

ART. XXI.—Notes on the Marine Turtle Archelon. I. On the Structure of the Carapace. II. Associated Fossils: by G. R. WIELAND.

IN my first contribution on the osteology of the huge turtle *Archelon ischyros* from the Fort Pierre Cretaceous of South Dakota, I figured (Plate VI, Reference 6*) the last cervical and first dorsal centra, together with the neurals and nine pairs of ribs, as found articulated in their approximately natural position, and associated with most of the other skeletal parts. Since then I have secured much additional material from which it will be possible to mount a quite complete skeleton. But as this will require an amount of time and museum resources equal, for instance, to that involved in the study or mounting of any Dinosaur yet placed on exhibition, a considerable period must elapse before any final contribution on this subject may be made. Hence it may be of some immediate service if the outline of the rib series in its entirety be given now, more especially since this is found to be of unusual interest.

Last autumn I secured near the Cheyenne River in South Dakota, among other material, an important additional skeleton of *Archelon*, in which the first rib, that articulating with the anterior end of the first dorsal centrum, is present. This makes it possible to complete the rib series, as shown in the accompanying text-figure.

In the absence of much careful work by a preparateur it would be difficult to indicate correctly the marginals in dotted line, because of the digitate or strongly serrate character of both the inner marginal borders, which vary much in different portions of the series. The illustration of the completed Carapace must for the present, therefore, remain in abeyance.

Description.—The *nuchal* is a large and handsome T-shaped element one meter in lateral width. I at one time provisionally regarded this bone as belonging to the plastron (7). This view was, however, in the opinion of Capellini supported by "neither embryological nor paleontological evidence" (2); Case in a manuscript note kindly submitted to me likewise opposed it. I am glad to find the complete evidence in accord with the views of these eminent authorities.

The *neuralia* are not of less area than in the Cheloninæ, but they are very thin, and are joined to each other and to the pleuralia by strongly marked, more or less imperfectly interlocking, sutural digitations. They are distinctly grooved on their median

* For convenience the references are grouped at the end of the article.

dorsal line, especially the first seven, this grooving being deepest and widest in the middle of each plate, from whence characteristic surface striations radiate. Regarding the number of neuralia I can only say that the boundaries of the first eight are distinct, but to make out clearly the relations and proportions in the pygal

1

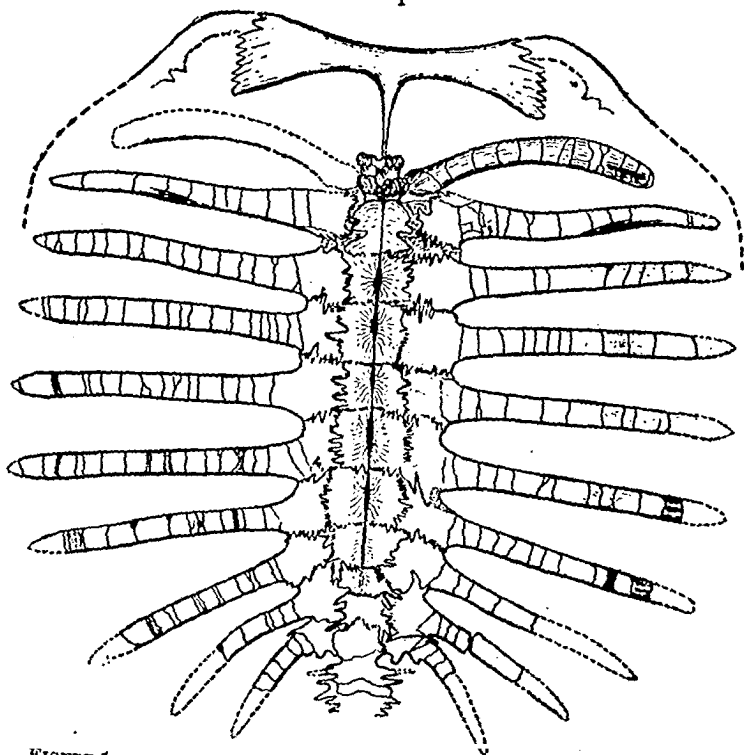


FIGURE 1.—*Archelon ischyros* Wieland. The nuchal, the anterior marginal border of the carapace, the neuralia, the pleuralia, and the complete rib series, with the last cervical and the first dorsal centra.—Dorsal view with nuchal set somewhat forward. (All the dorsal and sacral vertebrae are present and articulated in their natural position in the type specimen, on which the present figure is based, with the sole exception of the first rib.) One-twentieth natural size.

region cannot now be readily done, in the absence of work by a preparateur. The final median plate shown in the figure is possibly represented as too long. Fortunately, however, the fine specimens I have secured promise when fully elaborated to

supply these and other important details in the osteology of these great turtles. Their discussion may, therefore, profitably await the complete restoration of the types which I later intend to give.

The *pleuralia* are greatly reduced in size, being of even less area than the *neuralia*, and fully as thin. They unite with each other and with the *neuralia* by loosely interlocking digitations. The pleural of the second rib in particular is thin and small, occupying only about an eighth of the entire rib length. (See figure.)

The *ribs* are very characteristic, the first being remarkable. The only specimen of this rib recovered is massive, and 74^{cm} in length, or fully three-fourths the length of the second rib, which is one meter long (see measurements). In the *Cheloninae* (9) the length of the first rib, which is slender and reduced, is only about one-fourth that of the second. The first rib in *Archelon* is thus much more rib-like in general appearance than in all other turtles with which it may be directly compared, and must have extended out far enough for its distal end to rest in the marginal groove, as in the case of the ends of the other ribs. It is also quite possible that this rib was set even more obliquely to the vertebral column than is shown in the drawing. This point can later be determined. There is, however, no contact between this first rib and the first pleural, *Archelon* differing in this respect from all other turtles except *Dermochelys*.

The *second rib* is also more massive than in any of the *Cheloninae*, this being in full accord with the reduced small and thin first pleural which it bears. In the case of the remaining pairs of ribs, which are free for about four-fifths of their length, the only character that need be mentioned now is the distal increase in vertical thickness. The second to the fifth pairs of ribs, inclusive, which are only about 2.5^{cm} in thickness where they emerge from beneath the pleurals, have near their distal ends a thickness of from four to five centimeters.*

Discussion.—In *Archelon*, as has been noted, the *neuralia* are strongly reduced in thickness, and the *pleuralia* in both thickness and area. In fact neuro-pleural reduction is greater than in the case of any other turtle known to possess all the

*In the figure the ribs are drawn in the nearly flattened position in which they were found, the first being the only one preserving the original curvature as in life. The width of the carapace hence appears accentuated. Nevertheless the general form of body was very robust. Indeed there appears to have been an almost *Trionychian* rotundity, with the nuchal lying more or less athwart the ends of the first pair of ribs (not the second as in the *Trionychia*), and projecting over from three to four of the cervicals as in *Dermochelys* and certain *Pleurodirans*, as *Pelomedusa*.

elements of the normal testudinate carapace. On the other hand, the ribs are more fully developed than those of any other fairly well-known turtle, not even excepting *Protosphargis* (1, 2) and *Dermochelys*. In the latter genus, however, the carapace being replaced, in as far as an outer bony shield is concerned, by a strong osteodermal mosaic, there is no necessity for a fully normal development of all the ribs, and such is not present, the anterior pair of ribs being in fact quite as much reduced as in the living Cheloninæ (9). In the latter the first rib, after affording support to the distal extremity of the scapula, flattens and ends against the inner surface of the very large first pleural. And this first pleural, which is in the simpler sense only an expansion of the second rib, is in turn strongly united by suture to the nuchal, the whole arrangement being one of compactness and great strength.

In the absence of a strongly joined nuchal and first pair of pleurals, efficient support for the scapular region of the shoulder girdle would be clearly obtained in one of two ways: Either there must be an increased size of the first rib, or additional strength must be secured by dermal thickening, with or without the development of osteodermal plates. And it is evident that if one of these conditions is found present it may be justly concluded that the other is absent, or but slightly developed. Hence, because of the great strength of the first rib in *Archelon* we may conclude that there was no unusual development of the outer covering of the carapace, whether leathery or of horn, and that there certainly was no osteodermal mosaic as in *Dermochelys*. The entire arrangement of the ribs, and of the supporting bones of the shoulder girdle region in *Archelon* thus forms an exceedingly clear example of *compensatory change*. There is also involved a return to early and primitive conditions. The Protosteginæ (9) as we know were distinctly pelagic, and, accepting the views of Baur and of Dollo, they are, in common with all the marine turtles, descended from ancestors with a normally developed carapace and plastron; while in the case of these ancestral forms we may be quite positive that the neuralia and pleuralia were of strong, and the ribs proper of minor development. Moreover, such forms must, of course, have been descended in turn from Theromoran (3) ancestors in which there was a fully normal rib development. In *Archelon*, therefore, the ribs may be considered as having regained a large and full size quite equal to that which must have characterized the early Theromoran ancestry of the Testudinales, although changed fundamentally in position with reference to the shoulder girdle. The neuralia and pleuralia, on the other hand, have undergone much reduction as compared with the marine turtles of to-day, the margi-

nalialia remaining strong to robust. With reference to the first pair of ribs a word remains to be said. It would seem positively certain that in the ancestry of the Protosteginae these ribs were much suppressed, but for the fact that in *Proganochelys*, as described by Fraas (5), the first pair of ribs has a wholly unique development. In this, the most ancient turtle known, the first rib is very large, and of peculiar form, the distal end being widely expanded, but in the vertical direction. In *Archelon*, however, the very slight distal expansion is lateral, and there does not appear to be much in common with this terrestrial Pleurodiran from the Keuper that would suggest even remote ancestral relationship.

The return to a primitive condition, as seen in the ribs above noted, has seldom been demonstrated. The only other well-authenticated instance of such return among the vertebrates within my ken is that of the canines of the camels as explained by Dr. J. L. Wortman. In the Eocene camels, the canines are small and incisiform; in the Oligocene and Miocene forms, these teeth assume an enlarged and normally caniniform pattern, while in the Pliocene and modern forms they again take on the primitive Eocene condition.

Although it does not as yet seem possible to me to correlate the carapacial changes just described directly with those most probably undergone by *Dermochelys*, it is believed that the example of compensatory skeletal change here recorded must be regarded as a highly interesting one.

Measurements of *Archelon ischyros*.

(a) *The First Rib.*

(From specimen about 12/13 the size of the type.)

	M.
Greatest length	·74
Circumference, 18·5 ^{cm} out from head	·225
Width half-way from head	·075
Width 50 ^{cm} from head	·09
Girth " "	·23
Depth of head in the dorso-ventral direction ...	·15
Least circumference about 30 ^{cm} from head	·21

(b) The length of the second, third, fourth, fifth, and sixth ribs, respectively, in the type specimen, is ·95, 1·01, 1·02, 1·02, and 1·01 meters. (The first rib would be 80^{cm} long.)

(c) The width of the first to tenth ribs of the type taken at their middle point is, respectively, (·08), ·075, ·075, ·078, ·075, ·07, ·065, ·06, ·055, and ·05 meters.

II.—*Associated fossils.*—With *Archelon ischyros* and *Marshii* there occurs in the uppermost 100 feet of the Fort Pierre (No. 4 Upper Cretaceous), as developed on the Cheyenne River, a series

of immediately associated forms of more than ordinary interest. In the first place, I have obtained in this same horizon well preserved toe bones of a Dinosaurian nearly of the form and nearly as large as those of *Claosaurus annectens*, which I shall figure later as *Claosaurus* (?) *affinis* sp. nov. And presumably from the same drift from a not far distant shore, I secured an exquisitely preserved new species of Palm stem, later to be described as *Palmoxyylon cheyennense*.

Secondly, associated with these land forms are numerous Mosasaurs, a shark (a broad-toothed *Lamna*), a fish allied to *Beryx*, a Saurocephalodont, and the following invertebrates,—*Nautilus De Kayi* (very abundant in the matrix of one of the large turtle skeletons), *Placenticeras placenta*, *Scaphites nodosus*, *Emperoceras Beecheri* Hyatt, *Baculites ovatus* and *compressus* Say, *Callista Deweyi* M. and H., *Inoceramus*, etc., etc.—I hope again to call attention to this interesting assemblage, for it is not often that we are able to find in unquestioned association such well marked land and marine forms.

Yale University Museum, New Haven, Conn.

References.

1. Capellini, G. : Il Chelonio Veronese *Protosphargis Veronensis*. (36 pp., 7 pls.) Reale Accad. dei Lincei. Rome, 1884.
2. ——— Le Piastre Marginale della *Protosphargis Veronensis*. R. Accad. della Scienze dell' Instituto di Bologna, 1898.
3. Cope, E. D. : Second Contribution to the History of the Cotylosauria. Proceedings of the American Philosophical Society, vol. xxxv, No. 151, May, 1896.
4. Dollo, L. : Sur l'origine de la Tortue Luth (*Dermochelys coriaceæ*). Bulletin Soc. Roy. des Sciences Med. et Nat. de Bruxelles, Seance 4, février, 1901.
5. Fraas, E. : *Proganochelys Quenstedtii* Baur (*Psammodochelys Keuperina* Qu.) Ein Neuer Fund der Keuperschildkröte aus dem Stubensandstein. Jahreshefte des Vereins für Naturkunde in Württemberg, Stuttgart, 1899.
6. Wieland, G. R. : *Archelon ischyros*, a new gigantic Cryptodiran Testudinate from the Fort Pierre Cretaceous of South Dakota. This Journal, December, 1896.
7. ——— The Protostegan Plastron. Ibid., January, 1898.
8. ——— The Skull, Pelvis, and probable Relationships of the Huge Turtles of the Genus *Archelon* from the Fort Pierre Cretaceous of South Dakota. Ibid., April, 1900.
9. ——— Notes on the Cretaceous Turtles, *Toxochelys* and *Archelon*, with a classification of the Marine Testudinata. Ibid., August, 1902.