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NOTES ON RECENTLY MOUNTED REPTILE FOSSIL SKELETONS IN THE UNITED STATES NATIONAL MUSEUM

By CHARLES W. GILMORE*

SKELETON of a nearly complete Eocene crocodile and a partial skeleton of *Corythosaurus*, a crested dinosaur of the Upper Cretaceous, have recently been added to the exhibition collection of fossil vertebrates in the United States National Museum. In the brief notes presented here, attention is called to some of the more interesting anatomical features of these specimens, and measurements are given of all the more important bones in order to make these data available to students of the fossil Reptilia. The crocodile specimen appears to be unique in being the first complete skeleton to be mounted for exhibition in this country.

SKELETON OF CROCODILUS CLAVIS COPE

PLATES 12-15

Among the specimens collected by the 1930 Smithsonian Paleontological Expedition to the Bridger Basin in southwestern Wyoming was an unusually complete skeleton of a crocodile, U.S.N.M. No. 12719. It was found by George B. Pearee in the badlands between Levett and Little Dry Creeks in horizon B of the Bridger formation. The skeleton as it lay in the ground was only partially articulated, but inasmuch as it is an isolated specimen the few bones found detached and scattered can surely be regarded as pertaining to a single individual. The skeletal parts preserved are as follows: Skull, lower jaws, 23 presacral vertebrae, 2 sacral vertebrae, 33 caudal vertebrae, 17 chevrons, complete pectoral and pelvic girdles, 10 cervical ribs, 17

*Mr. Gilmore died on September 27, 1945.—Ed.

thoracic ribs whole or in part, right humerus, both radii, right ulnare, both radialia, parts of 2 metacarpals, both femora, both tibiae, both fibulae, both tarsi, all metatarsals, 11 phalangials, 2 unguals, and numerous dermal scutes.

On account of the rarity of good crocodylian skeletons in paleontological collections, it seemed desirable to articulate this specimen for public exhibition. After several months' work this was accomplished by Norman H. Boss, chief preparator, who is to be highly commended on the excellent results achieved.

The individual bones are thoroughly mineralized and practically free from postmortem distortion. A few elements, however, either through injuries or disease are abnormally deformed. The right scapula is a most interesting example of a badly healed fracture. In life the scapula was cleanly broken through the narrowest part of the blade. This upper portion dropped down on the inside of the proximal half for fully an inch below the point of fracture, and there the two parts were securely knitted together by extraneous bony growth. Although this fracture must have been exceedingly painful at the time, after healing the limb undoubtedly continued to function.

The second metatarsal of the left hind foot exhibits a pathologic condition that has enlarged the shaft of the bone to nearly twice its normal size. This lesion can probably be attributed to an injury. Other lesions are found on the left coracoid, anterior thoracic ribs, caudal vertebrae, chevrons, and skull. That this animal was a pugnacious individual and often engaged in combat, probably with others of its kind, is clearly indicated by the considerable number of healed wounds.

There are 23 presacral vertebrae preserved, but a restored lumbar was introduced between the first and second, the only point showing evidence of a break in the series, in order to make the presacrals correspond in total number to the vertebral formula of *Crocodylus americanus* as determined by Mook.¹ This introduction makes four lumbar vertebrae, whereas Mook recognizes only three in *C. americanus*; but as a mounted skeleton of this species (U.S.N.M. No. 14874) has four, it seems reasonable to assume that a similar variation may occur in the fossil species.

The caudal series consists of 37 vertebrae of which 33 are original bones. Four vertebrae at the tip of the tail are fully restored. According to authorities the total number of caudal vertebrae is subject to considerable variation among living individuals of the same species.

The skeleton, over all from tip to tip, measured along the curves of the spinal column has a length of about 9 feet 10 inches.

Pending the publication of the monographic study of the Croco-

¹ Mook, C. C., Bull. Amer. Mus. Nat. Hist., vol. 44, pp. 70-78, 1921.

dilia by Dr. C. C. Mook, this specimen is provisionally identified as pertaining to the species *Crocodylus clavis* Cope. Hay² recognizes 10 species of *Crocodylus* from the Bridger formation alone, but a thorough revision would doubtless greatly reduce this list.

The mounted skeleton has been given a defiant attitude (see pl. 13) with the jaws agape in order better to display the mouthful of teeth. The pose and style of mount adopted were largely determined by the character of the skeleton. Because of the extreme hardness and brittleness of the fossilized bone, it was found impractical to drill the bones for securing them to metal supports, and so Mr. Boss worked out a scheme of half relief and half free mount that overcame this difficulty and gives pleasing results, as is clearly shown in plates 12 and 13.

The skull and lower jaws are unusually complete and only slightly distorted by crushing.

In the upper and lower mandibles there are alveoli for 76 teeth, premaxillaries 10, maxillaries 30, and dentaries 36. Of this dental series 29 teeth were found in place; enumerated from the front these were distributed as follows: Second of the right premaxillary, a germ tooth, and fourth of the left premaxillary; in the right maxillary the fifth, ninth, tenth, and eleventh, none in the left maxillary; in the left dentary the first, fourth, fifth, sixth, seventh, (germ tooth), eighth (germ tooth), ninth (germ tooth), tenth, and eleventh; in the right ramus the first, second, third, fourth, fifth, sixth, seventh, eighth (germ tooth), twelfth, thirteenth, fifteenth, sixteenth, seventeenth, and eighteenth (the last four being germ teeth).

The other teeth, some 39 in all, were found loose in the matrix surrounding the skull, and these have been arbitrarily inserted in the jaws. Thus of the 76 teeth forming the complete dental series, original tooth crowns of 69 are preserved.

In *Crocodylus*, according to Mook,³ all the living species of the genus have 17 to 19 teeth in the upper series and only 15 in the lower, or a maximum total of 68 teeth in the mouth as contrasted with 76 in the extinct species. Of 4 other skulls from the Bridger in the National Museum's collections none shows less than 36 in the lower dental series, and it is evident that the greater number of teeth constitutes an important feature for distinguishing the extinct Eocene forms from the extant members of the genus. It also raises the question of the propriety of referring these Eocene crocodiles to the genus *Crocodylus*. That, however, is outside the scope of the present paper, and no doubt will be fully considered by Mook in the course of his monographic study of the order.

² Hay, O. P., Bibliography and catalogue of fossil vertebrates. Carnegie Inst., Washington Publ. 360, pp. 512-513, 1928.

³ Mook, C. C., Bull. Amer. Mus. Nat. Hist., vol. 44, p. 151, 1921.

The excellent preservation of the present skeleton offers an unusual opportunity for recording the important measurements of a single individual of an Eocene crocodile. In the tables that follow the principal measurements of the skeletal parts are given, following Mook's

TABLE 1.—Comparative measurements (in mm.) of skull, pelvic, and limb bones in two species of *Crocodylus*

Measurements	<i>C. clavii</i> (U.S.N.M. No. 12719)	<i>C. americanus</i> (A.M.N.H. No. 7139)
Length of skull, tip of snout to supraoccipital.....	418	735
Length of skull, tip of snout to ends of quadrates.....	481	793
Breadth of skull, cranial table.....	110	181.5
Breadth of skull, across fifth maxillary tooth.....	126	185
Length of mandible.....	535	895
Length of scapula, total.....	136	220
Anteroposterior diameter of superior border.....	77.3	83
Anteroposterior diameter of inferior border.....	75.4	89
Maximum thickness of distal end.....	27	34
Length of coracoid, total.....	101	199
Anteroposterior diameter, superior surface.....	60.4	84
Anteroposterior diameter, inferior surface.....	68.5	83
Length of humerus, total.....	180	† 168
Breadth of proximal end.....	54	71
Breadth of distal end.....	50.5	67
Circumference of shaft.....	61	69
Index of circumference over length.....	338	410
Length of radius, total.....	107	149
Maximum diameter, proximal end.....	26	34
Maximum diameter, distal end.....	26.1	31
Length of ilium, total oblique.....	125.6	171
Length of ilium, total anteroposterior.....	105	153
Distance across both ischiadic processes.....	145	107
Maximum length of ischium, oblique.....	139	175
Anteroposterior diameter, proximal end.....	49	31
Maximum diameter, distal end.....	68	88
Length of pubis, total.....	93.5	175
Maximum diameter, proximal end.....	27	31
Minimum diameter, proximal end.....	17.4	27
Breadth distal end.....	73.5	87
Length of femur, total.....	223	325
Breadth, proximal end.....	51.5	68
Breadth, distal end.....	51.5	70.5
Circumference of shaft.....	76	110
Distance from center of fourth trochanter to proximal end.....	81	115.5
Distance from center of fourth trochanter to distal end.....	142	209.5
Index ratio: $\left\{ \frac{\text{Center of fourth trochanter to proximal end}}{\text{Center of fourth trochanter to distal end}} \right\}$	0.570	0.551
Length of tibia, total.....	159	227
Maximum diameter, proximal end.....	43.1	50
Maximum diameter, distal end.....	38	51
Length of fibula, total.....	156	211
Maximum diameter, proximal end.....	25	33.5
Maximum diameter, distal end.....	24	31
Circumference of shaft.....	35	52
Index ratio: $\left\{ \frac{\text{Circumference of shaft}}{\text{Total length}} \right\}$	0.223	0.246

† Possibly an error, in view of greater proportions of most of the other measurements.

system⁴ used in describing the osteology of the extant *Crocodylus americanus*.

For convenience in reference I have included in parallel columns the measurements by Mook of a considerably larger *C. americanus*. In view of the antiquity of the extinct skeleton these measurements show a remarkable similarity of proportions between the living and extinct forms.

TABLE 2.—Comparative measurements (in mm.) of cervical, dorsal, lumbar, and sacral vertebrae

Vertebrae	Length of centrum ¹		Breadth of centrum, anterior end		Spread of prezygapophyses		Spread of postzygapophyses		Spread of diapophyses		Total height	
	U.S.N.M. No. 12719	A.M.N.H. No. 7139	U.S.N.M. No. 12719	A.M.N.H. No. 7139	U.S.N.M. No. 12719	A.M.N.H. No. 7139	U.S.N.M. No. 12719	A.M.N.H. No. 7139	U.S.N.M. No. 12719	A.M.N.H. No. 7139	U.S.N.M. No. 12719	A.M.N.H. No. 7139
Cervical 2.....	49.5	61.5	25	46	.....	30	26	33	51.7	53	79	87
3.....	34	67	25.5	40	26	40	.....	41	41	35.5	88	127
4.....	35	68	27	43	32.2	44	41	46	43	49	96	140
5.....	32.5	66	31	44	41	54	.....	54	51	55	.....	156
6.....	31.9	65	30.7	44	41	61	.....	58	49	58	.....	166
7.....	32.5	64	31	52	50	64	.....	61	60	63	105	167
8.....	31	65.5	.....	56	48.5	68.5	48	63.5	73.3	64.5	.....	175
Dorsal 1 ¹	32	63	.....	54	55	68	49	62	84	63	122.9	180
2.....	32	65	.....	56	54	66	52.5	63	101	61	121.5	185
3.....	34.9	60	.....	53	53	67	55	70	105	66	.....	180
4.....	30.0	68	32	50	49	76	62.5	79	127	107	118	181
5.....	37	68	33	48	60.5	82	58	81	149	156	95	160
6.....	39	71	33	49	60.5	84	60	79	159	183	90	150
7.....	39	73	33	49	60	82	59.5	76	150	200	88.5	148
8.....	39	73	33.9	50	61	80	58.5	78	160	213	85	145
9.....	41	74	32.8	50	58	81.5	50	78	166	218	80	140
10.....	41	76	34	51	61	80	62	79	160	230	81	140
11.....	41	78	35	57	62	80	54	83	160	242	79	136
12.....	41	79	35	55	63	86	59.5	81	144	275	80	139
Lumbar 1.....	39.9	78	30	55	55	83	55.4	81	136	277	.....	134
2.....	.....	77	.....	50	.....	82.5	.....	81	.....	250	.....	133
3.....	39	77	36.2	56	.....	85	54	85	120	235	83	132
4.....	38	69	33.5	55	.....	88	33.8	84	.....	218	.....	132
Sacral 1.....	42	59	44	60	44	87	28	62.5	155	230	88	135
2.....	43.7	62	30	50	36	55	42.6	53.5	110	202	79.8	142

¹ The measurements of the vertebral centra of the presacral series of the fossil specimen do not include the ball, and so in using these measurements allowance must be made for this omission. This discrepancy was due to the fact that this portion of the backbone was articulated in fixed position before it was decided to take this series of measurements.

⁴ *Ibid.*, pp. 71-100.

TABLE 3.—Comparative measurements (in mm.) of caudal vertebrae

Caudals	Length of centrum		Breadth of centrum, anterior end		Height of centrum, anterior end		Spread of prezygapophyses		Spread of postzygapophyses		Height total		Spread of transverse processes	
	U. S. N. M. No. 12719	A. M. N. H. No. 7139	U. S. N. M. No. 12719	A. M. N. H. No. 7139	U. S. N. M. No. 12719	A. M. N. H. No. 7139	U. S. N. M. No. 12719	A. M. N. H. No. 7139	U. S. N. M. No. 12719	A. M. N. H. No. 7139	U. S. N. M. No. 12719	A. M. N. H. No. 7139	U. S. N. M. No. 12719	A. M. N. H. No. 7139
1	55.9	73	34.3	51	29	46	45	58.5	34	52	83.9	130	122	196
2	51.7	69	32	50	30	43	-----	59.5	30	48	77	134	132	195
3	51	70	29.4	45.5	31.5	44	-----	54	27	43	83	135	126	186
4	52	73	27	46	31	42	-----	50	-----	40	79	135	116	175
5	55	75	27.4	44.6	28.6	41.5	27.8	46.5	26	38.5	-----	136	-----	166
6	55.7	76	26.9	43	27	38.5	28	45	21	36	75.5	130	112	157
7	53.7	67	25	40.5	24	37	26	42	21	32	-----	132.5	-----	141
8	53.2	77	25	44	25	44	25	37	22	29.5	-----	118	-----	130.5
9	53.5	68	23	34.5	23	36.5	28	37	20.9	32	67.5	103	-----	120
10	53	78	24.4	35.5	24.1	33	24	36.5	19	32	68.8	101.5	-----	118
11	53	77	23	33.5	23	30.5	27	38	21.5	27	71	100	-----	120
12	54.3	74	22	32	22.5	29	22	34	-----	27	67	107	-----	107
13	54	78	22.5	32	22	28	-----	33	-----	23.5	-----	104	-----	88.5
14	53.4	75	21.7	31	23	26	-----	28	-----	25	66	102	-----	44.5
15	-----	72	21.5	29.5	20.5	26	-----	28	-----	24.5	69	102	-----	-----
16	52	75	-----	28.5	-----	26	-----	28	-----	21.5	-----	106	-----	-----
17	52	74.5	19.5	27	21	24	15	25	10	18	-----	105	-----	-----
18	50	73	19	25	21	25	14	22	7	18	-----	118	-----	-----
19	51	70.5	20	20.4	18	23	-----	19	-----	15	-----	109	-----	-----
20	50	70	18	22.5	18	22	14	18	7	11	-----	88	-----	-----
21	49	66	17	21	16.6	20	12.5	15	6	11.5	65.5	96	-----	-----
22	49.8	66	18	20	16	20	11.2	14.5	4	7.5	65	87	-----	-----
23	47.5	65	16	18	16	18	10.5	12.5	4.5	5	-----	82	-----	-----
24	46	63	15	20	15.2	18	-----	10.5	4	3.5	-----	65	-----	-----
25	44.8	60.5	14.5	16	15	17	-----	9.5	4	3.5	-----	50	-----	-----
26	43.6	59	13.5	15	14	15	-----	8	3.9	2.5	-----	50	-----	-----
27	42.5	57	12	13.5	13.1	14	7	6.5	3	1	45	42	-----	-----
28	40.5	53	7	13	7.5	12	6.9	5.5	3	1	45	35	-----	-----
29	39	49	6.3	12	-----	11	6	3.5	-----	1	38.9	-----	-----	-----
30	-----	46	-----	10.5	-----	10	-----	2.5	-----	.5	-----	27	-----	-----
31	-----	45	-----	10	-----	9	-----	3	-----	3	-----	22.5	-----	-----
32	-----	34	-----	9	-----	8	-----	1.4.5	-----	1.2.5	-----	-----	-----	-----
33	30.5	34	9	7.5	7	11	-----	-----	-----	1	-----	13.5	-----	-----

¹ Estimates

NOTE ON DISEASED CROCODILE VERTEBRAE

PLATE 16

A second crocodile specimen, U.S.N.M. No. 12990, from the Bridger, Eocene, consisting of the greater portion of a skeleton, shows a pathologic condition of two dorsal vertebrae that is almost identical with the lesion described by Moodie⁵ on the caudal vertebrae of a sauropodous dinosaur from the Jurassic.

It is a spongy growth that surrounds the intervertebral articular surfaces extending well outward on the sides of both centra (see

⁵ Moodie, Roy L., Amer. Journ. Sci., vol. 41, pp. 530-531, 1916.

pl. 16). It entirely encircles the centra and has involved two-thirds of the two bones. All evidence of separate structure is practically obliterated. The growth is quite symmetrical on the two sides.

Moodie in the case of the lesion on the dinosaur caudals says: "The enlargement is somewhat suggestive of the lesion of chronic osteomyelitis. It may be a callous growth due possibly to a fracture of the caudal vertebrae; or it may be a bone tumor." Its true nature is, of course, uncertain, but mention is made of this specimen here in order to call it to the attention of students of modern pathology who may be interested in the study of the nature and origin of disease.

Ruffer⁶ has reported typical lesions indicating *spondylitis deformans* in the vertebrae of the Miocene crocodile *Tomistoma dowsoni*, from Egypt. In this specimen the extraneous osseous tissue, obviously pathologic, binds the vertebrae together. The new bone, however, is thicker on one side than on the other, and Moodie⁷ observes that "in the crocodile as in man the disease is more marked on one side." The symmetrical nature of the lesion in the National Museum crocodile shown in plate 16 would therefore rule out *spondylitis deformans* as being responsible for the development of this abnormality.

ON A SPECIMEN OF CORYTHOSAURUS

PLATES 17-19

A partial skeleton of *Corythosaurus* recently added to the exhibition series in the United States National Museum consists of the complete articulated tail, pelvis, hind limbs, and feet, with several small patches of skin impressions and ossified tendons. This specimen is mounted in relief so as to display the right side; the sandstone blocks containing the bones have been assembled in the same relationships they occupied in the ground. The preparation and mounting were done by Norman H. Boss, and it was due to his skillful manipulation that so much of the epidermal impressions were preserved.

The specimen (U.S.N.M. No. 15493) was acquired by purchase from the Royal Paleontological Museum of the University of Toronto for use in connection with the Smithsonian exhibit at the Texas Centennial Exposition at Dallas in 1937. It was collected by Levi Sternberg from the Belly River formation, Upper Cretaceous, 2 miles south of Steeveville, on the Red Deer River, Alberta, Canada, in 1933.

From an exhibition standpoint this specimen is of interest in having several patches of skin impressions preserved. When found the

⁶ Ruffer, Sir Marc Armand, A pathological specimen dating from the Lower Miocene period. In Appendix to Fourtau's "Contribution à l'Étude Vertébrés Miocènes de l'Égypte," pp. 101-109, illus. Survey Department, Ministry of Finance, Cairo, 1920.

⁷ Moodie, R. L., Paleopathology, p. 175, 1923.

skeleton was lying on its left side, but the definition of the skin pattern of that side had been dulled or wholly destroyed by the presence of a considerable amount of vegetal matter on which it lay. The bedding plane beneath the skeleton was unusually irregular, indicating that the cross-bedded planes were laid down by currents acting from different directions.

The caudal series consists of 75 vertebrae and appears to be complete. This information, together with that furnished by Brown,⁸ shows the complete vertebral formula of *Corythosaurus* to be 15 cervicals, 19 dorsals, 8 sacrals, and 75 caudals. It is presumed, however, that as in many other reptiles the caudal series will be subject to some individual variation in number. The first 16 caudal vertebrae have transverse processes as in the type. The first chevron on the tail of *Corythosaurus* is carried between the fifth and sixth caudal vertebrae; thus the total number of caudal vertebrae can be accurately determined and a close estimate of their combined length can be obtained from this specimen which has the first two caudals completely hidden by the overlying ilium and a patch of skin impressions. Measured along the curve this tail has a complete length of about 455 cm. (14 feet 11 inches).

A complete description of the ossified tendons of *Corythosaurus* has already been given by Brown, and thus it is only necessary to mention that the present specimen fully corroborates his determination that they are disposed in two layers.

Small patches of skin impressions are present on the midsection of the tail, on the pelvis, and on the feet. Those pieces of the integument best preserved cover the thirty-first to the thirty-fourth caudal vertebrae, respectively. The detailed mosaic pattern of the flat, polygonal scales is clearly and beautifully shown in plate 18. Originally the whole midsection of the tail beginning with the sixteenth caudal was covered by skin impressions, but most of the center of this patch was so friable that it could not be preserved. The outside portions, however, outline the original width of the tail at this point. The skin on and below the right ilium is composed of scales, slightly larger than those of the midcaudal region, but otherwise they seem to be indistinguishable. The pattern of the scales on the feet is dim and illy defined and adds nothing to our previous knowledge.

In the course of preparing this specimen many small detached pieces of skin were found in the matrix. Several of these were folded and others had been completely reversed. Six species of this genus have been named, all from the Belly River formation of midwestern Canada.

⁸ Brown, Barnum, Bull. Amer. Mus. Nat. Hist., vol. 35, p. 710, 1916.

Listed in chronological order these are: *C. casuarius* Brown,⁹ *C. excavatus* Gilmore,¹⁰ *C. intermedius* Parks,¹¹ *C. bicristatus* Parks,¹² *C. frontalis* Parks,¹² and *C. brevicristatus* Parks.¹²

Five of the six species were established on skull characters alone and are distinguished chiefly by differences found in the shape and extent of the crest. In the absence of the skull in the specimen under consideration it appears quite impossible at this time to make a definite identification of the species. However, on the basis of similarity of skin pattern and close agreement in proportions to the type specimen of *Corythosaurus casuarius*, as shown in table 4, this specimen is provisionally identified as pertaining to that species.

TABLE 4.—Comparative measurements (in cm.) of two specimens of *Corythosaurus casuarius*

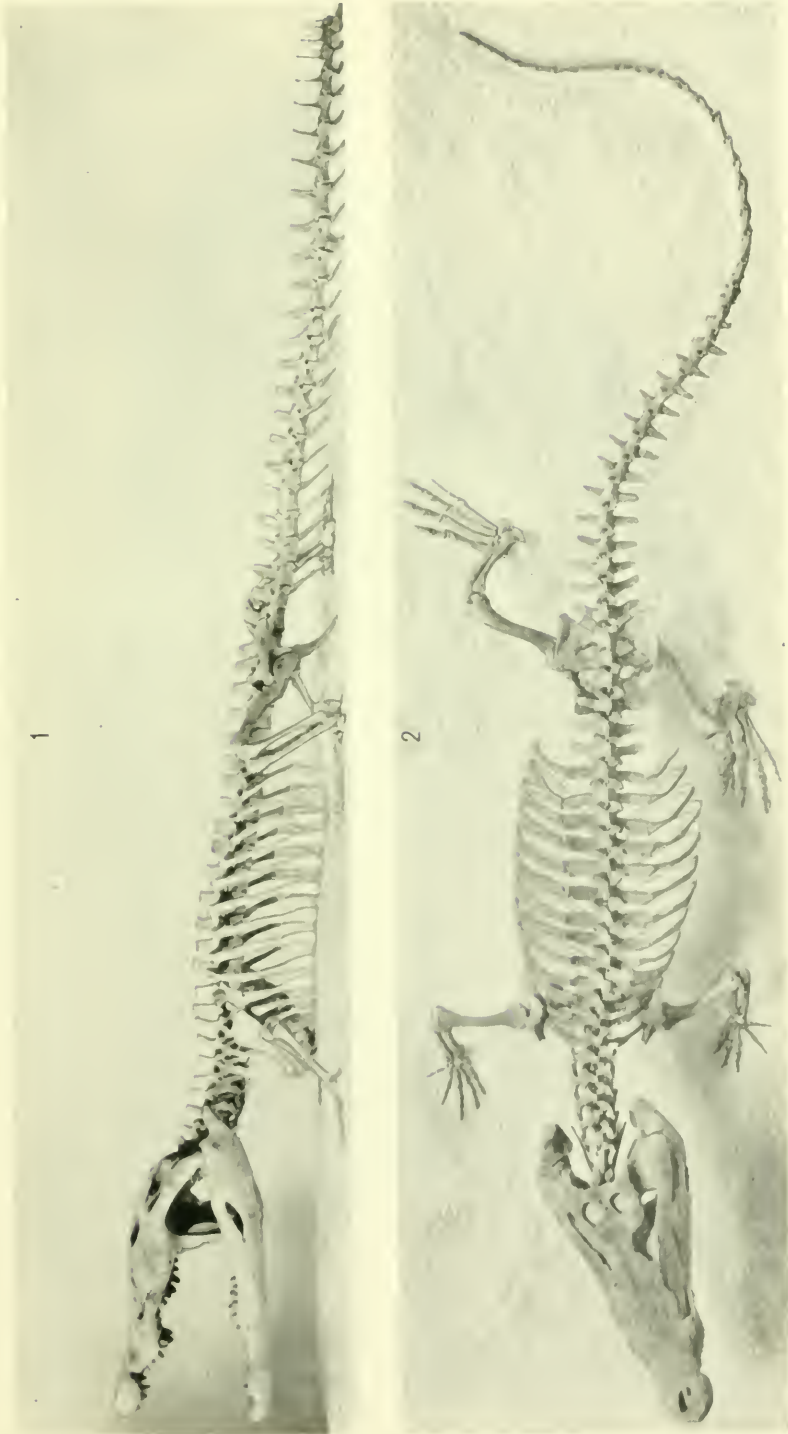
Measurements	U.S.N.M. No. 15493	A.M.N.H. No. 5338, type
Length of longest chevron.....	40	38.5
Ischium, greatest length.....	113.6	103
Ischium, length of terminal foot.....	20	22
Femur, greatest length.....	115.9	108
Femur, position of fourth trochanter from central point to top of femur.....	58.5	58
Tibia, length of tibia and astragalus.....	100.7	100
Fibula, length.....	98.2	95

⁹ Brown, Barnum, Bull. Amer. Mus. Nat. Hist., vol. 33, pp. 559-565, pl. 41, 1914.

¹⁰ Gilmore, C. W., Can. Field-Nat., vol. 37, pp. 46-52, 1923.

¹¹ Parks, W. A., Univ. Toronto Stud., geol. ser., No. 15, pp. 1-57, 13 figs., pls. 1-4, 1923.

¹² Parks, W. A., Univ. Toronto Stud., geol. ser., No. 37, pp. 29-45, pls. 4-8, 1935.



Mounted skeleton of *Crocodilus clavi*, Cope (U.S.N.M. No. 12719); 1, Viewed from the left side; 2, viewed from above. Both figures about one-eleventh natural size.



Skull and lower jaws of *Crocodylus elanus* Cope (U.S.N.M. No. 12719), lateral view. . About one-third natural size.



Skull of *G. elaeis* Cope (U.S.N.M. No. 12719), superior view. About one-third natural size.



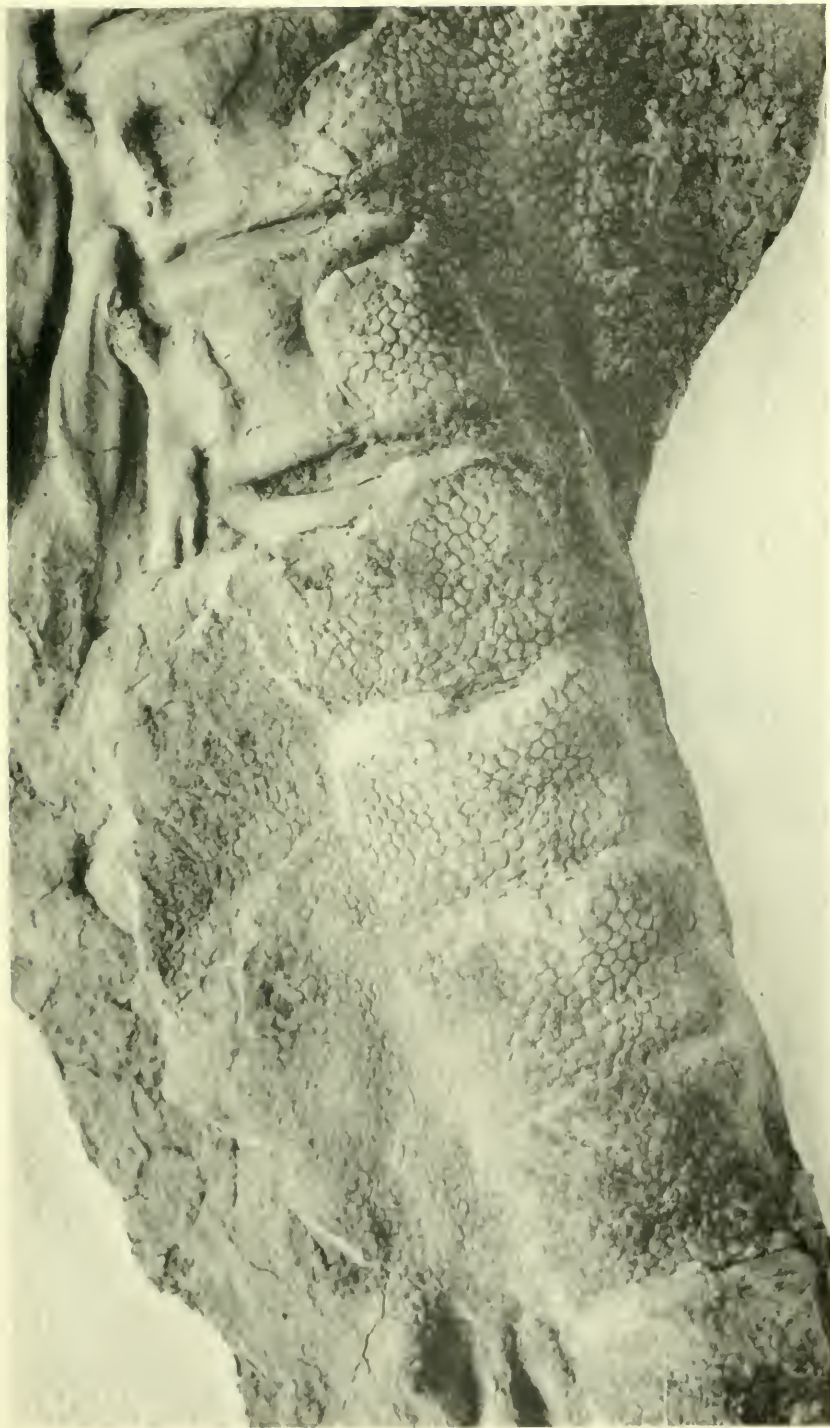
Skull of *Crocodilus clavis* Cope (U.S.N.M. No. 12719), palatal view. About one-third natural size.



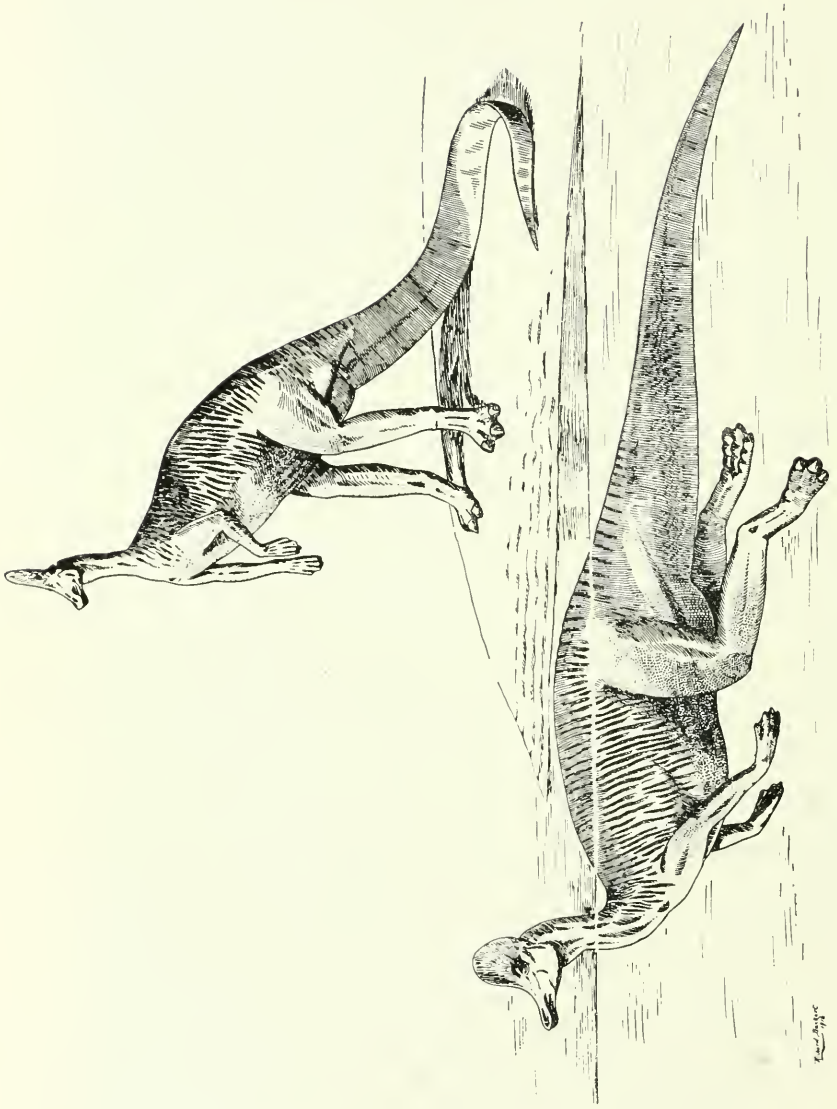
Dissected dorsal vertebrae of *Gracilites* sp. (U.S.N.M. No. 12990): Upper figure, ventral view; lower figure, lateral view. Both natural size.



Tail, pelvis, hind limbs, and feet of *Corythosaurus casuarius* Brown (U.S.N.M. No. 15493), viewed from right side. About one twenty-third natural size.



Skin impressions of *Corythosaurus casarius* Brown (U.S.N.M. No. 15493), from the middle of the tail. These impressions cover caudals 31 to 34, inclusive. About one-half natural size.



Restoration of *Corythosaurus casuarus* Brown. Drawn by Richard Deckert; after Brown.

Richard Deckert