, the proximal rugosities, and the lateral impressions for the attachment of the corpus fibrosum. In other mammals the corpus fibrosum is not attached laterally to the ossified element, but ends in a deep pit situated at the proximal end of the latter.

We have therefore to consider the following propositions:—

(1) That among the Mammalia it is the corpus fibrosum with which the os penis comes in close contact, forming the anterior prolongation into the glans penis, that the os penis ossifies from fibrous matter; that a corpus fibrosum is also present among Reptilia, and that therefore an os penis in Dinosaurs can only have originated from the corpus fibrosum.

(2) That in *Rhea* the corpus fibrosum is quite as hard as cartilage, and differs from this only by not possessing cartilage-cells.

(3) That in Sauropsida a glans is frequently present.

(4) That it is quite a common thing to find bird-like characters in various parts of the Dinosaurian skeleton.

(5) That among the birds the Ratites show the most primitive and still the best-developed male genital organ.

(6) That the shape and variation of the problematical bone in *Diplodocus* are well in accord with its being an os penis, while they militate against its determination as clavicular.

(7) Lastly, that this so-called clavicula when present is always found only as an unpaired organ showing the same direction of curvature.

Hence I am of opinion that it is at present advisable to remove the subject of this paper from the shoulder-girdle and determine it as the ossified axis of the penis.

Further evidence and, especially, further discoveries are naturally necessary before so delicate a question can be regarded as definitely settled; but since Hatcher's single argument against the bone in question being an os penis (namely, its asymmetry) breaks down on reference to *Struthio* or even to *Lutra*, the balance of the argument is at present in favour of this newer interpretation.

The existence of clavicles in Dinosauria must therefore still be considered doubtful.

In conclusion, I wish to express my thanks to Mr. Boulenger, Dr. Forsyth Major, Mr. Pycraft, and Dr. A. S. Woodward at the British Museum, and to Professor Stewart and Mr. R. H. Burne at the Royal College of Surgeons, for their kind help in studying so intricate a question.

Literature.

GADOW & SELENKA.—Birds: Bronn's Klassen und Ordnungen d. Thierreiches, vol. vi. part iv.

GILBER.—"Das Os priapi der Säugethiere." Gegenbauer's Morphologisches Jahrbuch, 1891.

HATCHER.—"*Diplodocus carnegii*." Memoirs of Carnegie Museum, Pittsburg, vol. i.

——. "Osteology of *Haplocanthosaurus*, with Appendix on *Diplodocus*." *Loc. cit.* vol. ii.

[NOPCSA.]—Critical Review of Hatcher's Paper on *Haplocanthosaurus*. Keilhack's Geologisches Centralblatt, 1904.

WEBER.—Die Säugethiere. Leipzig, 1903.

WIEDERSHEIM.—Lehrbuch der vergleichenden Anatomie d. Wirbelthiere. Leipzig, 1902.

PROCEEDINGS

OF THE

GENERAL MEETINGS FOR SCIENTIFIC BUSINESS

OF THE

ZOOLOGICAL SOCIETY OF LONDON.

1905, vol. II.

PART I.

CONTAINING PAPERS READ IN

MAY AND JUNE.

OCTOBER 1905.

PRINTED FOR THE SOCIETY,
SOLD AT THEIR HOUSE IN HANOVER SQUARE.

LONDON:
MESSRS. LONGMANS, GREEN, AND CO.,
PATERNOSTER-ROW.

[*Price Twelve Shillings.*]