ARTICLE IV.

SYSTEMATIC CATALOGUE

OF THE

SPECIES OF VERTEBRATA FOUND IN THE BEDS OF THE PERMIAN EPOCH IN NORTH AMERICA WITH NOTES AND DESCRIPTIONS.

BY E. D. COPE.

Read May 7, 1886.

PISCES.

SELACHII.

THORACODUS Cope ; Proceeds. Academy Philadelphia, 1883, p. 108.

1. *T. emydinus* Cope ; l. c., 109.

JANASSA Munster:

2. *J. gurleiana* Cope ; Proc. Amer. Phil. Soc., 1877, p. 191. Eastern Illinois.
3. *J. strigilina* Cope ; Amer. Naturalist, 1881, p. 163 ; *S. linguæformis* Cope ; Proc. Amer. Phil. Soc., 1877, p. 53, not of older authors. Eastern Illinois.
4. *J. ordiana* Cope. Texas.

ORTHACANTHUS Agass.

5. *O. gracilis* Newberry. Eastern Illinois.
6. *O. quadriseriatus* Cope ; l. c., p. 192. Eastern Illinois.

DIDYMODUS Cope ; Proc. Acad. Phila., 1883, p. 108 ; Proc. Amer. Phil. Soc., 1884, p. 572.

7. *D. texensis* Cope ; *D. ?compressus* Newb., Cope, l. l. c. c. Texas.
8. *D. platypternus* Cope ; l. c. Texas.

DIPNOI.

CTENODUS Agass.

9. *C. fossatus* Cope ; Proc. Amer. Phil. Soc., 1877, p. 54. Eastern Illinois.
10. *C. gurleianus* Cope ; l. c., p. 55. Eastern Illinois.
11. *C. periprion* Cope ; Proc. Amer. Phil. Soc., 1878, p. 527. Texas.
12. *C. porrectus* Cope ; l. c. Texas.
13. *C. vabasensis* Cope ; Proc. Acad. Phila., 1883, p. 110. East Illinois.
14. *C. dialophus* Cope ; Proc. Amer. Phil. Soc., 1878, p. 528. Texas.
15. *C. pusillus* Cope ; Proc. Amer. Phil. Soc., 1877, p. 191. Eastern Illinois.

PTYONODUS Cope ; Proc. Amer. Phil. Soc., 1877, p 192.

16. *P. vinslovii* Cope ; Proc. Acad. Phila., 1876, p. 410 Eastern Illinois.
17. *P. paucicristatus* Cope ; Proc. Amer. Phil. Soc., 1877, p. 54. Eastern Illinois.

GNATHORHIZA Cope ; Proc. Amer. Phil. Soc., 1883, p. 629.

18. *G. serrata* Cope ; l. c. Texas.

CERATODUS Agass.

19. *C. favosus* Cope ; Proc. Amer. Phil. Soc., 1884, p. 28. Texas.

TELEOSTOMI.*

ECTOSTEORHACHIS Cope ; Pal. Bull. No. 32, 1880, p. 19.

20. *E. nitidus* Cope ; l. c. Texas.

21. *E. ciceronius* Cope ; Proc. Amer. Phil. Soc., 1883, p. 628. Texas.

BATRACHIA.

GANOCEPHALA.

TRIMERORHACHIS Cope ; Proc. Amer. Phil. Soc., 1878, p. 524 ; 1880, p. 54.

22. *T. insignis* Cope ; l. c., p. 524. Texas.

23. *T. bilobatus* Cope ; l. c., 1883, p. 629. Texas.

RHACHITOMI.

ZATRACHYS Cope ; Proc. Amer. Phil. Soc., 1878, p. 523 et infra.

24. *Z. serratus* Cope ; l. c. et infra. Texas.

25. *Z. apicalis* Cope ; Amer. Naturalist, 1881, p. 1020, New Mexico.

ERYOPS Cope ; l. c., 1877, p. 188.

26. *E. megacephalus* Cope ; l. c. *Rhachitomus valens* Cope ; l. c., 1878, p. 526. Texas.

27. *E. erythroliticus* Cope ; l. c., 1878, p. 515 (*Epicordylus*) ; Trans. Amer. Phil. Soc., 1886, Pl. I, fig. 1. Texas.

28. *E. ferricolus* Cope ; l. c., 1878, p. 521 (*Parioxys*). Texas.

29. *E. reticulatus* Cope ; Amer. Naturalist, 1881, p. 1020. New Mexico.

ACHELOMA Cope ; Proc. Amer Phil. Soc., 1882, p. 455.

30. *A. cumminsi* Cope ; l. c., 456. Texas.

ANISODEXIS Cope ; l. c., 1882, p. 459.

31. *A. imbricarius* Cope ; l. c. Texas.

STEGOCEPHALI.

DIPLOCAULUS Cope ; Proc. Amer. Phil. Soc., 1877, p. 187 ; 1882, p. 451.

32. *D. salamandroides* Cope ; l. c., 1877, p. 187. Eastern Illinois.

33. *D. magnicornis* Cope ; l. c., 1882, p. 453. Texas.

EMBOLOMERI.

CRICOTUS Cope ; Proc. Acad. Phila., 1876, p. 405 ; Proc. Amer. Phil. Soc., 1884, p. 29.

34. *C. heteroclitus* Cope ; Proc. Acad. Phila., 1876, p. 405 ; Proc. Amer. Phil. Soc., 1884, p. 29 ; Trans. Amer. Phil. Soc., 1886, p. 247, Pl. I, figs. 7–8. *C. discophorus* Cope ; Proc. Amer. Phil. Soc., 1877, p. 186. Eastern Illinois.

35. *C. gibsoni* Cope ; Proc. Amer. Phil. Soc., 1877, p. 185. Eastern Illinois.

36. *C. crassidiscus* Cope ; Proc. Amer. Phil. Soc., 1884, p. 29 ; *C. heteroclitus* Cope ; l. c., 1878, p. 522 ; Amer. Naturalist, 1884, p. 39. Texas.

37. *C. hypantricus* Cope ; Proc. Amer. Phil. Soc., 1884, p. 30 ; Transac. Amer. Phil. Soc., 1886, p. 253, Pl. I, figs. 2–6. Texas.

* Owen ; Hyopomata Cope ; Teleostei et Ganoidei pars Müller.

REPTILIA.

THEROMORPHA.

Clepsydropidæ.

? LYSORHOPHUS Cope ; Proc. Amer. Phil. Soc., 1877, p. 187.

38. *L. tricarinatus* Cope ; l. c. Eastern Illinois.

ARCHÆOBELUS Cope ; Proc. Amer. Phil. Soc., 1877, p. 192.

39. *A. vellicatus* Cope ; l. c. Eastern Illinois.

CLEPSYDROPS Cope ; Proc. Acad. Phila., 1876, p. 404.

40. *C. collettii* Cope ; l. c. p. 407. Eastern Illinois.

41. *C. vinslovii* Cope ; Proc. Amer. Phil. Soc., 1877, p. 62. Eastern Illinois.

42. *C. pedunculatus* Cope ; l. c., p. 63. Eastern Illinois.

43. *C. natalis* Cope ; Proc. Amer. Phil. Soc., 1878, p. 509. Texas.

44. *C. macrospondylus* Cope ; l. c., 1884, p. 35. Texas.

45. *C. leptocephalus* Cope ; l. c., 1884, p. 30. Texas.

DIMETRODON Cope ; Proc. Amer. Phil. Soc., 1878, p. 512 ; l. c., 1880, p. 42 et infra.

46. *D. gigas* Cope ; l. c., 1878, p. 513 ; l. c. 1880, p. 44. Texas.

47. *D. incisivus* Cope ; l. c. Texas.

48. *D. rectiformis* Cope ; l. c., p. 514. Texas.

49. *D. semiradicatus* Cope ; Bull. U. S. Geol. Surv. Terrs., 1880 (81).

NAOSAURUS Cope ; Amer. Naturalist, 1886, p. 545 et infra.

50. *N. cruciger* Cope ; *Dimetrodon cruciger ;* Proc. Amer. Phil. Soc., 1880, p. 44 ; Amer. Naturalist, 1878, p. 830. Texas.

51. *N. claviger* Cope ; Amer. Naturalist, 1886, p. 545 et infra. Texas.

52. *N. microdus* Cope ; l. c., 1886, p. 545 ; *Edaphosaurus microdus* Cope ; Proc. Amer. Phil. Soc., 1884, p. 37. Texas.

THEROPLEURA Cope ; Proc. Amer. Phil. Soc., 1878, p. 519 , 1880, p. 40.

53. *T. retroversa* Cope ; l. c. Texas.

54. *T. uniformis* Cope ; l. c., 1878, p. 519 ; 1880, p. 40. Texas.

55. *T. triangulata* Cope ; l. c., 1878, p. 520. Texas.

56. *T. obtusidens* Cope ; l. c., 1880, p. 41. Texas.

EMBOLOPHORUS Cope ; l. c., 1878, p. 518.

57. *E. fritillus* Cope ; l. c. Texas.

58. *E. dollovianus* * Cope ; Proc. Amer. Phil. Soc., 1884, p. 43, Pl. I, figs. 4–5. Texas.

EDAPHOSAURUS Cope ; Proc. Amer. Phil. Soc., 1882, p. 448.

59. *E. pogonias* ; l. c., 449. Texas.

Pariotichidæ.

PARIOTICHUS Cope ; Proc. Amer. Phil. Soc., 1878, p. 508.

60. *P. brachyops* Cope ; l. c. Texas.

61. *P. megalops* Cope ; l. c., 1883, p. 630, Texas.

ECTOCYNODON Cope ; l. c., p. 509.

62. *E. aguti* Cope ; l. c., 1882, p. 451. Texas.

63. *E. ordinatus* Cope ; l. c., 1878, p. 508. Texas.

64. *E. incisivus* Cope, infra. Texas.

PANTYLUS Cope ; Bull. U. S. Geol. Surv. Terr., 1881 (80).

65. *P. cordatus* Cope ; l. c. Texas.

*Dedicated to Dr. L. Dollo, the distinguished palæontologist of the Royal Museum of Brussels.

Bolosauridæ.

BOLOSAURUS Cope ; Proc. Amer. Phil. Soc., 1878, p. 506.

66. *B. striatus* Cope ; l. c. Texas.

CHILONYX Cope ; l. c., 1883, p. 631.

67. *C. rapidens* Cope ; l. c. Texas.

Incertæ sedis.

METARMOSAURUS Cope ; Proc. Amer. Phil Soc., 1878, p. 516.

68. *M. fossatus ;* l. c. Texas.

Diadectidæ Cope.

Pal. Bull. No. 32, 1880, p. 8.

DIADECTES Cope ; Proc. Amer. Phil. Soc., 1878, p. 505.

69. *D. sideropelicus* Cope ; l. c Texas.

EMPEDIAS Cope ; Proc. Amer. Phil. Soc. ; *Empedocles* Cope ; Proc. Amer. Phil. Soc., 1878, p. 516 ; 1880, p. 634.

70. *E. phaseolinus* Cope ; Pal. Bull. No. 32, 1880, p. 9. Texas.

71. *E. alatus* Cope ; l. c. Texas.

72. *E. latibuccatus* Cope ; l. c. Texas.

73. *E. molaris* Cope ; Pal. Bull. No. 32, 1880, p. 10. Texas.

74. *E. fissus* Cope ; Proc. Amer. Phil. Soc., 1880, p. 634. Texas.

HELODECTES Cope ; Pal. Bull. 11, No. 32, p. 11.

75. *H. paridens* Cope ; l. c. Texas,

76. *H. isaaci* Cope ; l. c., p. 12. Texas.

SYNOPSIS OF THE SPECIES.

	Gen.	*Species.*
PISCES.		
Selachii,	5	8
Dipnoi,	4	11
Teleostomi,	1	2
BATRACHIA.		
Ganocephala,	1	2
Rhachitomi,	4	8
Stegocephali,	1	2
Embolomeri,	1	4
REPTILIA.		
Theromorpha,	15	39
Total,	32	76

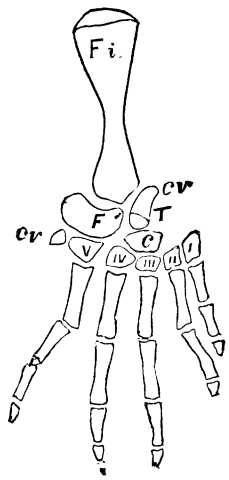
The only catalogue of this fauna hitherto published appeared in the American Naturalist for February, 1881, p. 162. In that list fifty-one species were enumerated.

CTENODUS VABASENSIS Cope ; Proc. Phila. Academy, 1883, p. 110.

Two fine teeth received from Mr. W. F. E. Gurley, from Danville, Illinois, probably belong to this species, their anterior crests being perfect. They are proven to be produced forwards as in *C. porrectus* Cope. One of the specimens agrees with

the type in the number of its crests, while the second, which is a little larger, has them $7\frac{1}{1}$ instead of $6\frac{1}{1}$.

ERYOPS PLATYPUS Cope. *Ichthycanthus platypus* Cope ; Proc. Amer. Phil. Soc., 1877, p. 574.



A reëxamination of the type specimen of this species from the Coal Measures of Ohio, preserved in the museum of Columbia College, New York, enables me to refer this species to the Rhachitomi. The neural spines are distinct, showing that it belongs, probably, to the Eryopidæ. As the skull is not preserved I cannot determine the genus positively, but refer it for the present to Eryops. I append a figure of the posterior foot, which displays the characters of the tarsus of this group for the first time. The number of tarsals is as in a Theromorph reptile, except that two elements represent the cuboid bone, as in the reptile *Stereosternum tumidum* Cope; giving five elements in the distal tarsal row. There is but one centrale and no intermedium. Two fragments of caudal vertebræ adhere to the specimen (marked *cv* in the accompanying cut). The lettering of the cut is as follows: *Fi*, fibula; *F*, fibulare; *T*, tibiale; *c*, centrale; I–V, tarsalia.

ZATRACHYS SERRATUS Cope; Proceedings of the Amer. Philos. Soc., 1878, p. 523; American Naturalist, 1884, p. 36.

This species has been thus far certainly known from a portion of the maxillary bone only. Analogy of general characters led me to associate with it a second species under the name of *Z. apicalis*. This form was clearly rhachitomous, so that in the American Naturalist, as above cited, I referred the genus Zatrachys to the family of the Eryopidæ.

A skull of the *Z. serratus* having come to hand, I am able to give some of its characters. These indicate that the position assigned to it as above is correct, and that it represents a genus different from any of the others of the family so far as our present understanding of the characters goes.

There are two approximated occipital condyles. There is no distinct basi-occipital bone distinguishable, and it is possibly wanting. The palatopterygoid arch is convex outwards, keeping near the maxillary bone, and separated from the parasphenoid by a wide foramen. The intercalare forms a prominent angle on each side of the cranial table. The occipital aspect of the skull displays fontanelles between two ascending portions of the exoccipitals, one of which bounds the foramen magnum, and the other the intercalare. The latter has a superior and inferior posterior angle which are sepa-

rated by a notch. The posterior part of the quadratojugal arch forms a wide roof or ledge overhanging the lower jaw. The teeth are small, acute, and close together. The median and anterior teeth are unknown, as the anterior half of the skull is wanting. The angle of the lower jaw projects little or not at all beyond the cotylus. The condyle of the quadrate is narrow and little distinguishable. Between the intercalare and the transverse process of the parasphenoid, is the deep tympanic chamber. It is traversed on one side of the specimen by a curved club-shaped bone, with the larger end truncate and internal. Its tissue is very spongy. It may be the columella auris, but its slender external extremity appears to be continuous with the os intercalare. This may, however, be due to the mode of preservation.

The surface of the skull has a dense reticulated sculpture, which is in places radiated. It is especially pronounced along the external border of the quadratojugal arch where it develops nodules which are arranged in a serrate manner. There is a pronounced fossa in front of each orbit, which is bounded within by a convex ridge extending forwards from the orbit. Between these ridges is another deep fossa of the middle regions, whose posterior border is in line with the anterior edge of the orbits. The cranial wall is here very thin. On each side of the supraoccipital bone a sharp process projects backwards and inwards forming a short horn. I do not imagine that the value of this character is more than specific. The external face of the mandible is sculptured, the sculptured surface presenting an obtuse angle upwards, and leaving a narrow smooth face anterior and posterior to the angle.

Measurements.	*M.*
Width of skull posteriorly,	.138
" between intercalare bones inclusive,	.062
" " occipital processes "	.019
" " orbits,	.039
Diameters of orbits { anteroposterior,	.017
Diameters of orbits { transverse,	.020
Elevation of occiput from foramen inclusive,	.010
Width of parasphenoid behind transverse processes,	.024

This cranium presents a curious mixture of defective and excessive ossification. Its form is more depressed than any others of the family. I await the discovery of its anterior regions with interest.

ECTOCYNODON INCISIVUS, sp. nov.

A nearly complete but somewhat distorted cranium represents this species. It presents the generic characters of roofed temporal fossæ, sculptured cranial bones without lyra, and an elongated tooth near the middle of the maxillary series.

The muzzle is quite prominent, a character somewhat exaggerated in the specimen by pressure. The nostrils are large, lateral in direction, and situated close to the end of the muzzle. The orbits are subround, of medium size, and look mainly upwards in the present condition of the specimen. One of the most important peculiarities of the species is the disproportionately large size of the first or anterior incisor or premaxillary tooth. The crown is conical and nearly straight, with an acute apex slightly posterior to the central point. Its section at the base is slightly angulate. The two other premaxillary teeth are much smaller, the third quite minute and with a sharp apex.

There are three maxillary teeth separated by rather wide interspaces anterior to the large tooth which gives character to the genus. The latter is abruptly large, but not equal in dimensions to the large first incisor. Posterior to it the maxillary teeth are closely placed, and with obtuse crowns. They commence very small, and increase in size posteriorly. At a point where the palatine or ectopterygoid, as the fact may be, joins the maxillary, the tooth-bearing surface is wide, and supports four rows of small obtuse-crowned spaced teeth of equal size. This dental patch is triangular, with its long angles extending anteriorly and posteriorly. The latter angle terminates a little posterior to the middle of the orbit. The teeth have a small axial pulp cavity, and the dentine is perfectly simple.

The head sculpture is well defined, and is reticulated in pattern.

Measurements.	*M.*
Length from end of muzzle to posterior border of orbit,	.054
Transverse diameter of orbit,	.016
" " " interorbital space,	.020
Length from end of muzzle to orbit,	.034
Vertical diameter of nostril,	.008
Vertical depth of maxillary in front,	.013
Length of first premaxillary tooth,	.0065
Transverse diameter of do.,	.0038
Distance between first incisor and large maxillary teeth,	.013
Distance from large maxillary tooth to posterior angle dental patch,	.024
Width of dental patch,	.0105
Elevation of a posterior tooth,	.0015

This species is intermediate in size between the *E. ordinatus*, which is small, and the *E. aguti*, which is large. In its disproportionate inequality in the size of its teeth, it differs from the latter; while the former has larger orbits and a different sculpture, besides having half the linear measurements. The sculpture of the *E. ordinatus* is in parallel ridges, enclosing minute deep punctiform pits between them.

The characters of this species confirm the propriety of my proposition that Pantylus, Ectocynodon and Pariotichus are members of a single family which differs from the Clepsydropidæ in the overroofing of the temporal fossa.*

DIMETRODON SPECIES.

My last account of this genus was published in the Proceedings of the American Philosophical Society, 1880, p. 42. Since that time additional material has enabled me to develop more fully the characters of this singular type.

Ribs.—In this genus and in Naosaurus the sacral ribs are present as in Batrachia. They are short, and vertically compressed, forming a wedge-like body.

Vertebræ.—I have at various times described the extraordinary development of the neural spines of the dorsal vertebræ in the genus Dimetrodon, which belongs to the Clepsydropidæ, one of the carnivorous families of the Saurian order Theromorpha. The dentition of these animals is of the most formidable character, consisting of compressed finely serrate teeth on the maxillary and dentary bones mingled with huge conic tusks on the middle of the maxillary anterior end of the dentary, and occupying the entire alveolar face of the premaxillary. The huge neural spines formed an elevated fin on the back. In a medium-sized specimen of *Dimetrodon incisivus*, where the vertebral body is 35 mm. in length, the elevation is 900 mm. or twenty and a half times as great. The apex of the spine in this species is slender, and apparently was flexible. Its utility is difficult to imagine. Unless the animal had aquatic habits, and swam on its back, the crest or fin must have been in the way of active movements. Accordingly the spines are occasionally found distorted by union of surfaces of fracture. The limbs are not long enough nor the claws acute enough to demonstrate arboreal habits as in the existing genus, Basiliscus, where a similar crest exists.

Sternum.—A singular bone which I can only regard as this element accompanies a fragmentary skeleton of the *D. incisivus* or *D. gigas;* and other examples occur with other specimens.

The anterior two-fifths of the bone is nearly square, and slightly concave above, with three angles, one at each side and one anterior; the rest contracts posteriorly into a long, narrow, flattened shaft, which constitutes three-fifths of the length. This portion is depressed, so that the transverse section is lenticular. The lateral edges are acute, and without articular facets of any kind. The distal extremity is first grooved, and then fissured, each half terminating in an obtusely narrow apex which is applied to the other half. The surface of this part of the element is longitudinally grooved both above and below.

* See Proceedings Amer. Philos. Soc., 1883, p. 631.

Clavicles.—The clavicles in the genus Dimetrodon are well developed elements. They consist of a vertical narrow and a horizontal expanded portion. The anterior border of the bone is rounded; the internal border is serrate or semidigitate. If the latter unites with the episternum by suture it must be by a very open one. This portion is more expanded than in the monotreme mammalia; while the episternum is more produced posteriorly. The type of structure of this part of the scapular arch is less mammalian than is that of Empedias above referred to, but is not far removed from the latter.

Posterior foot.—A posterior foot of a species of Pelycosaurian, from Ne Mexico, displays the characters more perfectly than any specimen in my collection. It confirms the inferences I have derived from the posterior foot of *Clepsydrops natalis* Cope, as to the mammalian affiliations of this order of reptiles. Thus it has the same number of tarsal bones distributed in the same manner. That is an astragalus and a calcaneum in the proximal series; then a navicular distad to the astragalus, which is succeeded by three cuneiform bones. Distad to the calcaneum is but a single bone, the cuboid. The specimen described differs in some important particulars from that of the species above mentioned. Thus the astragalus and navicular together are as long as the calcaneum, while in the *C. natalis*, the calcaneum and astragalus have equal lengths. It is possible that there are but four digits in the posterior foot; at least I can only find one metatarsal in connection with the cuboid. The internal edge of the astragalus is broken away, so that the presence of the spur or a homologous digit cannot be substantiated.

As the astragalus of Dimetrodon is closely similar to that of Clepsydrops, the species now described does not enter that genus. The rather numerous vertebræ which accompany it resemble, on the other hand, those of Theropleura, and it may be that they belong to a species of that genus. By comparison of the plate, with the cut given under the head of *Eryops platypus*, the difference between that type and this may be perceived.

The lettering of the figure is as follows: *As.*, Astragalus; *Ca.*, Calcaneum; *Cu.*, Cuboid; *Na.*, Navicular; *Enc.*, Entocuneiform; *Msc.*, Mesocuneiform; *Ecc.*, Ectocuneiform; I–IV, Metatarsals.

NAOSAURUS CLAVIGER Cope. American Naturalist, June, 1886.

Char. gen.—Naosaurus differs from Dimetrodon only in the presence of transverse processes on the neural spines.

The above named very peculiar species is congeneric with the Saurian described under the name of *Dimetrodon cruciger* Cope. The neural spines are not quite so ele-

vated as in the *D. incisivus*, but they are more robust, and have transverse processes or branches which resemble the yard-arms of a ship's mast. In a full-sized individual, the longest cross-arms, which are the lowest in position, have an expanse of two hundred and sixty millimeters, or ten and a quarter inches, while the spine has about the height of five hundred millimeters (19.75 inches), the body being 60 mm. long. The animal must have presented an extraordinary appearance. Perhaps the yard-arms were connected by membrane with the neural spine or mast, thus serving the animal as a sail, with which he navigated the waters of the Permian lakes.

The three species of Naosaurus differ as follows:

I. Neural spines distally cylindric.	
Distal transverse processes represented by tuberosities,	*N. cruciger.*
II. Neural spines distally dilated and compressed.	
Palatine teeth small, widely spaced,	*N. claviger.*
Palatine teeth large, closely packed,	*N. microdus.*

The skull.—One of the best preserved skeletons of the *N. claviger* includes a skull, but the extremity of the muzzle is unfortunately wanting. The median line rises forwards so that the convexity of the top of the muzzle is higher than the posterior parts of the skull, whose profile descends rapidly. This throws the orbit far back and gives the animal a peculiar appearance.

The orbit is nearly round, the superciliary border being arched. Anterior to it is a large anteorbital fossa bounded by a longitudinal ridge above. Above the ridge is a longitudinal groove, which is separated from that of the opposite side by a narrow ridge only. The quadrate bone is large and laminiform, and is truncate above, having a good deal the shape of the corresponding bone in a fish. The parietal buttress is produced downwards and backwards, and is in contact with the superior third of its posterior border. Beneath and within it is a narrow opisthotic. The pterygoid is large, and is distally vertically compressed. Anteriorly it becomes flattened so as to be horizontal, and is studded with small conical teeth rather distantly placed.

The transverse series of palatine teeth on a massive Z-shaped bone, seen in the *D. incisivus*, is not preserved in this specimen, but the explanation of the structure is furnished by a specimen of the *Dimetrodon semiradicatus* Cope, of which a second specimen has been found by Mr. Cummins. Here the palatine bones with their teeth are preserved. They are not so massive as in the *D. incisivus*. Posteriorly they pass into the longitudinally flattened part without interruption by suture, so that I suspect that this part is to be referred to the palatine rather than to the pterygoid bone. It is studded with small teeth, but they are not nearly so numerous as in the *N. cruciger*.

These specimens show that the species I named *Edaphosaurus microdus** must be placed in Naosaurus, where it represents the second species with transverse processes on the dorsal neural spines. The teeth of the palatine patch in this species are larger and more closely placed than in the *D. cruciger*. The distinction between the two species in the form of the apices of the neural spines, to which I referred in my description (l. c.) holds good; but the *N. claviger* has them dilated anteroposteriorly nearly as in the *D. microdus*.

Vertebræ.—A large series of these is preserved, and they show many interesting characters. The intercentra are not distinct in the anterior part of the column, but are separated posteriorly and in the sacrum. The centra are compressed and have an acute inferior heel. The neural spines are moderately compressed below the first transverse processes; above this point they are anteroposteriorly oval in section. The distal half is compressed. They expand to a point below the apex, where the anterior edge extends obliquely backwards to the summit. A short corresponding oblique edge truncates the posterior superior angle. The medullary cavity of the spine is not closed at the apex. On several of the vertebræ the lowest transverse process is double, but the sides of the same vertebra differ from each other in this respect in some instances.

The two sacral vertebræ are not coössified, and the zygapophyses are well developed and distinct, as are the intercentra. The latter are flat, and but little developed in the upward direction. The neural spines are rather elevated and slender. They are compressed without cross-processes, and the apex of the spine has small tubercles.

Ribs.—The ribs are long and well curved, and are moderately compressed on their proximal half, and cylindric for their distal. The head is well distinguished from the tubercle as in the manner of a mammal. That is, the tubercular surface is sessile on the convexity of the rib, and not pedunculate. In this respect these ribs differ from the usual form of two-headed reptilian ribs. The head is so long on the anterior dorsal vertebræ, as to articulate with the posterior edge of the vertebra in front of the one with which its tubercle articulates. It becomes shorter on the posterior parts of the column, articulating with the edge of the rib which supports the tubercle. On the caudal series the head is retracted so as to be close to the tubercular articulation, which is the most extensive, and which is deeply notched on one of its faces. This gives the appearance of a three-headed rib in this genus and in Dimetrodon.

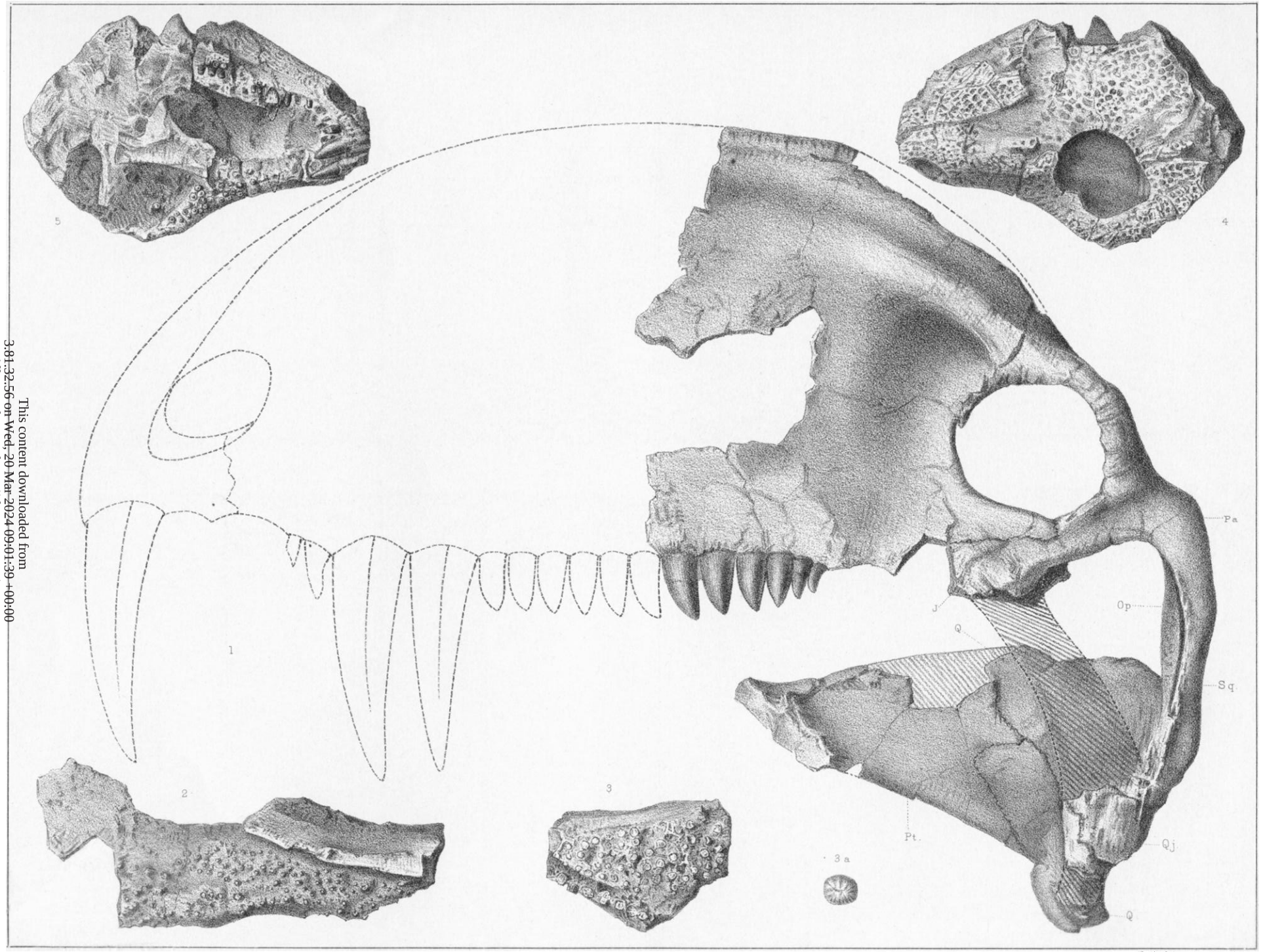
* Proc. Amer. Philos. Soc., 1884, p. 37.

Besides the skull, the vertebræ and the ribs, I cannot yet positively identify the skeleton of this species.

Measurements.	*M.*
No. 1. (Skull.)	
Depth of muzzle at sixth tooth from last,	.172
Length of skull posterior to same tooth,	.232
Diameters of orbit { anteroposterior,	.057
Diameters of orbit { vertical,	.056
Vertical depth from line of eyebrow to end of quadrate,	.200
Width of condyles of quadrate,	.050
Diameters of crown of sixth tooth { vertical,	.028
Diameters of crown of sixth tooth { anteroposterior,	.014
Diameters of crown of sixth tooth { transverse,	.011
Thickness of maxillary bone at sixth tooth,	.022
No. 2. (Vertebræ, probably of No. 1.)	
Diameters of dorsal neural arch, with zygapophyses { anteroposterior,	.064
Diameters of dorsal neural arch, with zygapophyses { transverse (posterior),	.036
Diameters of neural spine near base { anteroposterior,	.033
Diameters of neural spine near base { transverse,	.027
No. 3. (Vertebræ.)	
Diameters centrum dorsal vertebra { anteroposterior,	.039
Diameters centrum dorsal vertebra { transverse,	.034
Diameters centrum dorsal vertebra { vertical,	.035
Expanse prezygapophyses do.,	.041
" diapophyses do.,	.082
Elevation of neural spine to first process,	.024
Transverse diameter of process,	.025
Diameters neural spine at process { anteroposterior,	.030
Diameters neural spine at process { transverse,	.028
Length of the two sacral vertebræ,	.084
Elevation of neural canal of do.,	.010
" " " spine of do.,	.084
Length of rib on outside of curve,	.260
" " head of rib,	.045
Transverse diameter of rib just beyond tubercle,	.017
Anteroposterior do.,	.020

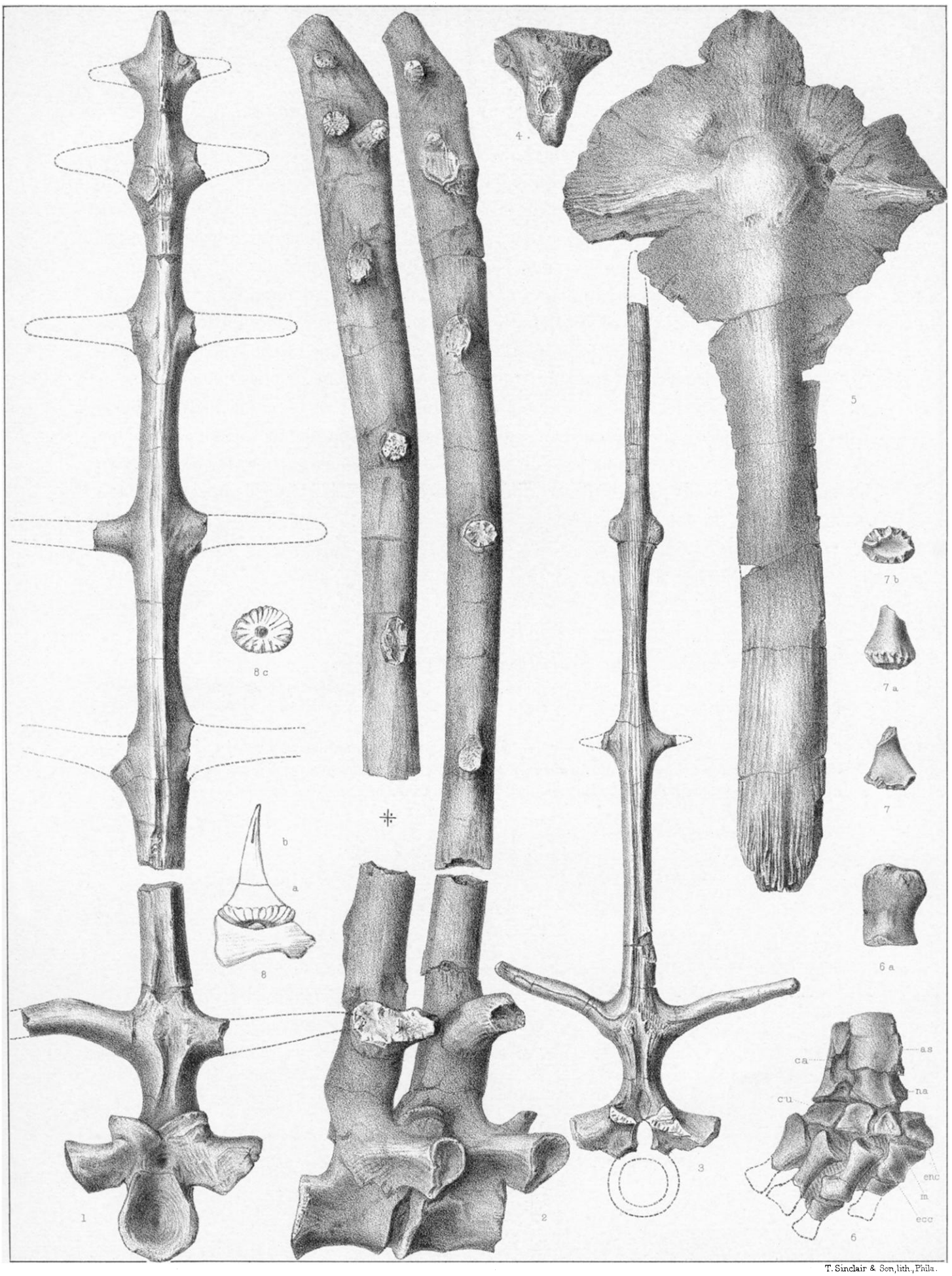
?SPUR OF A PELYCOSAURIAN.

In Plate III, fig. 7, is represented the basal part of a bone which has the form and characters of a metapodial of one of the Clepsydropidæ. It differs from all of these which have come under my notice in the burred or serrate character of the border of the proximal extremity. I do not know of any genus which is likely to have such a metapodial of the usual series. The first of the series, which articulates with



T. Sinclair & Son, lith., Phila.

1 2. NAOSAURUS CLAVIGER ½-⅜. 3. N. MICRODUS ¾, 3 a do 2/1. 4-5. ECTOCYNODON INCISIVUS ¼.



T. Sinclair & Son, lith., Phila.

1-2. NAOSAURUS CLAVIGER ½. 3. N. CRUCIGER ½. 4. N. MICRODUS ¾. 5. DIMETRODON ½.
6. THEROPLEURA ? ¾. 7. METAPODIAL ? 8. PLATYPUS.

the distal part of the astragalus has, however, not yet been discovered, and this bone may be that missing piece. Some probability attaches to this identification from the fact that the corresponding element in Ornithorhynchus (Pl. III, fig. 8), is burred in the same manner at its proximal extremity. The present piece is, however, longer than the bone of Ornithorhynchus, and has much more the usual character of a metatarsal. It is not perforate at the base, and has only the usual medullary cavity. It is flat on one side, and convex on the other. It must, however, be regarded as probable that from a more or less normal metatarsal, the basal bone of the spur of Ornithorhynchus has been derived; the spur proper representing one or more phalanges.

That the posterior foot of Vertebrata includes six toes is maintained by Baur. This is confirmed by the presence of a digit within the hallux in various Batrachia Anura. In *Rana catesbeiana* this digit has three segments, a metatarsal and two phalanges, the former resting directly on the astragalus. This digit appears to have been present in the Clepsydropidæ.

EXPLANATION OF PLATES.

PLATE II.

Figs. 1–2. *Naosaurus claviger* Cope. From the Permian formation of Texas.

Fig. 1. Posterior part of skull, left side; one-half natural size. Restored from skulls of *N. cruciger* and *Dimetrodon incisivus*. *Pa*, Parietal bone; *J*, jugal; *QJ*, Quadratojugal; *Opo*, Opisthotic; *Sq*, Squamosal; *Q*, Quadrate; *Pt*, Pterygoid.

Fig. 2. Part of palatopterygoid arch of the same from below; three-quarters natural size.

Fig. 3. *Naosaurus microdus*, part of palatopterygoid arch from below; three-quarters natural size.

Figs. 4–5. *Ectocynodon incisivus*, skull; from the Permian formation of Texas; natural size.

Fig. 4. From above.

Fig. 5. From below.

PLATE III.

Figs. 1–2. *Naosaurus claviger*, dorsal vertebræ; one-half natural size.

Fig. 1. Front view.

Fig. 2. Right side.

Fig. 3. *Naosaurus cruciger*, neural arch and spine, from front; one-half natural size; centrum in outline.

Fig. 4. *Naosaurus microdus*, distal view of distal end of neural spine; three-fourths natural size.

Fig. 5. *Dimetrodon?* sp., sternum, inferior face.

Fig. 6. *Theropleura* sp. ?, part of posterior foot; three-fourths natural size. *As*, Astragalus; *Ca*, Calcaneum; *Na*, Navicular; *Cu*, Cuboid; *Ecc*, Ectocuneïform; *M*, Mesocuneïform; *Enc*, Entocuneïform; phalanges partly restored.

Fig. 6a. Calcaneum, anterior view.

Fig. 7. Supposed first metatarsal of Pelycosaurian, twice natural size; 7 and 7*a*, opposite lateral views; *b*, proximal end.

Fig. 8. *Ornithorhynchus anatinus*, internal digit or spur, from Owen, Anatomy of Vertebrata, ii, fig. 199; *a*, metatarsal; *b*, phalange; *c*, metatarsal, proximal view.