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ART. VII.—*The Cretaceous Armored Dinosaur, Nodosaurus textilis Marsh;* by RICHARD SWANN LULL. With Plates I to IV.

[Contributions from the Othniel Charles Marsh Publication Fund, Peabody Museum, Yale University, New Haven, Conn.]

TABLE OF CONTENTS.

Introduction.
History of discovery.
Extent of material.
Original description.
Morphology.
Endoskeleton.
Pre-sacral vertebræ and ribs.
Pelvis.
Caudal vertebræ.
Fore limb.
Hind limb.
Exoskeleton.
Armor.
Taxonomy and relationships.
Family characteristics.
Re-definition of *Nodosaurus* Marsh.
Relationships with other genera.

INTRODUCTION.

The "paleontologic revival" at Yale has as its first fruits the naming and description of new species out of old specimens in the Marsh Collection, some of which have awaited recognition for nearly half a century since they were exhumed. Incidentally there remains the other task of redescribing, in the light of further preparation and of greater opportunity for comparative study, such type material as had already had the scientific recognition of the master. Of such is the type of *Nodosaurus*, the importance of which is manifest when it is realized that it is not only a generic and specific type, but that of

the family of American plated dinosaurs, and was, moreover, essentially the first of these remarkable reptiles to be described in American literature of science. The preparation of the skeleton has been an arduous task, as it was sent in from the field in the form of shattered, bone-containing fragments of one or more great concretions. The only possible mode of procedure was to fit together these fragments and then, after pouring plaster into every bone impression in the rock where the osseous tissue had been eroded away, to hew the matrix from both the contained bone and the plaster continuation thereof. In this way, through weeks of patient toil, the creature has been revealed, and while by no means complete, will enhance very materially our present knowledge of these forms. *Stegosaurus,* although difficult to understand, is of course well known, owing to the researches of Marsh, Gilmore, and the writer, but it represents an aberrant side branch of the Stegosauria, and is early extinct (Morrison time), while *Nodosaurus* and its allies are in many respects more conservative and trace their lineage from the Lower Jurassic *Scelidosaurus* to *Ankylosaurus* of the Lance—almost the entire length of recorded predentate dinosaurian history.

Aiding in the work of preparation were F. W. Darby, a preparator of high skill and long service, Edward L. Troxell, associate on the research staff of the Peabody Museum, and others. I am also indebted to W. D. Matthew and Barnum Brown of the American Museum of Natural History for photographs and the privilege of studying the *Ankylosaurus* specimens collected by the latter; to Charles W. Gilmore of the United States National Museum for photographs and criticism; and to our lamented colleague, S. W. Williston, for the loan of the type specimen of *Stegopelta.* Mr. Kirkham of Yale aided in certain interpretations for which my knowledge was insufficient, while Professor Schuchert and Miss LeVene have as usual given their very real aid to the undertaking.

History of discovery.—When the veteran collector, William H. Reed, was working for Professor Marsh in 1881, searching for mammals and reptiles in the Morrison strata on the western slope of Como Bluff, Wyoming, he happened to discover the dinosaur which Marsh later described as *Nodosaurus textilis.* The specimen was found about 1½ miles east and south of the famous

Quarry 13 which was so highly productive of dinosaurian life (Gilmore 1914, pp. 2-24), and as it lay on the easterly slope of the Como anticline was therefore considerably above the Morrison stratigraphically. The label bears the statement "400 feet above the Dacota sandstone" in Professor Marsh's handwriting, while Reed's letter of July 17, 1881, says: "I found a saurian today in the Cretaceous between the Dacota rocks and the shale above them." This would bring it within the limit of the Benton sands and therefore in marine deposits, a not infrequent occurrence with the plated dinosaurs. The specimen lay in one or more concretions of dense bluish limestone which is extremely difficult to distinguish in some instances from the bone itself. The material was collected in fragments and its reconstruction has been a three-dimensional puzzle of great difficulty, especially as all of the pieces are evidently not preserved. Reed himself says in a letter dated July 12, 1882: "It is not very good and all in concretions so I could make no diagram of it."

Extent of Material.—The material as now prepared (1920) consists, first, of the pelvis, including the armored-over sacrum with the well preserved ilia attached. What appear to be the spinal ends of the scapulæ are also present, together with a detached mass containing portions of at least three imperfect vertebræ with their attached ribs and overlying armor. Yet another large piece contains a number of ribs with the highly nodular overlying armor. There is, however, no present connection between this and the other masses. Thirteen caudal vertebræ are also present. Of the appendicular skeleton, one approximately complete left femur is preserved, and parts of the other, the left tibia, and part of the fibula, a considerable portion of the right tibia, together with an almost complete left hind foot. Of the fore limbs, fragments of the humeri are present, together with the incomplete left radius and ulna, and portions of the fore foot. There are also a number of detached dermal elements.

The specimen bears the catalogue number 1815, 1815a, and 1815b Y. P. M., but there is no reason to suppose it to be other than one individual, and the number 1815 only will be used hereafter.

Original description.—Marsh (1889, p. 175) thus describes the animal:

"Another new member of the Stegosauria, from a lower horizon [than the Denver beds] in the Cretaceous, was discovered several years since, in Wyoming, and is now in the Yale Museum. The skull is not known, but various portions of the skeleton were secured. One characteristic feature in this genus is the dermal armor, which appears to have been more complete than in any of the American forms hitherto found. This armor covered the sides closely, and was supported by the ribs, which were especially strengthened to maintain it. In the present specimen, portions of it were found in position. It was regularly arranged in a series of rounded knobs in rows, and these protuberances have suggested the generic name.

"Near the head, the dermal ossifications were quite small, and those preserved are quadrangular in form, and arranged in rows. The external surface is peculiarly marked by a texture that appears interwoven, like a coarse cloth. This has suggested the specific name, and is well shown in the cut below [our Fig. 1].

"The fore limbs are especially massive and powerful, and are much like those of the Jurassic *Stegosaurus*. There were five well-developed digits in the manus [see below], and their terminal phalanges are more narrow than usual in this group. The ribs are T-shaped in transverse section, and thus especially adapted to support the armor over them [see, however, below]. The caudal vertebræ are more elongate than those of *Stegosaurus*, and the middle caudals have a median groove on the lower surface of the centrum.

"The animal when alive was about 30 feet in length. The known remains are from the middle Cretaceous of Wyoming."

This description was repeated almost verbatim in *Dinosaurs of North America*, 1896, p. 225, pl. 75, fig. 5, as Professor Marsh did not extend his study of the form. He prefixed the family designation Nodosauridæ at the beginning of this reprinted description, but without definition. In 1895 (p. 497), however, he thus defines it:

"Family Nodosauridæ. Heavy dermal armor. Bones solid. Fore limbs large; feet ungulate.

"Genus *Nodosaurus*. Cretaceous America."

This is also repeated verbatim in *Dinosaurs of North America*, p. 243.

MORPHOLOGY.

ENDOSKELETON.

Pre-sacral vertebræ and ribs.

(Pl. I, figs. 1-3; text fig. 2.)

One mass of matrix contains two nearly complete and apparently ankylosed vertebræ, with the attached ribs

of the left side and portions of the vertebræ preceding and following. They seem to pertain to, or to be somewhat posterior to, the mid-dorsal region. The mass also contains the antero-posterior calcified tendons lying on either side of the spinous process, and the overlying armor of the left side. The vertebræ themselves resemble those of *Stegosaurus* somewhat, but differ in that they do not show the extreme exaggeration of the elevation of the neural arch. They are in this respect more nearly of the proportions of *Polacanthus* and *Struthiosaurus,* in that the diapophyses originate slightly below the zygapophyses, although distally they rise above them. In so far as the centra are preserved, either in bone or by matrix impression, they are quite stegosaur-like. Laterally the centra show a distinct concavity as in *Stegosaurus,* but there is nothing comparable to a pleurocœle. The neural arch is robust, as are the

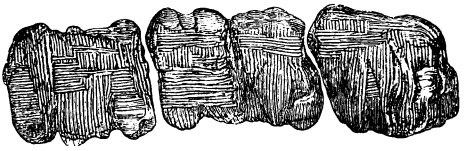

FIG. 1.—Dermal [subdermal] ossicles of *Nodosaurus textilis.* After Marsh. Natural size.

prezygapophyses, to which a portion of the postzygapophyses of the preceding vertebra, together with the spinous process, are so firmly united, in part by matrix, that the line of demarcation is nearly invisible. The diapophyses are curved on their external margin and are firmly ankylosed with the superior surface of the capitulum of the rib, as in *Ankylosaurus;* the two elements are clearly separated, however, by a deep groove. So far as one can see, the low tuberculum of the rib seems to be free from the diapophysis, but the space between is filled with an apparent matrix which is with great difficulty, and not always with certainty, distinguishable from bone. The neural canal is oval in section, with the apex uppermost, and is of considerable size.

The ankylosed left rib abuts against the neural arch, the facet being elliptical and elongated vertically. The rib has a sigmoid curve, being ventrally convex to the level of the tuberculum and thence concave. Beyond the tuberculum it is distinctly T-shaped in cross-section,

giving thus a broad bearing surface for the armor, although, as has been shown (Gilmore, p. 64), this type of rib is not confined exclusively to the armored forms. The lateral expansion of the rib begins as a low ridge about midway between the capitulum and tuberculum. The prezygapophyses overhang the centrum forward to a marked degree. The spinous process is thin, but has a marked fore and aft extent, with a straight superior margin. This may be seen from above where the armor is broken away, and exhibits little if any lateral expansion, being simply a thin plate of bone, narrowing slightly toward its posterior end. The spinous process overhangs the postzygapophyses, so that while obscured by matrix, its outline must have approximated that shown in the figure (text fig. 2). The outline of the bone seems to have resembled quite closely that of *Ankylosaurus* as figured by Brown (1908, fig. 11); it is also suggestive of *Stegosaurus,* but without the exaggerated heightening of the neural arch of the latter. Calcified tendons are present, lying close to and on either side of the spinous process. Those present diverge somewhat posteriorly. They are heavy and quite rib-like in appearance, except for their orientation and lack of curvature.

Measurements of Pre-sacral Vertebræ.

	mm.
Length over all	130
Height over all, est.	220
Centrum, length	88
Neural canal, width	13.5+
Width across pedicels	56
Width across prezygapophyses	68
Width across diapophyses	152
Spinous process, length of summit	66
Calcified tendon, width	14
Calcified tendon, depth	15.8

Pelvis.

(Pls. II, III.)

Sacrum.—The sacrum of *Nodosaurus* consists of three sacral vertebræ in the primary sacrum, and, as preserved, of at least four coalesced presacrals (sacro-lumbars) and two sacro-caudals, making a total of nine vertebræ in the entire syn-sacrum complex. The centra are so firmly

coössified that the line of demarcation between the successive vertebræ is practically obliterated; there is generally not even the usual dilatation at the articular ends of the centra to betray their limitations. Ventrally they are characterized by a median longitudinal groove, which is continued throughout the entire known series of caudal vertebræ as well. The anterior centra (sacro-lumbars) are relatively long and slender, broadening posteriorly. The three primary sacrals bear heavy sacral ribs, the rounded lower margins of which are at the same level as that of the centra from which they arise. The expanded ends of the sacral ribs abut against

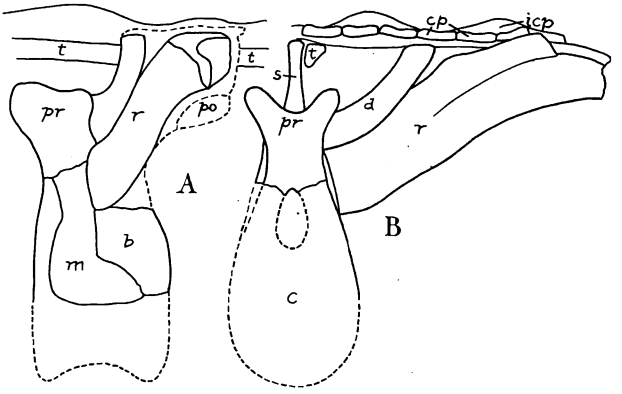

FIG. 2.—Dorsal vertebra of *Nodosaurus textilis*. A, left lateral, B, anterior aspect. One-fifth natural size. *b*, actual bone of centrum; *c*, centrum; *cp*, costal (armor) plate; *d*, diapophysis; *icp*, intercostal plate (seen beyond the costals); *m*, matrix impression of centrum; *po*, postzygapophysis; *pr*, prezygapophysis; *r*, rib; *s*, spinous process; *t*, longitudinal tendon.

the inner wall of the acetabulum, and the first two are more massive than the third. Dorsally these ribs are continuous with the diapophysial lamina, of which the horizontal upper plate passes into the surface of the ilium as seen from above (pl. II). The ribs borne on the four presacral elements are comparable except for their much greater slenderness. There is, as with the true sacrals, an expanded horizontal diapophysial lamina, especially near the vertebra and beneath the overlying armor. This arises, as does the rib, from the neural arch. Beneath this lamina, and united with it, without line of demarcation, lies the slender rib, the expanded horizontal portion extending at first entirely

behind the rib, so that the section of the bone at this point is roughly L-shaped. Further out, the rib becomes T-shaped in section, as its upper surface extends in front as well as behind. In the last pair of these ribs the vertical portion becomes practically obsolete at mid-length, and the bone becomes a thin blade-like expansion which merges into the thin inner margin of the ilium just in front of the acetabulum. This rib is clearly visible in plate II, and resembles the diapophyses of the three following sacral vertebræ very closely when viewed from above. The three anterior pairs of ribs were not visible from above, except for a fragmentary impression of one (pl. II), as they had been broken away beyond the

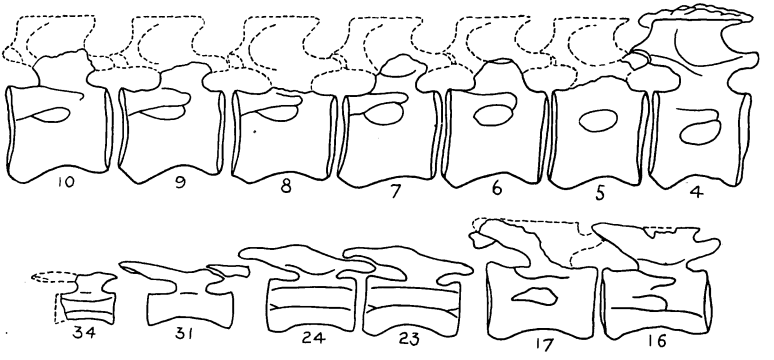

FIG. 3.—Caudal vertebræ of *Nodosaurus textilis*. Right lateral aspect. One-fifth natural size. Nos. 9 and 10, 16 and 17, 23 and 24, in contact in matrix.

preserved limitations of the sacral armor. It was only upon preparing the ventral side that they became evident (pl. III). The spinous processes of the entire synsacrum are coalesced into a continuous vertical plate of bone, the summit of which is visible at intervals in plate II, *s*, where the armor is lacking.

In the sacro-caudals, the first pair of ribs are typically T-shaped in section and extend, as do the second pair, outward and somewhat backward. The first pair evidently abutted against the posterior portion of the ilium, as a slight depression exists in about the right place. The restoration of the rib has been made accordingly. The presacral ribs probably extended to the ilium, as in *Polacanthus* and in the pelvis of *Ankylosaurus* on exhibition in the American Museum of Natural History, and

they have been thus restored (pl. III). The neural canal shows a sacral dilatation reaching an apparent maximum at the beginning of the primary sacrum, but it has by no means the exaggerated development shown in *Stegosaurus.*

Ilia.—Both ilia are imperfect, but in a measure supplement each other, so that except for the outline of the anterior portion, especially its forward limitation and its inner margin, the shape was probably as shown in plates II and III. The ilia lie largely in the horizontal plane except anteriorly and toward their outer margin, the iliac crest, where they curve downward. Dorsally their inner margin is continuous with the sacral diapophyses, which become more broadly wedge-shaped posteriorly and have their apex directly inward. The posterior extremity of the ilium is thickened, convex below, with a corresponding although much less pronounced concavity above. The remainder of the upper surface is relatively smooth, first concave and then convex from the rear forward. There are, however, well defined blood-vessel impressions indicating a close-fitting corneous investment, but no trace of overlying armor comparable to that over the sacrum. The iliac crest or margin is somewhat undulating and in places is thickened and rugose for muscle or tendinous attachment.

Ventrally, the ilia show three rounded ridges diverging from the acetabulum, flanked by four concavities of varying extent, of which the greatest lies beneath the whole anterior portion of the ilium. Behind this lies the lateral depression just without and almost confluent with the acetabulum. This receives the great trochanter of the femur. The acetabulum is large, almost perfectly hemispherical, and was bounded in front by a well developed pubic peduncle, the entire height of which is not preserved. The ischiatic peduncle was much lower and less well defined, but it also is ill preserved; it had, however, a rugose surface (pl. III, *i*). The inner margin of the acetabulum was well developed and buttressed by the three sacral ribs.

Sacral armor (see also page 120.)—The dermal armor over the pelvis, unlike that of either *Polacanthus* or *Stegopelta,* seems to have been confined to the sacral region only, although it probably in part overlay the inner margins of the ilia, and with them formed what Wieland has called the lumbar-hip carapace. In both *Polacanthus*

and *Stegopelta* the armor was continuous over and closely united with the ilia as well. The limitations of the elements which formed the sacral armor in *Nodosaurus* are very indistinct, but in so far as they can be identified are hexagonal. One near the anterior end of the pelvis, clearly shown in the photograph (pl. II), and susceptible of measurements, is 13.5 mm. in its greatest (transverse) diameter by about 75 mm. antero-posteriorly. This plate has a depressed superior surface, whereas that which adjoins its forward outer margin shows a distinct but low nodule (see below).

Measurements of Pelvis.

	mm.
Dorsal aspect:	
Length of sacral armor preserved	820
Breadth of sacral armor preserved	325
Breadth of sacral armor, est.	487
Breadth of pelvis	1273
Length of restored right ilium:	
Between perpendiculars	930
Over curve	1100
Width of right ilium to notch between diap. I and II	337
Length over diapophyses	320
Breadth of spinous processes	20
Ventral aspect:	
Length of nine coalesced centra as preserved	730
Centrum II, width, anterior end	70
Centrum II, width, center	57.5
Ant.-post. diameter, diapophysis	43
Height of vertebra II, about	120
Height of ilium at pubic peduncle, est.	185
Acetabulum, length	14
Acetabulum, breadth	17

Comparison with other genera.—A very close resemblance exists between this pelvis and that of *Polacanthus* (cf. Hulke 1887, pl. 9), which is of course especially in evidence when the latter is viewed from below. *Polacanthus* shows the same characters in the centra,—slender anteriorly with very vague demarcation between the successive vertebræ. Hulke indicates five sacrals, the anterior one bearing light but transversely expanded ribs, as in that which I have called the last sacro-lumbar. He shows in sacrals 2 to 4 bones comparable in their development to the true sacrals of *Nodosaurus*. His

sacral 5 corresponds to my first sacro-caudal and shows a rib which is nearly as robust as that of sacral 4 and which runs nearly parallel with it and is coalesced with the posterior portion of the ilium. Another vertebral centrum which is partially detached Hulke calls a caudal; in *Nodosaurus* the equivalent of this is coössified with the rest and forms the second sacro-caudal. In front of sacral 1 of Hulke there are five pairs of slender, rather irregular ribs apparently partially attached to the overlying armor. In a later figure by Seeley (1892, fig. 1) these are shown as lying *above* the ilia but beneath the armor. There is no evidence that this is true in *Nodosaurus*, for,

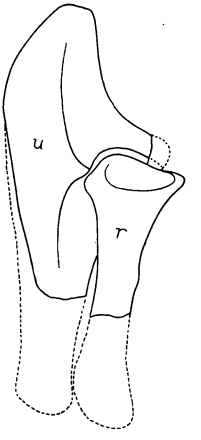

FIG. 4.—Right radius and ulna of *Nodosaurus textilis*. Inner oblique aspect. *r*, radius; *u*, ulna. One-eighth natural size.

as Lydekker (1892, p. 85) remarked, the position of the ilium of *Polacanthus* internal to the ribs is a character found elsewhere only in adult tortoises, in which it is probably due to the impact of the shield on the ribs, thus rendering it impossible for another bone to grow between them, a condition which would not occur in *Nodosaurus* because of the lateral limitations of the sacral shield.

The pelvis of *Nodosaurus* differs from those of both *Polacanthus* and *Stegopelta* in the absence of dermal armor from above the ilia. In both genera mentioned, the armor is firmly coalesced with the ilia, although in the character of the sacral armor *Stegopelta* is nearer its contemporary *Nodosaurus* than is *Polacanthus*.

Caudal Vertebræ

(Pl. I. fig. 5; text fig. 3.)

Thirteen caudal vertebræ are present, together with impressions in the matrix and fragments of at least four more. The vertebræ seem to be fairly representative of the entire series, as there are seven apparently proximal ones, two from near the middle of the tail, two from the posterior two thirds, and two from near the distal end.

Judging from the character of the sacrum, with its

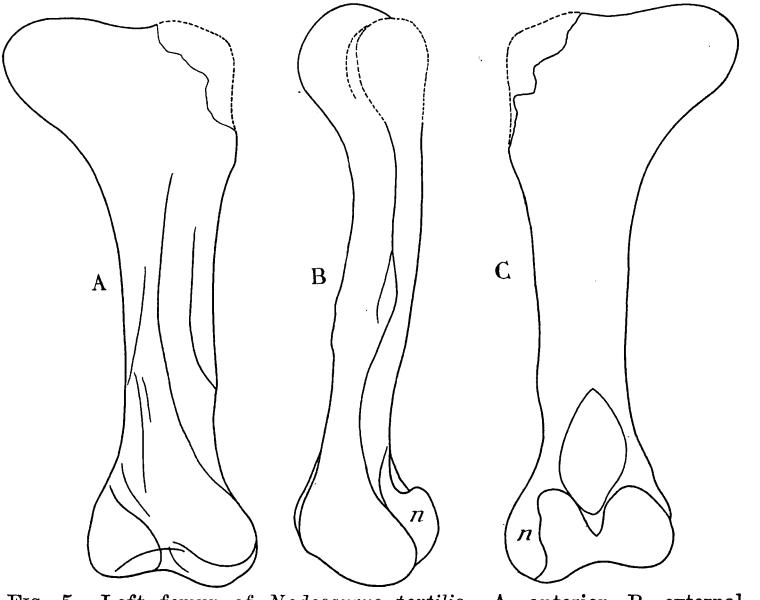

FIG. 5.—Left femur of *Nodosaurus textilis*. A, anterior, B, external, C, posterior aspect. *n*, notch. One-eighth natural size.

small centra and low spines, there are no caudals which correspond to the short, high-spined, large-centrum, anterior caudals of *Stegosaurus* in form. The correspondence is, on the other hand, more with the anterior caudals of *Scelidosaurus*. The numbering of the caudals in the following description is arbitrary and merely approximate.

Caudal 4 (pl. I, fig. 5; text fig. 3).—This bone is well preserved, having the entire neural arch and spine, overlain on the left with dermal bones. While both diapophyses are absent, the impression of that of the left

side is still to be seen in the matrix, and from it that of the right has been restored. The centrum is roughly cylindrical and the length is somewhat less than its greatest diameter. Ventrally it is characterized by a shallow longitudinal groove which Marsh mentions in his original description, and there is evidence of at least one chevron facet at its posterior end. Laterally there is no trace of pleurocœle, and the diapophysis arises from a little above the middle of the bone. The diapophysis is light, and curves somewhat toward the rear. Below the diapophysis, the surface of the centrum is somewhat concave, with evidence of a faintly impressed vertical groove. The anterior face is practically plane, the posterior slightly concave.

The pedicels are of considerable antero-posterior length, which somewhat exceeds half the length of the centrum. The pedicels are simple, being unsupported by buttresses or laminæ. The spinous process is thin but expanded fore and aft, so that its total length is nearly as great as is that of the entire centrum. The summit merges into a layer of irregular dermal bones which extend in a horizontal manner from the left side; on the right they are not preserved. The zygapophyses are simple, those in front looking inward and upward, while those in the rear look downward and outward. A slight fore-and-aft lamina—horizontal lamina—connects the zygapophyses on either side with each other; above these the face of the spinous process is for the most part concave. The neural canal is oval in section, with the apex uppermost, and is of considerable size, as the measurements show. The ventral median groove and the character of the low spinous process are the most distinctive features of this bone.

Caudals 9 and 10 (fig. 3).—These were in contact in the matrix and except for their processes are very well preserved. No. 10 is a little the wider. The anterior face of the centrum shows a slight dorso-ventral convexity, and the posterior face is correspondingly but somewhat more markedly concave. Transversely, each face is flat. The ventral groove is apparently deeper than in caudal 4 and the posterior chevron facets are especially marked. The better preservation of the bone surface leads to the supposition that these and other distinctions from caudal 4 are more apparent than real. The diapophyses are not preserved, but their bases are

situated somewhat higher on the centrum than in No. 4 and apparently the processes themselves were lighter. The same shallow vertical groove is discernible on the centra, and the surface of the latter is slightly rugose toward the articular faces, especially ventrally. A slight fore-and-aft ridge runs from the hinder margin forward about two thirds the length of the bone above the diapophysis.

Caudals 16 and 17 (fig. 3).—These vertebræ were also in contact, and No. 16 particularly is very well preserved. It also has numerous small dermal ossicles associated with it, together with an oval armor plate (see below).

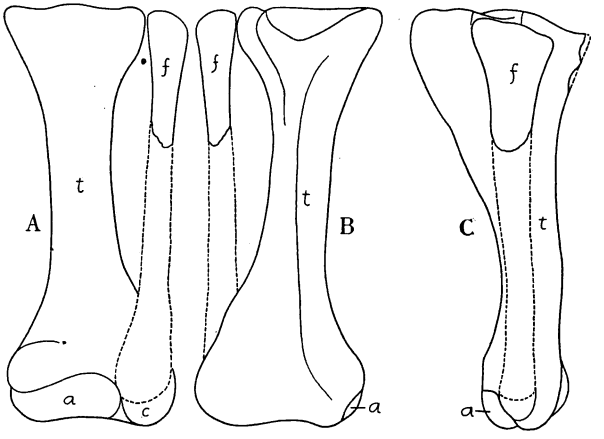

FIG. 6.—Left tibia and fibula of *Nodosaurus textilis*. A, anterior, B, posterior, C, external aspect. *a*, coalesced astragalus; *c*, calcaneum; *f*, fibula; *t*, tibia. One-eighth natural size.

Caudal 16 is relatively longer and slenderer of centrum than are caudals 4 to 10, implying a gap of perhaps five vertebræ between it and the tenth. The articular faces of the centrum are essentially plane and the centrum itself begins to exhibit the distinct longitudinal ridges seen in Nos. 23 and 24. Diapophyses are still present and arise about the middle of the bone. The spinous process is strong and prolonged fore and aft, the postzygapophyses merging into the posterior angle of the spine. Horizontal laminæ are faint, but distinct. Both zygapophyses overhang the centrum.

Caudals 23 and 24 (fig. 3).—These are again in contact, with an estimated omission of perhaps six vertebræ between them and No. 17. Here the diapophyses are

lacking, but longitudinal ridges give the centra almost a fluted appearance. The ventral grooves are especially marked. The neural arch and spinous process, proportionally to the centrum, are much as in Nos. 16 and 17. The superior margin of the spinous process is curved, in contrast to the straight margins which have characterized those before.

Caudal 31 (pl. IV, fig. 1; text fig. 3).—This bone is markedly different from its predecessors in the lack of fore-and-aft ridges on the centrum, and in the character of the zygapophyses. The prezygapophyses are short, not extending to the end of the centrum, while the postzygapophyses are very long, with an extremely long articular facet. There is no upward extension of the spinous process above the zygapophysial level, unless a small rounded eminence over the prezygapophyses represents it.

Caudal 34 (fig. 3).—This caudal is imperfect but is curiously abnormal in that the very narrow ventral groove lies well toward the left side of the rather broadened lower aspect of the bone. Otherwise the bone shows no marked distinctions from caudal 31, except that the centrum is not apparently prolonged in front of the pedicel to the extent that it is in the latter.

Measurements of Caudal Vertebræ.

	4 mm.	17 mm.	24 mm.	31 mm.
Length over all, over zygapophyses	86.5		69	87*
Height over all	114	77 +	53.5	43
Centrum, length	65.5	73.5	62.5	57
Centrum, ant. face, height	64	50 ±	35.5	24
Centrum, ant. face, width	68	55	40 ±	
Centrum, ant. face, circumference	210	165 ±		
Centrum, post. face, height	66	52.5	35.5	23
Centrum, post. face, width	69.4	54 ±	43.5	31
Centrum, post. face, circumference	215	190 ±	135 ±	
Neural canal, ant. end, height	23	13		5
Neural canal, ant. end, width	12.5	9.5		
Width across pedicels	30			
Width across prezygapophyses	39			
Width across postzygapophyses	39	13		
Spinous process, length, summit	64.5			
Index, centrum, length to height, ant. face.	1.0234	1.47 ±	1.732	2.376

* Postzygapophysis prolonged.

Fore Limb.

Scapula (fig. 7).—Both scapulæ are represented by fragments which unfortunately do not supplement one another, as they all pertain to the extremity of the blade.

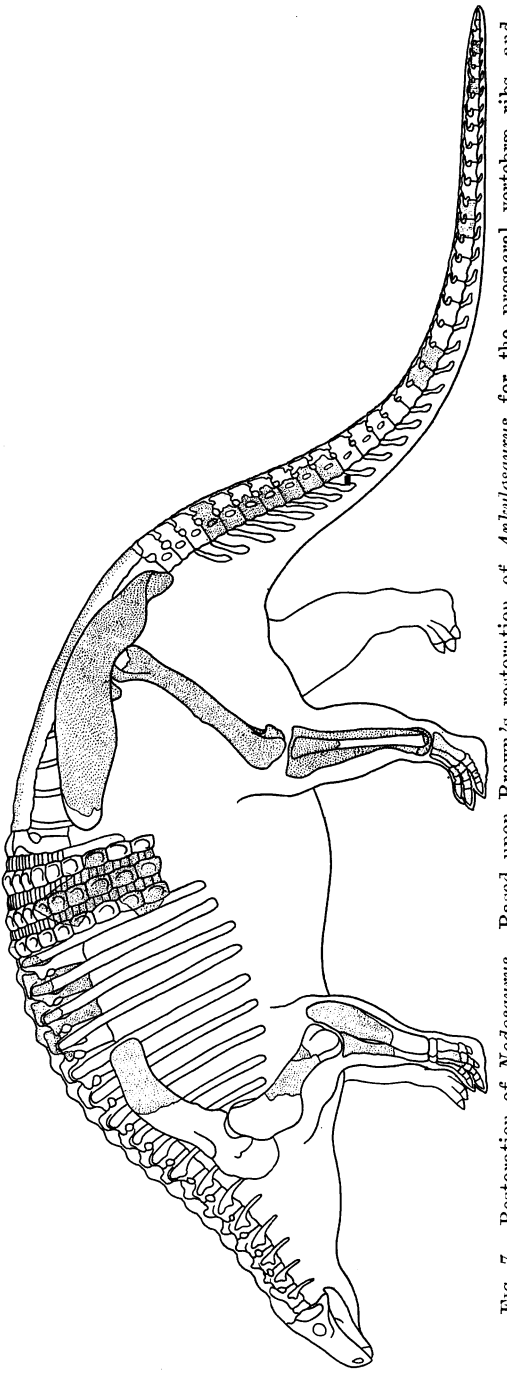

FIG. 7.—Restoration of *Nodosaurus*. Based upon Brown's restoration of *Ankylosaurus* for the presacral vertebræ, ribs, and scapula. Fore limbs partly from *Stegosaurus stenops*. Skull a compromise between *Scelidosaurus* and *Ankylosaurus*. Stippled bone actually present. The position of the presacrals is not assured, but they probably did not vary much throughout the dorsal series. The mass of armor probably came from further forward, but was presumably similar over the entire dorsal half of the torso. One twenty-fourth natural size. Estimated length between perpendiculars, 14 feet; on curve, 17½ feet (Marsh estimate, 30 feet); height to mid-back, 5 feet.

The largest fragment belongs to the right scapula, and is massive, with a curved extremity. The lateral margins are roughly parallel and the bone is not only curved in two dimensions but twisted as well, as though it fitted closely over the curved ribs. It resembles, in so far as a comparison can be made, that of *Ankylosaurus* (Brown, 1908, fig. 15), but has about three fourths the dimensions of the latter.

Measurements of Scapula.

	mm.
Width at extremity	172.5
Thickness	33
Max. thickness of fragment	49.5

Humerus.—Several fragments which are believed to pertain to the humerus are present, but are inconclusive and not worthy of description. They do, however, give a check on relative proportions (see restoration, fig. 7).

Radius and ulna (pl. IV, figs. 2, 3; text fig. 4).—The proximal ends of the right radius and ulna, and a portion of the left ulna, are present and are typically stegosaurian or ceratopsian and totally unlike those of any other dinosaurian group. The olecranon process is very massive and extends considerably beyond the humeral articulation. The humeral facet, however, covers about half of its anterior face. The radial facet is a clearly defined depression and gives the bone a triangular cross-section at that point, with two hollow faces. The articular face, as with the femur and tibia, had a smoother, more finished appearance than in the *Stegosaurus* specimens I have seen. Proximally and externally the grain of the bone is coarse.

The radius shows an ovate cross-section in the shaft, but is somewhat more irregular in outline at the expanded proximal end. The proximal face bears a circular saucer-shaped depression, whereas in *Stegosaurus* such a depression is barely discernible. The difference may be due to the relatively thick articular cartilage in the latter as compared with that of *Nodosaurus,* as indicated by the rugose character of the articular ends in *Stegosaurus.* Aside from this and certain proportional distinctions, the resemblance of *Nodosaurus* to *Stegosaurus* in these elements is quite marked. The elbow must have been very readily flexed and carried in a partially bent

position. The character of the proximal radial facet would indicate a rotatory movement as well, but whether the distal end of the ulna would bear this out is of course impossible to ascertain from the present material. The insertion of the biceps muscle on the radius is clearly indicated.

Manus.—Marsh speaks of the manus in some detail; I find, however, but few bones which through a process of elimination may have pertained to the manus, as the remainder seem to be those of the nearly complete pes. There are two complete metacarpals, apparently the second and fourth, and fragments of one, probably the third, as it was in contact with the second. Some of the scattered phalangeal elements may also be of the hand but they are difficult to place. If these bones really pertain to the hand, they are exceptionally long, as the entire ones, though more slender, are fully equal in this dimension to their apparent equivalents in the pes, differing in this regard from *Stegosaurus,* but if Baron Nopcsa's restoration (1905, pl. 12) be correct, resembling the proportions of the Wealden *Polacanthus,* which in many respects is similar to the form under discussion (see under generic comparisons, *infra*).

Metacarpal III has a subtriangular proximal face with a rounded rugose area on the outer side. Distally the articular end is semi-cylindrical, dilating somewhat externally. The mid-shaft section is subtriangular, with rounded faces. The shaft bears two low tuberosities on the posterior oblique face. Metacarpal IV is somewhat more slender and has a short proximal phalanx in articulation therewith. An ungual is also present, and while its form may be somewhat attenuated, due to erosion of its lateral margins, it seems to have been much more claw-like than were those of the pes.

Measurements of Metacarpals.

	mm.
Metacarpal II	
Length over all	125.6
Max. diameter, proximal end	57.6
Max. diameter, distal end	65
Max. diameter, mid-shaft	38.3
Length of entire digit	ca. 245
Metacarpal IV	
Length over all	123

Hind Limb.

The limb-bones of the type specimen of *Nodosaurus* differ decidedly from those of *Stegosaurus* or *Hoplitosaurus* in the smoothly rounded character of the articular ends, which in the latter genera are rugose, indicating articular cartilages of considerable thickness. The cartilage in *Nodosaurus* was doubtless relatively considerably reduced. On the other hand, the surface grain is more distinct in *Nodosaurus,* giving a fibrous character to the bone which seems to be unique. These features, together with the extreme ankylosis of tibia and astragalus (see below), are interpreted as indications of the advanced age of the individual, in which the articular cartilages would become more perfectly ossified and the bony tissue of the limb bones might in a sense invade the tendinous muscular attachments as well. (See pl. IV, figs. 4, 5.)

Femur (pl. IV, fig. 4; text fig. 5).—The left femur is complete as to length and well preserved, although portions are missing, notably in the region of the several trochanters, the extent of which can not, therefore, be ascertained. The bone is less straight than in *Stegosaurus,* and in its degree of curvature resembles more nearly that of *Hoplitosaurus* (Gilmore 1914, fig. 69), especially when comparison is made with the actual bone (U. S. N. M. No. 4752). In Mr. Gilmore's figure (fig. 69, 3) the lower curve of the shaft has been exaggerated to correct for crushing, giving a decided S-shaped outline to the bone when viewed from the side. Thus the knee of *Nodosaurus* must have been habitually partially flexed, giving a very different appearance to the limb from that of the mounted *Stegosaurus ungulatus* at Yale (Lull 1910, pl. II and fig. 2). The surface of the shaft in the *Nodosaurus* femur also agrees with *Hoplitosaurus* rather than *Stegosaurus* in that the limitations of the muscle areas are clearly defined by well developed ridges, whereas in *Stegosaurus* the surface is relatively smooth. The great trochanter is missing, but the preserved outline of the summit of the bone seems to indicate that it was more prominent than in either *Hoplitosaurus* or *Stegosaurus,* as figure 5 shows.

While the fourth trochanter is missing from the bone, there is no reason to suppose that it was more than a mere roughened area for the insertion of the caudofemoral muscle. This is in keeping with the strictly quadrupedal gait of the animal. The anterior aspect

exhibits a number of the ridge-enclosed muscle areas mentioned above. One ridge arises from the region of the great trochanter and descends somewhat obliquely two thirds the length of the bone. It is separated externally by a wide, shallow, oblique groove from a second muscular area on the antero-external face of the bone. The internal condyle is the larger of the two when viewed from the rear. In front they are more nearly equal and the inner one is defined by a narrow curved groove which arises on the inner face of the femoral shaft and runs obliquely down between the condyles. Posteriorly the external condyle, as in *Hoplitosaurus,* while having a somewhat greater fore-and-aft diameter than the internal one, is nevertheless very much narrower, especially toward the distal end of the bone, thus forming a deep vertical notch between the external surface of the condyle and the remainder of the articular surface (see fig. 5 B and C, *n*). Above the condyles the shaft bears a rather deep ovoid depression, above which the surface of the bone exhibits an interwoven fibrous surface resembling the textile character of the dermal ossicles which suggested the specific name of the animal. A cross-section of the mid-shaft has a somewhat trihedral form, being flattened on the posterior aspect.

Tibia. (pl. IV, fig. 5; text fig. 6).—The left tibia is approximately entire, although the two halves were not together nor were there definite "contacts" between them. The bone may therefore have been somewhat longer originally, but could not have been shorter. The distal half of the right tibia is also present, together with a portion of the proximal articular extremity. There is a chance for error in the orientation of proximal and distal halves, but the surfaces curve into one another fairly, so that the error is probably not great. As restored, the long axes of the articular ends make a greater angle with each other than in *Stegosaurus,* and the curvature of the bone is somewhat greater. Proximally, the bone is expanded and narrows rather rapidly into the shaft, to expand again distally. The distal extremity is more flattened in one diameter (antero-posterior) than is the proximal, and the astragalus is so closely ankylosed with the bone as to be almost undiscernible, forming a smoothly rounded though somewhat pitted articular face (see above). In *Stegosaurus* the astragalus, while coalescing with the tibia with age, is

very distinct in all specimens known to me. The surface of the tibial shaft is less characteristic than that of the femur, and in this regard is more *Stegosaurus*-like. Whether the calcaneum was present or not I can not be sure, but a detached concavo-convex bone may represent it.

Fibula (pl. IV, fig. 5; text fig. 6).—The proximal end of the fibula is present, as indicated in the figures, but while held in position by the matrix, it had evidently shifted somewhat downward. The impression of the distal end is also preserved in the matrix, but is quite evidently out of position, having shifted inward upon the face of the tibia away from the regular fibula facet, which is a clearly defined flattened area. The fibula seems to have been relatively more robust than in *Stegosaurus*, especially in its antero-posteriorly expanded proximal end.

Measurements of Limb Bones.

	1 mm.	2 mm.	3 mm.	4 mm.	5 mm.	Ratios Cols. 1 and 5
Femur:						
Length	975	1080	1200	495	593	1.644
Max. breadth, prox. end..	266	283	329	190	180	1.477
Max. breadth, dist. end..	251	276	263	170	230*	1.091
Min. width, shaft.....	114	145	147	65	93	1.225
Average ratio						1.357
Tibia:						
Length	630	643	696		454	1.385
Max. width, prox. end...	247	265	275		182	1.356
Max. width, dist. end....	238		245		182	1.307
Min. diam., shaft.....	79	85	98		61	1.295
Average ratio						1.333
Ratio, fem.: tib., length....	1.548	1.679	1.724		1.306	1.184

1 = *Stegosaurus stenops*, Y. P. M. 1856. Femur and tibia may represent different individuals.
2 = *S. stenops*, U. S. N. M. 4934, right.
3 = *S. ungulatus*, U. S. N. M. 6646.
4 = *Hoplitosaurus marshi*, U. S. N. M. 4752.
5 = *Nodosaurus*, Y. P. M. 1815.
* Estimated.

Pes (fig. 7).—A partially complete left hind foot has been assembled from the material pertaining to this specimen and proves to be strikingly suggestive of that of *Monoclonius* (Brown 1917, pl. 12, E. G.). There are four well developed digits, digit I, while shorter, being fully as robust as the others. The proximal surface of metatarsal II is concave, that of the others convex.

Metatarsal II has also the greatest proximal area. Some question may exist as to the position of the phalanges, but some were in contact, and of these there can be no question. Digit I is correct throughout, of II the associated ungual is doubtful, of III there is little question, but IV is incomplete. The metatarsals are narrow in mid-length, with dilated extremities, and the unguals are broad and hoof-like. The articular ends of the bones are relatively smooth, as with the limb bones, but here the distinction from *Stegosaurus stenops* (Y. P. M. 1856) is less marked, as the proportion of articular cartilage must have been relatively small in either case.

Measurements of Pes.

	mm.
Metatarsal I, length	85
Entire first digit, length	210
Metatarsal II, length	125
Metatarsal II, max. diameter, proximal end	73
Metatarsal II, max. diameter, distal end	71
Metatarsal II, max. diameter, mid-shaft	42.5
Entire second digit, length	240
Metatarsal III, length, est.	130
Entire third digit, length	290
Metatarsal IV, length	124

Exoskeleton.

Armor.

General character.--Marsh's description of the armor of *Nodosaurus* defines two types of elements, the one regularly arranged in a series of rounded knobs in rows which suggested the generic name, the other consisting of dermal ossifications placed *near the head* (italics mine). These were described as quite small, quadrangular, arranged in rows, with their external surface peculiarly marked by a texture that appears interwoven, like a coarse cloth. This has suggested the specific name and is well shown in the only figure Marsh published to represent the animal (our fig. 1). His reference of these elements to a position near the head is not founded upon observed fact, as no trace of the head and neck of the animal is present, but was probably reasoned from analogy, as small rounded scutes have been found *in situ* near the head of *Stegosaurus*. As a matter of fact, the two sorts of dermal elements were contiguous, and in

certain portions of the body, as over the ribs, the one series in part overlay the other. What they really represent was suggested by Wieland (1911, 1912), although not for *Nodosaurus* specifically. They are ossifications of the two—the outer and the nether—dermogene layers, the larger nodular plates being derived from the outer and the lesser from the nether. Wiedersheim (1907, p. 25) states:

> "In the derm [of reptiles], a superficial and a deeper layer may be distinguished. The latter is composed mainly of strong bundles of connective tissue fibres which as a rule cross one another at right angles, as in fishes and amphibians."

This would account for the textile character of the smaller subdermal (nether-layer) ossicles which are merely ossifications or calcifications of this fibrillar connective tissue. Marsh's statement that the interwoven striæ are on the external surface is true, but they are just as visible on the internal surface and there is reason to believe that in the figured specimen the inner and not the outer aspect is exposed, as armor plates of the dermal (outer dermogene) layer lie contiguous to the surface which is embedded in the matrix. Another fragment shows the relative position of the two armor layers very clearly. The ossicles of the subdermal layer average some 16 mm. square, though varying in length. Their thickness averages about 3 mm. (see fig. 1).

Dorsal armor.—One mass of matrix contains a group of five or six ribs (pl. 1, fig. 3) overlain in part by the armor. The ribs themselves have shifted somewhat from their position during life, so that at least three of them converge distally (*r, r*). These three are mainly matrix impressions, with very little actual bone remaining, and here the armor is lacking. The other ribs are covered with the typical nodular armor of the outer dermal layer, and here again two sorts of scutes are discernible, for the larger nodular scutes are intercostal (*icp*) in position as preserved and are separated one row from another by a series of smaller rectangular scutes (*cp*), the surface of which is approximately plane except for the rugosity of the entire outer dermal series. The rows of smaller rectangular scutes are costal in that they approximately overlie the broadened outer surface of the ribs, although sometimes shifted slightly *post mortem*. The smaller scutes average 25×28 mm. in size. They are not everywhere distinct, but were probably pretty regularly dis-

tributed throughout this mid-torso region of the body. The nodular intercostals average about 80×55 mm. in size, the greatest diameter lying parallel with the ribs. The nodules are well rounded eminences, elliptical in section, and rising some 15± mm. above the general level of the scute. The nodular scutes thus form regular transverse rows across the creature's back. They seem to have formed longitudinal rows as well, as in the crocodiles, and at least nine such longitudinal rows existed on either side of the midline, probably more in this region of the body (see restoration, fig. 7). Toward the distal ends of the ribs, which are, however, not complete, the scutes of the subdermal layer become visible and one can view their passage dorsally beneath the dermal scutes (*sd*). The scutes give an impression of crowding in the longitudinal axis of the body, as though the force that tended to converge the ribs distally had also wrinkled the skin. It would seem, therefore, as though, as in the alligator, the nodular (or keeled) scutes are dorsal, the flanks and belly being protected by smaller elements. The homology is not, however, precise, for in the crocodile the subdermal armor is lacking and the lateral and ventral protective elements are entirely cutaneous. In *Nodosaurus* a cutaneous investiture was of course present, but seems to have been in a larger degree supported by osseous dermal and subdermal scutes.

In the group of vertebræ described above, the proximal ends of the ribs only are preserved. They bear comparable dermal scutes similarly arranged, with, however, no trace of the subdermal elements. Over the vertebræ themselves the nodular scutes are larger, somewhat hexagonal, although irregularly so, averaging 80×86 mm. in size, with the greatest diameter fore and aft. There is no median row, single as in the turtle, but two, one on either side of the spinous processes, form the neural series (pl. I, fig. 1, *np*).

Sacral armor.—On the sacrum the armor plates are very obscurely defined, but are in the main hexagonal, although very irregular in outline, the two neural rows being continuous with those just mentioned. Whether they were separated during life by the now visible summits of the spinous processes is not clear. The armor, as has been said, did not form a complete shield as in *Polacanthus,* but was confined to a longitudinal belt overlapping only the sacral diapophyses and not the ilia.

Deep blood-vessel impressions on the superior inner portion of each ilium, which appear somewhat abruptly along a definite line, seem to indicate that beyond that line the dermal armor ceased and the cutaneous investment was closely applied to the surface of the ilia themselves (see above, page 105, and pl. II). Thus the latter formed an endoskeletal continuation of the median dermal carapace. The actual dermal scutes are not preserved for the full width of their former extent (see pl. II). The nodular prominences over the sacrum are almost obsolete, increasing apparently in height forward toward the dorsal region and laterally in that region from the neural series outward. There is no preserved trace of subdermal ossicles in the pelvic region of *Nodosaurus*.

The evidence afforded by *Nodosaurus* emphasizes Wieland's statements concerning the dinosaur-turtle analogy. In the crocodile-like reptiles, the outer dermogene-producing layer only is present;[1] the turtles had originally both outer and nether dermogene layers. The latter early tended to strengthen and use the under layer only. The dinosaurs developed both body and cranial armature in both upper and nether dermogene layers. The latter, Wieland thinks, gave rise to the huge plate roofing the entire skull in *Ankylosaurus* and the hip armature of *Polacanthus*. However the greater portion of the *Polacanthus* carapace may have originated, the occasional keeled plates which arise above the level of the main structure seem to be homologous with the nodular scutes of *Nodosaurus* and thus to be, like those of the crocodiles, of outer dermal origin. Thus the dinosaurs, as Wieland says, instead of eventually confining extensive dermal development to but a single nether layer, covering the body region only as in the turtles, tended to develop both the nether and outer layers in body or skull, or both.

[1] Scutes from *Deinosuchus hatcheri*, a Judith River crocodile, described and figured by Holland (Ann. Carnegie Mus., 6, 291, 1909) "show on the under surface numerous fine straight lines decussating with each other at an angle of about 45°, indicating the structure of the dermal tissues in which they were embedded and to which they adhered." Sir Richard Owen (Rept. British Assoc., 1841, p. 71) calls attention to a similar feature in the scutes of *Goniopholis crassidens* Owen. The figure (fig. 10) published by Holland shows a very distinct layer, in part broken away from the overlying cancellous bone, which bears the intersecting lines. This would seem to indicate that the scute as a whole is of dual origin, derived in part from the outer dermal and in part from the subdermal layers.

Keeled plate.—One keeled plate free from its attachment is associated with the *Nodosaurus* specimen (pl. I, fig. 4). It is similar to those of *Ankylosaurus, Hoplitosaurus* (Gilmore 1914, fig. 70), and *Hierosaurus* (Wieland 1909, fig. 5), and measures 143 mm. long by 99 mm. wide and 27 mm. high. This plate was one of a pair from the left side of the body, and probably came from near the base of the tail. It is almost the counterpart in size and appearance of the *Hierosaurus* element shown by Wieland in his figure 5, except that in the *Nodosaurus* plate the keel is lower, due in part to its having been broken away.

Caudal plate.—Yet another plate of a similar character, except that it rises to a point at one end instead of bearing a keel, is associated in an inverted position with caudal 17 and must have formed one of a row which lay on either side of the mid-line along the dorsal surface of the tail. The under surface is concave, especially under the above-mentioned point. Above, it is pitted and also bears vascular grooves. Subdermal ossicles apparently underlay it, as they now lie between it and the spinous process of the caudal.

Measurements of Caudal Plate.

	mm.
Length	77
Width	59
Height	19.5

Spine-like plate.—This element, while incomplete, is very suggestive of the dermal plates of *Hoplitosaurus* as figured by Gilmore on his plate 30, and also that of *Hierosaurus* shown by Wieland on his figures 3 and 3a (1909). Similar plates are also associated with *Polacanthus* and gave the reptile its generic name. Nopcsa (1905, pl. 12) figures such elements along the presacral vertebræ, a row on either side. In *Nodosaurus,* this element is large, with a somewhat elliptical base and two sides concave in their vertical diameter and convex fore and aft. The basal portion is ill preserved, but was in part at any rate highly rugose. The lateral faces resemble the limb bones in their surface texture, but were impressed with shallow vascular grooves. The size is greater by far than that of the plate of *Hierosaurus* and its fore-and-aft diameter exceeds that of *Hoplitosaurus.*

Dimensions are minimum and were probably exceeded in the perfect bone.

Measurements of Spine-like Plate.

	mm.
Preserved length	240
Preserved width	110
Preserved height	135
Estimated height, ca.	250

Mr. Gilmore's statement that "these skin ossifications in *Hoplitosaurus* present far more variety of form than do those obtained with the remains of any American dinosaur known at the present time" (1914, p. 120) no longer holds, as *Nodosaurus* rivals it completely. They may, however, be congeneric (see below).

TAXONOMY AND RELATIONSHIPS.

Superorder Dinosauria Owen.
Order Ornithischia Seeley=Predentata Marsh.
Suborder Stegosauria Marsh. Plated dinosaurs.
Family Nodosauridæ Marsh 1890.

Family characteristics.—Quadrupedal dinosaurs with heavy dermal armor, vertebræ somewhat procœlous or amphiplatyan, with low neural arches, presacrals tending to ankylose with each other and with the ribs. Ilia broadened horizontally. Pelvis and posterior presacrals united with the overlying armor to form a carapace; limbs massive, fore limbs relatively large, digits five in manus and four in pes, terminating in broad unguals. Distinguished from the Stegosauridæ principally in that the latter have upstanding armor plates and caudal spines.

Genera: *Nodosaurus* and *Stegopelta,* Benton, Cretaceous; *Hoplitosaurus,* Dakota; *Hierosaurus,* Niobrara; *Ankylosaurus,* Edmonton and Lance. Also a close ally, if not actually included in the family, *Polacanthus,* of the European Wealden.

Re-definition of Nodosaurus Marsh.—Armor consisting of nodule-bearing plates, intercostals, separated over the torso by rows of smaller costal plates, armor of pelvis apparently limited to sacral region, not extending over the ilia. Oval keeled and spined plates, as well as

subdermal ossicles, the last bearing a characteristic textile appearance, also present. Skull and neck region unknown.

Relationships with other genera.—This genus was first described in 1889 and therefore takes priority over every other genus of plated dinosaurs in North America, save only the aberrant *Stegosaurus,* to which it is but remotely related. As the type is now made known as fully as may be, it must be the point of departure for all subsequent description of the related genera. Of these, *Hierosaurus* Wieland shows no point of generic distinction, as the common elements of each specimen are nearly identical. The latter genus is founded on very uncharacteristic material and is of questionable generic differentiation; specifically the form *H. sternbergi* is doubtless distinct.

Hoplitosaurus Lucas again is based upon insufficient material for absolute distinction from *Nodosaurus,* as in the armor the elements common to both types are essentially similar. The femora differ mainly in the form of the great trochanter, but as this is somewhat conjectural in *Nodosaurus,* there may not be even here a very marked distinction. *Nodosaurus textilis* and *Hoplitosaurus marshi,* while very nearly the same size, are again surely specifically distinct, and possibly generically, although closely related.

Stegopelta Williston differs from *Nodosaurus* in its much smaller size, but especially in the development of the armor over the ilia, in which there is so close a union that the two are inseparable. The armor consists of closely united but clearly defined hexagonal plates, each with a low eminence which is, however, occasionally almost obliterated by a more or less circular and irregularly placed depression which may have been the seat of a spine-like element. In the character of these iliac armor plates *Stegopelta* seems to be unique.

With *Ankylosaurus* Brown, on the other hand, a very close relationship apparently existed, some of the evidence for which I am not at liberty to publish through courtesy to Mr. Barnum Brown, whose discovery of this interesting type gives him prior descriptive rights. There are, however, certain characters which render them generically distinct, but I see no reason for excluding *Nodosaurus* from the direct ancestry of *Ankylosaurus,* nor the latter from the family Nodosauridæ, the description of which preceded that of the Ankylosauridæ of Brown by nearly a score of years. Brown says (1908, p. 190):

"The fragmentary skull of *Stereocephalus* Lambe does not show generic distinctions from the present specimen [type of *Ankylosaurus magniventris* Brown], as far as can be judged from the figures and description, but it is much smaller, and apparently the plates are not as symmetrical. It was found in the Belly River beds of Canada, an earlier horizon than the Hell Creek [Lance] beds, and is probably ancestral to *Ankylosaurus.*"

To what extent Brown will revise this opinion in the light of his recently discovered ankylosaur material from the Edmonton series, one can not say, nor is it possible to compare *Stereocephalus* with *Nodosaurus,* as homologous elements are as yet unannounced. The same may be said of *Paleoscincus* Leidy.

Of the Old World forms, *Polacanthus,* with its very perfect lumbar-hip carapace, is clearly the most suggestive of *Nodosaurus,* possibly because of the fine preservation of the most characteristic element, the pelvis. The latter, seen from below, has been very useful in the reconstruction and interpretation of that of *Nodosaurus,* but the very perfection and extent of the armor, covering as it does the entire posterior presacral and pelvic regions, so that the outline of the ilia is scarcely perceptible, is a marked distinction from the condition of armor development found in *Nodosaurus. Polacanthus* in this regard is more suggestive of *Stegopelta* than of *Nodosaurus.* It is undoubtedly of the same lineage as the American forms, but probably not directly ancestral to *Nodosaurus,* unless there has been a secondary reduction of the hip armature in the latter.

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DESCRIPTION OF PLATES I TO IV.

Pl. I.—*Nodosaurus textilis*. Holotype. Cat. No. 1815, Y. P. M. Fig. 1, dorsal vertebræ and armor, superior aspect. Fig. 2, oblique lateral aspect of the same. Both × about 2/9. Fig. 3, complex of ribs and dorsal armor, superior aspect; proximal end to the right; × about 1/6. Fig. 4, keeled armor plate, external aspect; × about 2/9. Fig. 5, ca. caudal 4, right aspect; × about 2/9.

a, armor; *b*, actual bone of centrum; *c*, centrum; *cp*, costal armor plates; *icp*, intercostal plate; *m*, matrix impression of centrum; *np*, neural plate; *pr*, prezygapophysis; *r*, rib; *s*, spinous process summit; *sd*, subdermal scutes; *t*, transverse process; *ten*, tendon; × and dotted line, restoration.

Pl. II.—Pelvis of *Nodosaurus textilis*. Holotype. Cat. No. 1815, Y. P. M. Dorsal aspect, showing overlying sacral armor. × 1/8. *d*, diapophysial lamina; *np*, neural armor plate; *r*, *rib* impression; *s*, summit of spinous process.

Pl. III.—Pelvis of *Nodosaurus textilis*. Holotype. Cat. No. 1815, Y. P. M. Ventral aspect. × 1/8. *a*, acetabulum; *i*, ischiatic peduncle; *p*, pubic peduncle; *r*, rib impression; *sr*, sacral rib.

Pl. IV.—*Nodosaurus textilis*. Holotype. Cat. No. 1815, Y. P. M. × about 1/6. Fig. 1, posterior caudal (31), right aspect. Fig. 2, right ulna, oblique inner view. Fig. 3, right radius. Fig. 4, left femur, anterior aspect. Fig. 5, left tibia and proximal portion of fibula.