P A L A E O N T O G R A P H I C A

CONTRIBUTIONS TO THE NATURAL HISTORY OF THE PAST

FOUNDED BY

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IN BERLIN

WITH THE COOPERATION OF

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AS REPRESENTATIVES OF THE GERMAN GEOLOGICAL SOCIETY

SUPPLEMENT VII

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SUPPLEMENT I.

C O N T E N T S :

SCIENTIFIC RESULTS OF THE TENDAGURU EXPEDITION 1909-1912

W. JANENSCH: THE COELUROSAURS

AND THEROPODS OF THE TENDAGURU FORMATION, GERMAN EAST AFRICA

(PAGES 1-100 WITH PLATES I-IX AND 32 TEXT-FIGURES)

S T U T T G A R T

S C H W E I Z E R B A R T ' S P U B L I S H I N G H O U S E

(E R W I N N Ä G E L E) G. M. B. H.

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SCIENTIFIC RESULTS
OF THE TENDAGURU EXPEDITION
1909-1912

N E W R E S U L T S

FOUNDED BY

GEOLOGICAL-PALEONTOLOGICAL
INSTITUTE AND MUSEUM OF THE
UNIVERSITY OF BERLIN

THROUGH

W. JANENSCH
IN BERLIN

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THE COELUROSAURS
AND THEROPODS
OF THE TENDAGURU FORMATION
GERMAN EAST AFRICA

BY

W. JANENSCH

WITH PL. I-X AND 32 TEXT-FIGURES

translated by John D. Oldroyd (date unknown)
transferred to computer and emended by Matthew Carrano, August 2000*

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Foreword.

The coelurosaurs and theropods found on the Tendaguru Expedition from 1909-12 come mainly from the area of the Tendaguru, that is, from the main digging area south of the Mbemkuru River. Even if the material is not plentiful at the start, it is nevertheless important in that it furnishes important information about the carnivorous portion of the terrestrial fauna of the Tendaguru Formation, and by rounding out the picture of this fauna provides a basis for comparison with other faunas, particularly that of the Morrison Formation in North America. In a purely paleontological respect, the major accomplishment of this work is the knowledge of the greater part of the skeleton of the new coelurosaur genus *Elaphrosaurus*, as already noted with some other information in an earlier paper by me.

The entire body of prepared material divides itself naturally into three parts: the remains of coelurosaurs, those of the large theropods, and the rich collection of individual teeth of both groups. Just as the many imperfect and unimposing finds and the teeth that are generally considered as of little worth systematically, altogether present a thorough representation, so it is that nothing in the collection was left unused, in order that the most complete knowledge possible could be obtained about the fauna.

With the division into coelurosaurs and theropods I superficially use the assumption of the independence of the coelurosaurs, as W. D. MATTHEW, O. ABEL, and F. BROILI have furthered F. Baron v. HUENE's model. For the large, big-headed, short-necked carnivores I use, as do the first three authors mentioned above, MARSH's old term theropod. I must state, however, that in my opinion the ranking of both groups as suborders is too high a taxon, and in light of the meaningful similarity of the organization I think they are more closely related.

That I received the material of coelurosaurs and theropods to work on, I am indebted to the earlier Director of the Geologic-Paleontologic Institute and Museum of the University of Berlin and organizer of the Tendaguru Expedition, Mr. Geh. Rat Prof. Dr. W. v. BRANCA. To the present Director of this Institute and Museum, Mr. Geh. Rat Prof. Dr. J. F. POMPECKJ, am I obliged to give the largest thanks for valuable promotion of these papers, in particular for the fact that he generously provided the means from the Preussischen Akademie der Wissenschaften for preparing the illustrations. My friend, Mr. Prof. Dr. Baron v. HUENE supported me by providing a not yet published work and his rich collection of drawings for perusal, for which I heartily thank him. I thank Mr. Dr. EBERT for allowing Mr. V. W. KRÜGER, teacher of art anatomy, to do almost all of the illustration in this work; the teeth were photographed carefully by Mr. Kartograph TÖBBICKE.

W. Janensch.

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Coelurosaurs.

Elaphrosaurus bambergi Janensch.

The finding of this species has already been noted in my earlier paper (1920). The material, except for a dorsal vertebra and a manual phalanx from the *Dysalotosaurus*-quarry, is limited to those parts of a skeleton that were found in the Middle Saurian Bed north of T e n d a g u r u at K i n d o p e at the very productive quarry (dd) in association with material from the sauropod genera *Dicraeosaurus*, *Brachiosaurus, Gigantosaurus*, and *Barosaurus*(?) (=*Gigantosaurus africanus* E. FRAAS). Sixteen individual presacral vertebrae, the sacrum with a wide, fused presacral vertebra, 18 isolated caudal vertebra, 2 incomplete ribs, a haemapophysis, the right humerus, a questionable first and fourth metacarpal, the ilium and ischium, an isolated pubis, from the left hind limb the femur, tibia, fibula, astragalus, three metatarsals, two phalanges of the second and one of the fourth toe. That these separated bones belong to the same skeleton does not appear to me to be the least bit doubtful.

The state of preservation merits a short discussion. Most of the bones of quarry dd were covered with a layer of thick, light (in color) sometimes secondary* chalk. The fine ridges (carinae) and projections that poke through the chalk covering, and therefore not protected by the chalk, are usually both preserved. The thin, fine laminae and ridges, as also the delicate edges of the processes of the vertebra and especially the cervical vertebrae are for the most part destroyed; the ends of the transverse processes and the zygapophyses are generally broken off and missing. In addition, most of the remaining various processes are often more or less bent or projecting in the wrong direction as a result of pressure. The bones are also highly fractured and the spaces are filled with secondary chalk-spar; but the form of most of the bones is only slightly, if at all, altered. The imperfections and changes of form had to always be kept in mind in order to prevent error. That the descriptive parts are therefore somewhat longer than may be desirable is regrettably unavoidable.

Skeleton from Quarry dd.

P r e s a c r a l V e r t e b r a e .

The 14 individual presacral vertebra are designated by consecutive letters in the following description; the given position is the one assumed by me.

a) Third Presacral Vertebra.

Pl. II, Fig. 1.

The centrum is strongly compressed laterally through deep pockets behind the anterior end and in the posterior half by extensive pleurocentral grooves (directed above and behind) that are not bounded by sharp edges; and compressed to such a degree that only a thin, median wall of bone remains. The ventral surface of the centrum widens quickly toward the front to the parapophyses, and then, before the middle, becomes very narrow and then widens again; in the posterior half it is imperfectly preserved and therefore unclear. The ventral outline makes a flat ascending arch, from

* "spätigen" = late, so it probably means secondary. – JDO.

a lateral view, whose highest point lies before the middle, and passes posteriorly to a concave, but very flat bow. The end surface of the centrum, whose edges are generally imperfectly preserved, slant posteriorly down as compared to the long axis; the anterior end is low and broad, about 13 mm high and 23 mm across, the posterior about 18 mm across and the same height. Both ends are strongly concave. The prezygapophyses are broken off. The postzygapophyses are two flat projections whose ends are not completely presented and are strongly divergent posteriorly and are inclined upward somewhat under 45 degrees. A corner (or edge) proceeds anteriorly from the top edge of the postzygapophyses to about the middle of the vertebra. A second edge (or corner, brim, etc.) runs more deeply on the outside of the postzygapophyses toward the front and meets the posterior border of the diapophysis. Lastly there is a broad, triangular, laterally slanting process with a thin anterior border and likewise reaches to about the middle of the vertebra. All free projecting parts are lacking on the cervical rib that is fused to the vertebra. In the place of the spinous process there is a low, narrow ridge. Below it there is a 4-5 mm high and wide concavity. The neural canal has a circular lumen 12-13 mm in diameter. Because the vertebra has a concave end surface, well-developed di- and parapophyses which are fused to the cervical rib, and, as the remaining material shows, strong prezygapophyses, it cannot be the "epistropheus". The shortness of the vertebra in comparison to the length of the rest of the cervical vertebrae makes it very probably the third one. If one were to assign it as the fourth, then the third would need to be even shorter and the length would become impracticably small.

b) Fourth Presacral Vertebra.

Pl. II, Fig. 2.

The vertebra has a more elongated shape than the previous one. The anterior end of the centrum was not directly connected with the rest of the vertebra and was fitted to it with a 1 cm bridge of plaster-of-Paris. The length of the centrum, the position of the anterior end, and also the anterior section of the ventral outline are therefore approximated. The anterior end surface is broadly elliptical, the posterior, whose edges are now well preserved, is subquadrate; both are markedly concave, the posterior more deeply that the anterior. The ventral surface of the centrum is bordered on the side by sharp edges[*] and is a little bit depressed along the midline. In the middle and slightly anterior to it, the ventral surface has a width of 1 cm but broadens to 2 cm in the posterior third. The ventral outline is a convex arch in the posterior half and changes to a concave arch in the middle. The extensive pleurocentral grooves of the posterior half are quite deep and have only a very thin wall of bone between themselves. The neural arch is roof (or dome) shaped, very low and has a very thin, imperfectly preserved longitudinal keel. The right prezygapophysis is the only one preserved and is compressed strongly to the side. It is quite high posteriorly but becomes equally low anteriorly. On top there is a narrow, about 7 mm wide surface whose anterior, marginally projecting part looks like an articulating surface in the longitudinal direction. The postzygapophyses, whose ends are poorly preserved, form a uniform, flat in the middle surface. A short, anteriorly projecting branch of the right cervical rib, which is apparently fused to the centrum, is preserved. The neural canal is 16 mm across posteriorly and 10 mm high.

c) Fifth Presacral Vertebra.[*]

Pl. II, Fig. 3 Text-fig. 1.

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[*] "scharfkantig" = sharply cornered. – JDO.

[*] In the context of vertebrae, lateral = side, not lateral as opposed to medial. Janensch uses the word "side", but sidely or sidewise do not sound good in English, so I translated it as laterally, etc. – JDO.

The anterior half of the centrum is 120 mm long and has fully lost its form through disintegration and crushing. As far as the centrum is well preserved, it is like the above described vertebra, only just a little stronger and the top margin of the pleurocentral depression is somewhat sharper. The posterior end surface, whose margins (or edges) are not distinctly preserved, measures 26 mm in every direction. The vertebra is important because the extensively (or bulkily, voluminously, etc.) developed diapophysis on the left is preserved back to its posterior margin, even if it probably is distorted. It has the form of a laterally rather broadly projecting wing, that triangularly narrows itself anteriorly and laterally to the connection with the cervical rib, with its posterior end on the neural arch behind the middle and almost as high as the top wall of the neural canal. A branch of the cervical rib juts out towards the anterior for a length of about 18 mm and is apparently completely preserved; it is bent inward towards the anterior. An approximately 25 mm long, thin bar, that is directed steeply up is the broken posterior branch, or at least a part of it. The crest of the top arch is about 55 mm long. The postzygapophyses show a transition from the top flat form of the previous vertebra to the steep, narrow cross-cut of the following vertebra.

d) Sixth Presacral Vertebra.

Pl. II, Fig. 4.

This rather complete vertebra can be more thoroughly described. The centrum is somewhat stronger than in vertebra b. The ventral outline climbs rapidly into a widely spanned, open to the bottom (concave?) arch and bends tack about in the middle into a flat, closed to the bottom (convex?) arch; its highest place lies just in front of the middle. The deeply concave anterior end surface is notably larger than on vertebra b and of relatively higher circumference, the posterior end surface is more flatly concave; its ventral section bends somewhat to the posterior. The edges of the end surface, when viewed from the side, show a weak divergence toward the bottom. The posterior pleurocentral grooves differ from those of vertebra c in that the top margin bends down to the posterior and therefore has the form of a sharp, overhanging ridge (or ledge, carina, etc.). Close behind the anterior end, immediately over the ventral surface on this side surfaces of the centrum, lie deep, elongate-oval pleurocentral grooves about 25 mm long, that are bordered above and below by sharp edges. The underside of the centrum represents a narrow field of about 12 mm width against its flanks, that widens quickly toward the anterior, and here and in the posterior part is a weakly trench-shaped depression, but is even in the middle. The upper arch forms an elongated, steeply rising, low roof (or dome), under which a hollow (depression, concavity, etc.) leads anteriorly and posteriorly. The hollow (or depression, concavity, etc.) is separated from the neural canal by a strong wall. A tacked-on, narrow, spinal ridge whose incompletely preserved length is about 40 mm, apparently was not very high. The prezygapophyses extend considerably beyond the anterior end; in cross-section they are an angular, uneven-sided triangle, whose short small side lies diagonally on the top inward side. The entire length cannot be given. The poorly preserved postzygapophyses are – as opposed to those of the previous vertebra – divided by a deep cleft with perpendicular (or vertical) walls. The left diapophysis wing shows that the anterior margin, rising steeply to the prezygapophysis, is preserved, whereas the posterior one is missing. Behind the middle of the vertebra it branches and sends a segment slanting up to the postzygapophysis and one straight posteriorly. The strong parapophysis is bent slightly down. The cervical ribs are firmly fused and form, together with the diapophysis and parapophysis, a very wide foramen. The neural canal has a cross-section of about 11 mm width and 9 mm height.

e) Seventh Presacral Vertebra.

Pl. II, Fig. 5; Text-fig. 2a, b.

It is thoroughly similar to the previous cervical vertebra, only somewhat wider and taller, that is, more robust. The highest place of the ventral outline lies just a little bit posterior, a little before the middle. The perfectly preserved right edge of the ventral surface shows a conspicuous swollen thickening of about 2 cm anterior to the posterior end. Of the anterior lateral grooves, the left has a rounded top margin and the right has a sharp one. The base of the broken spinal crest is 50 mm long, The apparently perfectly preserved right postzygapophysis projects about 11 mm above the top edge of the posterior end surface. It is formed by a wall of bone that climbs about 23 mm diagonally across the basal surface of the neural canal and then bends 90 degrees to the outside. The left cervical rib shows an anteriorly projecting point that is partially preserved.

f) Ninth Presacral Vertebra.

Pl. II, Fig. 6.

The vertebra is the same type as the previous ones, but more robust. The differences from vertebra e are as follows: the underside of the centrum runs in a uniformly strongly arched line; the convexity in the posterior half of this line, as is present in the previous vertebrae, is not there any more. The posterior pleurocentral hollows (or cavities, sockets, etc.) in this vertebra centrum are flatter and lack the sharp edges on the top border; the same goes for the anterior left depression (or concavity, socket, hollow etc,), but the right one is deeply depressed. The posterior end surface is a little bit flatter. The base of the spinal ridge is only 33 mm long; because the contours of pre- and postzygapophyses ascend to it, it is assumed that the spinal ridge was somewhat higher than on the previously described vertebra. The almost completely preserved postzygapophyses reach 21 mm (left) above the top margin of the posterior centrum edge. The cervical rib is also fused to this vertebra; its almost completely preserved anterior branch is free for about 1 cm.

g) Tenth Presacral Vertebra.

Pl. II, Fig. 7.

This vertebra differs strongly from the previous cervical vertebrae and already shows the transition to the dorsal vertebrae. The entire shape is somewhat shorter. The cross-sectional form of the centrum is no longer positively identifiable because of mechanical compaction. The anterior end surface is strongly concave and is more circular, although still a low ellipse, that is billowed on the bottom of the sides because of the depressed parapophyses; the posterior end surface is a little more flatly concave, of rather circular shape but broadened a little bit dorsally. In the side views the edges of the end surfaces show a weak divergence toward the bottom; the posterior margin is nevertheless bent forward somewhat toward the bottom, A contrasting, narrow ventral surface of the centrum is distinct only anteriorly and posteriorly; posteriorly it is flat, with a rounded corner that passes into the side of the centrum; in the middle, however, the centrum exhibits a ventral, longitudinal edge (or corner). The posterior pleurocentral depressions (or concavities, hollows, sockets, etc.) are gone, the anterior ones are still hinted at. On the top, the top arch has a projecting spinous process only 15 mm long along the midline, whose height is not preserved, but probably was not much. The postzygapophyses are heavy, semicircular in cross-section, and concave to the outside projection that jut out strongly upward. The prezygapophyses are broken off. The outermost section of the right diapophysis is missing; that part is present on the left one but is cracked towards the bottom and pushed to the front. The entire diapophysis has a three-sided, wing-shaped form and continues out in an approximately 15 mm wide facet[*]; it is somewhat bent toward the horizontal surface and on the top side, under the spinal process is sunken in; it could have extended 6 cm on each side. Under the right diapophysis are two supports (braces, struts, etc.) that converge toward the middle and enclose three pockets between themselves and the wall of the neural arch. The facets for the capitulum are sunk in quite far down on the side of the anterior end of the centrum. The ribs, therefore, were not fused.

h) Eleventh Presacral Vertebra.

Pl. II, Fig. 8; Text-fig. 3a, b.

This vertebra shows a further substantial shortening as compared to the previous one. A bottom longitudinal surface is no longer developed on the centrum, instead there is anteriorly a large keel that projects downward. The end surfaces diverge somewhat toward the bottom; both are more flatly concave than on the previous vertebrae. The posterior is circular, the anterior is a little lower. Pleurocentral depressions (or concavities, sockets, etc.) are neither anteriorly nor posteriorly present. The postzygapophyses are somewhat heavier than on vertebra g and extend somewhat higher. The right diapophysis on the side of the top arch is preserved all the way to the lateral margin; it juts out with moderate inclination, probably increased by pressure, about 60 mm from the median plane of the vertebra and has a tubercular facet of about 20 mm width; it is supported by two thin supports (or braces, struts, etc.) that are under 20 degrees toward the horizontal and come together near the top; the front support is weaker and the rear is stronger. The spinal process that is retained is 17 mm long and projects only a little bit above the postzygapophyses. It reaches a height of about 46 mm above the base of the neural canal. The facets for the capitulum are well sunk in and sit a little below the middle of the end surfaces of the centrum.

i) Twelfth Presacral Vertebra.

Pl. II, Fig. 9.

The vertebra differs from h in that the anterior ventral keel is lacking. The end surfaces are becoming more similarly constructed and the anterior ones are more deeply concave, but that is at least partially a consequence of the preservation. The narrow, weakly arched, concave parapophyseal facets sit somewhat higher on the edge of the anterior end surface, with its middle of the same height as the base of the neural canal; they are carried by strong platforms as far as they reach beyond the top margin of the end surfaces; the platforms rise upward in the rear. Immediately behind them is a round depression. The diapophyses are known only from their bases and were directed upward; their posterior support is steeper and makes a 45 degree angle with the horizontal, whereas the much weaker anterior one also makes less of an angle. The spinous process is broken off but, to judge from its basal cross-section, was considerably longer in the anteroposterior direction than in vertebra h.

k) Thirteenth Presacral Vertebra.

Pl. II, Fig. 10, Text-fig. 4.

The centrum is noteworthy in that the very concave end surfaces converge strongly toward the bottom. Faint grooves extend from the margins of the end surfaces for about 2 cm, toward the sides and the bottom. This vertebra differs from i in that the anterior end of the centrum is as round as the posterior, that the platform-like parapophysis is slanted upward more, and that its facet sits

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[*] Original German is "Fazette"; the dictionary does not have this word, but it may be another spelling for "Facette", which means facet – JDO.

higher than the base of the neural canal. The diapophyses have only one large support and its angle with the horizontal is less than 60 degrees. The postzygapophyses are somewhat weaker than on i and considerably weaker than on h; they consist of flat grooves that are a little more flatly arched and extend longer toward the back; they are just a little higher than the top edge of the posterior end of the centrum. Behind the prezygapophyses is an indentation on both sides. The completely preserved spinous process, however, is longer than on i; its two-edged anterior edge rises almost vertically, the posterior slopes gradually to the rear; its top horizontal contour is about 30 mm long. The spinous process is about 57 mm tall above the base of the neural canal.

l) Fourteenth Presacral Vertebra.

Pl. II, Fig. 11, Text-fig. 3.

The moderately strongly concave ends of the centrum converge a little on the bottom. The parapophysis of this vertebra is a rather extensive (or bulky, voluminous) platform (or plate) that extends to the diapophysis and has a round, deep indentation anteriorly. The facet sits higher and farther out laterally and is more button-shaped.(or knob-shaped) than on vertebra k. The postzygapophyses are fused together all the way to the end and sit somewhat deeper. The spinous process is again longer and the top is about 28 mm higher than the base of the diapophyses and about 31 mm higher than the base of the neural canal; its dorsal edge rises a little in the back. The length of the spinous process is about 4 cm in the anteroposterior direction and is therefore larger than in vertebra k. On its posterior edge is a flat furrow, on its anterior edge is a deep cleft (or slit, crack, etc.). The neural canal approaches being circular in cross-section, with a diameter of 13 mm anteriorly and 11 mm posteriorly.

m) Fifteenth Presacral Vertebra.

Pl. II, Fig. 12, Text-fig. 6.

This vertebra is compressed very little and diminishes in the middle to a cylinder with a diameter of about 19 mm. The weak end surfaces converge at the bottom and are more extensive than on l. The preserved portion of the prezygapophyses are two horizontally flattened projections that extend about half a cm above (or beyond) the anterior end of the centrum. Postzygapophyses are missing, the spinous process is incomplete. The vertebra differs from the previous one by the parapophysis, which is a thin platform (or plate) and projects back and to the side more; its facet sits higher, exactly below that of the anterior, wing-like broadening of the diapophysis. The left parapophysis is the only one preserved and also has a peculiar horizontal lamella that rises weakly upward and backward to unite with the diapophysis, and in connection with it closes off a small pocket. The previous vertebra lacks this lower lamella. The support of the diapophysis is placed further back.

The cross-section (Text-fig. 6), gained from a break in about the middle of the vertebra, shows the light construction that is especially expressed in the hollow space of the centrum. The same hollow space is also shown in the anterior caudal vertebrae.

n) Nineteenth Presacral Vertebra.

Pl. II, Fig. 13.

The anterior end of the centrum is crushed; the poorly preserved anterior end is pushed against the neural arch, the middle part is destroyed. It appears that both end surfaces are flatly concave. The wide, wing-like diapophyses have a triangular outline, as can be determined on the better preserved right diapophysis, whose posterior side extends out laterally perpendicular to the long axis. It is difficult to determine if this position of the diapophysis is natural or if it is a result of pressure. A large support leads to the tubercular facet, a short, thicker one behind the prezygapophysis leads to the capitular. The postzygapophyses form two fused grooves. The spinous process is pushed out of the middle position a little and has a rectangular profile, a free height of about 32 mm, a length along the dorsal margin of 59 mm; anterior and posterior margins are split. In spite of its imperfectly preserved condition, a comparison of the vertebra with m and l shows that it differs considerably in the longer length of the neural arch and spinous process.

o) Twentieth Presacral Vertebra.

Pl. II, Fig. 14.

The vertebra is almost completely preserved. The body is quits constricted in its middle part, but apparently by deformation of great magnitude. The anterior end surface is circular, very concave, the posterior is broadened through pressure. The well preserved, horizontal, extensive, ring-shaped transverse process goes: along the entire length of the top arch from the prezygapophyses to the postzygapophyses and, when viewed from above, form a right-angle triangle, whose right angle lies in the back on the inside. The outside margins are almost completely preserved on the right. The tubercular facet lies on the outermost point, a little behind the middle of the vertebra about 7 cm from the median plane; on the bottom of the wing a strongly-built support runs out to the tip. About 2 cm behind the plane of the anterior end surface and not quite 4 cm from the median plane on the edge of the diapophysis wing is the capitular facet, that is supported by a weaker support. The prezygapophyses are imperfectly preserved as rather weak projections that reach about 1/2 cm beyond the anterior end of the surface. The postzygapophyses are two very close to each other, very concave trenches (or grooves), that rise weakly to the rear and reach 14 mm past the centrum. The spinous process climbs straight to the front, to the posterior is a concave arch, so that the dorsal margin extends to the rear. The length of its dorsal edge is 68 mm, the shortest length where it is about half the height of the free part is 60 mm; it reaches 70 mm above the base of the neural canal in the rear. Anterior and posterior margins show a definite trench (or groove). The anterior end of the neural canal has an almost circular lumen of about 12 mm diameter. The vertebra differs from n by having a longer and higher spinous process.

p) Twenty-first Presacral Vertebra.

Pl. II, Fig. 15.

Just like vertebra o, but built somewhat taller. The centrum, as opposed to the top arch, is pushed a little to the side. The end surfaces of the centrum are markedly concave, the anterior more so than the posterior. The posterior half of the left diapophysis wing is pressed away from the top arch and pushed toward the spinous process. The exact form of the outline of the wings is not preserved. The facet of the diapophysis is button (or knob)-shaped, of about three-sided shape, that of the parapophysis is semicircular, concavely depressed. The prezygapophyses have a narrow, dorsal facet. The spinous process is arch-like on both anterior and posterior contours; it extends about 79 mm beyond the base of the neural canal, has a length of about 79 mm along the dorsal edge, and a shortest length of 60 mm. The difference between this one and vertebra o is namely in the greater height and length of the spinous process and in the more posterior placement of the tubercular facet and their supports.

q) Twenty-second Presacral Vertebra.

Pl. II, Fig. 16.

The undeformed centrum is somewhat shorter than the previous vertebra, it shows a large growth on the ventral side and on the flanks in the posterior half of the centrum in front of it, in the axial part under a shallow longitudinal indentation it has a round cross-section. The posterior end surface is more weakly concave than the anterior; both converge on the bottom. The lateral wings and the spinous process are mostly broken off. The wings were probably horizontal. The parapophysis extends about 43 mm laterally from the median plane, further than on o and p; its round facet is very arched. The base of the spinous process is all of that part that is preserved and it is a little shorter than on the previous vertebrae.

Dimensions of the Presacral Vertebrae.

Desig-nation	Assumed position	Length of centrum		Anterior end face of centrum		Posterior end face of centrum		Distance of the ends from the pre- and post-zygapophyses	Overall height Height of the highest point of the spinous process over the line connecting the upper edges of the two end faces
		upper	lower	breadth	height	breadth	height		
a	3	77 (?)	77 (?)	21?	13 (?)	19?	20 (?)	75 + [84]	37 (?)
b	4	[114]	[108]	25	16	22	24 (+)	127 (+) [133]	[49]
c	5	120?	—	—	—	26 (+)	26	120 +	—
d	6	119	121	30	24	29 +	26	121 +	47 (+)
e	7	115	119	31	28	32	31	124 +	54 (+) [59]
f	9	112	112	42	35	43	41	141	70 + [80]
g	10	99	98 (?)	521	42[1]	48	42	96 +	74 + [83]
h	11	82	84	521	39	47	41	93 (+) [96]	87[3]
i	12	85 (?)	81	591	40	40 +	40	79 +	80 +
k	13	83	76	43	37	42	39	95 (+) [99]	91
l	14	84	79	38	39	46	40	95 (+) [100]	92
m	15	88	82	46	43	49?	44?	82 +	79 +
n	19	—	—	—	—	—	—	110 + [117]	—
o	20	108 (?)	94 (?)	61	57	80 —	57?	130	124
p	21	103	95	62	53	65?	57 (?)	132	133
q	22	96	89	62	32	61	54[2]	125[2]	98 +

[1] Amount increased by projections of the parapophyses.
[2] Not measured along the rampant growths at the centrum.
[3] Not measured along the anterior ventral median keel.

Assertion of the characters.
(Also valid for subsequent tables of dimensions).

?	Amount uncertain.
(?)	Amount in small measure uncertain.
+	Amount too small because of incomplete preservation or because of deformation.
(+)	Amount around slightly too small because of incomplete preservation or deformation.
—	Amount too large because of deformation.
(—)	Amount around slightly too large because of deformation
[ ]	Estimated complete measure.

Number of Presacral Vertebrae.

It is not possible to definitely determine the original number of presacral vertebrae from the morphologic characters of those available. OSBORN (1917, p. 735) estimates that *Struthiomimus* has 23 presacral and 5 sacral vertebrae. He also estimates the same number of presacrals for *Ornitholestes*, but only 4 sacrals. In *Compsognathus* there are 22 presacrals. On the mold (or cast) there is such a large space between the 22nd and the acetabulum that at least 3 vertebrae could fit in there. Of the latter, the first might be the first sacral vertebra, but could just as well be a dorsosacral; at any rate there are only two genuine sacral vertebrae in front of the acetabulum in *Elaphrosaurus*. In the more distant *Allosaurus* (*Antrodemus*) and *Tyrannosaurus* there are 23 presacral vertebrae and 5 sacrals, in *Plateosaurus*, according to JAEKEL (1914, p. 177), there are 23 presacrals and usually 3 sacrals, in *Anchisaurus solus* (v. HUENE, 1907-08, p. 273, 274) there 9 cervical and 14 dorsal, that is 23 presacrals and 3 sacrals. The number of 23 presacral vertebrae is, therefore, not proven for *Struthiomimus* which is the most important for comparison, but is shown on more distantly related forms. If I accept this number for *Elaphrosaurus*, including the dorsosacrals, it would probably not be off more than plus or minus one. Because 17 presacral vertebrae were found, the first 2 and 4 others had to be added. An apparent space existed between vertebrae m and n. The differences between the two vertebrae are so obvious just in terms of size that several vertebrae were probably between them. A more accurate estimation of the exact number is not possible because vertebra n is so poorly preserved. When comparing o with m it appears that the difference is so great that 4 vertebrae would fit between them, therefore 3 would most probably fit between m and n. Another vertebra could be inserted between e and f to account for the difference in size of the end surfaces. In respect to length, the difference between a and b is also significant. In spite of that, however, I do not believe there is one missing between a and b because there is also a considerable size difference between the 3rd and 4th vertebrae of *Struthiomimus*.

To decide the boundary between the cervical and dorsal vertebrae, it must be decided whether g is the first dorsal or last cervical vertebra. It has free ribs like the dorsal vertebrae, the spinous process is also more similar to the dorsal ribs; the high postzygapophyses and diapophyses are also similar to the following dorsal vertebra. The form of the centrum could be designated as transitional between cervical and dorsal vertebrae. In keeping with these characters, vertebra g would most likely be the first dorsal vertebra. In length, the vertebra is between the long middle and posterior vertebrae of the throat and the anterior vertebrae of the trunk. In *Struthiomimus* the best comparison, OSBORN (1917, pl. 24) shows the total length of the last cervical vertebra as being shorter than the preceding cervical vertebra but markedly longer than the first dorsal vertebra, or in other words, the same relationship as vertebra e in *Elaphrosaurus*. Because the accompanying ribs for g are missing, it appears better to not make a definite statement and just say that g is a transitional vertebra, which is true in either case.

Summary statement of the changes of the important characteristics within the presacral vertebrae.

The progressive changes in dimensions and in single morphologic characters of the presacral vertebrae are very clear. The length jumps from the third to the fourth and then stays about the same to the transition vertebra, the tenth. The latter leads the way to the considerably shorter, anterior dorsal vertebrae. An enlargement takes place again in the middle of the dorsal vertebrae, followed by another shortening in the last two. The size of the end surfaces generally becomes increasingly larger in the presacral vertebrae, but it is important to note that they increase rapidly in the cervical vertebrae and then remain the same size or become partially smaller in the anterior dorsal vertebrae. A definite fluctuation in the measurements is a product of the difference in preservation of the margins that are necessary for measuring, and also of the changes caused by the types of preservation. The centra are all distinctively biconcave, but the posterior end surface of the next to last and the anterior surface of the last two dorsosacral vertebrae are only weakly concave; there is the possibility, however, that this is due to the growth by both of these two end surfaces and that as a result the mobility against each other was either accelerated or decreased. The edges of the end surfaces show a weak divergence in the middle and posterior cervical vertebrae and also in the anterior dorsal vertebrae, but in the rest of the dorsal vertebrae they converge toward the bottom. It could be concluded that the vertebral column forms an arch that is open to the top (or concave upward) from the middle of the throat to the start of the trunk and in the trunk is closed to the top (or convex upwards). If the form of the third cervical vertebra is still the original form, then there is a convergence of the end surfaces on it, which means that the anterior part of the neck would also be convex upward (or an arch closed at the top). The bottom of the contour of the centrum describes a line at the third cervical vertebra, that is a high arch, open to the bottom, and posteriorly is a flat, oppositely flexed arch. The cervical vertebrae progressively lose the posterior bending until it disappears in the transitional vertebra. In this and all following presacral vertebrae the bottom shape is a single arch that is open to the bottom (or concave downward). The volume of the vertebral centrum is decreased to a thin wall in the back by the pleurocentral grooves, which causes a sharper modeling of the top margin to the seventh vertebra; on the ninth this top edge is less sharp and the groove is shallower, and on the transitional vertebra the latter is very weak and then disappears on the dorsal vertebrae.

The spinous process forms a low, elongated crest on the cervical vertebrae, but by the ninth it is considerably shorter, on the transitional vertebra and the next one it is very short – in the anteroposterior direction – but then becomes taller and longer to the next to last presacral vertebra. The prezygapophyses of the neck are poorly preserved, as are those of the trunk, but as far they are recognizable, they seem to be quite similar. The postzygapophyses of the neck are short, platform-like processes that protrude laterally from a middle, even surface; they assume a rectangular cross-section in the middle of the neck and enclose a deep, steep-walled, median depression; they rise ever higher above the top of the centrum until the transitional vertebra, where they become straighter and fused together further back. In the neck region the wing-like diapophyses are almost all poorly preserved and fused to the ribs, but aside from the size differences, they are quite similar. The diapophysis on the transitional vertebra is quite like those of the dorsal vertebrae and projects laterally and a little downward, but on the next vertebra it projects out and a little up and then becomes almost horizontal on the rest of the dorsal vertebrae. The double support of the diapophysis on the transitional vertebra become united by the fusing of the two branches and the disappearance of the anterior by the thirteenth vertebra, and changes from an anteriorly directed position to a perpendicular one. The bowl-shaped parapophysis extends from the edge of the anterior end surface of the centrum increasingly more upwards from the transitional vertebra on; on the thirteenth vertebra it is already as high as the base of the neural canal, then becomes more laterally and posteriorly upward with a peculiar anterior support, and on the 15th vertebra lies directly under the wing of the diapophysis. On the posterior dorsal vertebrae the parapophysis sticks out further laterally, and on the dorsosacral vertebrae comes very close to the facet of the diapophyses; at the same time, it develops a knob-shaped (or button-shaped) facet on the next to last vertebra.

Comparison of the presacral vertebrae.

For a comparison of our African species the first to be considered must be the North American *Coelurus*. The number of illustrated skeletal elements that MARSH gives is small. Nevertheless, it can be determined from them and MARSH's descriptions that they differ considerably. *Coelurus* is markedly smaller; the vertebrae of all sections have a very weakly arched, almost straight ventral profile. Also important is the fact that MARSH describes the first 3 cervical vertebrae behind the axis as being opisthocoelous, whereas all the others are biconcave. But there are also obvious differences in the shape of the vertebrae. The cervical vertebrae lack the pleurocentral grooves, the top arch does not have the steeply roof-shaped (or dome-shaped) cross-section or the deep indentations anterior and posterior, instead they have a barrel-shaped arch with a longitudinal keel, without indentation; the transverse processes of the dorsal vertebrae are not strengthened by supports. The caudal vertebra pictured by MARSH (1896, pl. 7, fig. 4) has a very elongated form with normal, short prezygapophyses, whereas those of *Elaphrosaurus* with similarly elongated shapes have very long prezygapophyses. GILMORE (1920, p, 128) considers *Coelurus* congeneric with OSBORN's (1903, 1917) briefly described *Ornitholestes hermanni*, and MATTHEW (1922, p, 371) also considers them as very closely related. OSBORN's general views offer very uncertain comparison possibilities with respect to the vertebrae. On the other hand, OSBORN's (1903, p. 460) description of the cervical vertebrae as opisthocoelous is very different from *Elaphrosaurus*. OSBORN's (1917) general views are also the only ones available for comparison, and the cervical vertebrae of *Struthiomimus altus*, from which it can be concluded that they are considerably shortened in the American genus, and also especially so in the dorsal vertebrae. The posterior dorsal vertebrae pictured by LAMBE (1902, pl. 4, fig. 1) have relatively shorter centra than the posterior dorsal vertebrae of *Elaphrosaurus*, also have taller spinous processes. The cervical vertebrae illustrated by SEELEY (1888, p. 79, fig. 1-5) as *Thecospondylus daviesi* from the Wealden of the Isle of Wight have a smaller form that deviates greatly from *Elaphrosaurus*. The vertebra is known only from the anterior half and has a flat or very slightly concave anterior articulating surface, the upper arch is built much taller and very close to the anterior end; instead of an anterior, broad indentation there is only a narrow foramen; the ventral surface of the centrum is much broader, the centrum is not nearly so restricted (or thinned, narrowed) in the middle, the entire vertebra is more moderately built. SEELEY's reconstruction attempt shows a completely differing diapophysis that rises steeply, right from the prezygapophysis. That *Elaphrosaurus* differs generically from the Wealden dinosaur is as definite as the difference from the already-mentioned North American forms.

Sacrum.

Pl. III, Fig, 1a, b, c; Text-fig. 8.

Both ilia and both pubes are fused to the complete sacrum. The anteriormost part of the sacrum was pushed a little to the side as a result of a break through the first sacral vertebra. After preparation, the entire sacral vertebral column was just about correctly positioned. There are 6 vertebrae that are completely fused together and form a rather strongly, dorsally convexly arched rod. The anteriormost of these vertebrae can be considered as a dorsosacral because of its characters; the other five are sacral. vertebrae. The place of fusion between the centra of the dorsosacral and first sacral vertebrae approaches the size of the anterior end of the first. All following places of fusion of two sacral vertebrae have significantly smaller dimensions. The dimensions of the individual vertebrae are in the accompanying table. It is apparent from the table that the length decreases to the third sacral vertebra and then increases to the last one, but does not reach the size of the first sacral or the dorsosacral vertebrae; the width, however, measured on the narrowest place, increases steadily from front to rear.

	Length of centrum	Breadth of centrum in the narrowest place
Dorsosacral vertebra	88	23
1. Sacral vertebra	76	24 (?)[1]
2. Sacral vertebra	50	25
3. Sacral vertebra	42	27
4. Sacral vertebra	49	30
5. Sacral vertebra	64	33

[1] Uncertainly, something pressing there.

The centrum of the dorsosacral vertebra shows the form of the preceding dorsal vertebrae; its anterior end surface is 63 mm wide and 52 mm high; in its center it is narrowed to a cylinder of 23 mm thickness; above it the centrum is narrowed to 13 mm thickness because of deep troughs, and is quite a bit taller than is the case in the preceding dorsal vertebrae. Just like the rear half of the preceding vertebra, the anterior half of the dorsosacral vertebra has a very large bony growth. The centrum of the second sacral vertebra is generally like that of the dorsosacral, but has a flatter ventral side. That is also the case to a greater degree in the following vertebra, whose underside becomes quite even (or flat). On the fourth and especially on the fifth vertebra a flat arch reappears. The dorsal sides of the second and third sacral vertebrae are not known because they were not preserved. It appears, however, that they had a low cross-section. This is definitely the case on the fourth sacral vertebra. The centrum of the last sacral vertebra has a cross-section on the anterior part like that of the previous one; the posterior half has a higher, circular cross-section and the posterior surface is 59 mm wide and 57 mm tall.

The connection of the vertebrae in the sacral region with the ilia is quite variable. The dorsosacral vertebra is still very much like the dorsal vertebrae and has wing-like diapophyses that rises up only slightly as broad lamellae and join their ends with the gently arched anterior wings of the ilia. The anterior contour of the diapophyses extends diagonally in a straight line backward and outward from the poorly preserved prezygapophyses. Directly in front of the start of the line of fusion there is a strong, knob-shaped (or button-shaped) tubercular facet on both sides; directly in front of that a smaller, narrow capitular facet sits on the edge of the wing. A large support runs upward from a little posterior of the tubercular facet; a smaller strengthening the bone lamella indicates a second support, which supports the capitular facet. The distance between the outer edges of the two tubercular facets is about 12 cm. With respect to the type of connection of the first sacral vertebra with the ilium, it is clear that a strong connection ran from the top arch to the free anterior wing of the ilium. This diagonal bridge is preserved only on the right side and reaches the ilium with its top edge at a distance of about 21 mm from the median plane, whereas the distance at the bottom edge is much more, about 35 mm, because of the bowing of the ilium. In the anterior view this bridge looks like a strong beam that rises diagonally up and out, with a height of 27 mm on the inside and 38 mm on the outside. In a dorsal view one sees bridges on the second and third sacral vertebrae that rise steeply on the medial side of the ilia, but their exact form cannot be ascertained because of insufficient preservation. The distance of the ilia from this vertebral centrum is small and at the narrowest place, between the place of fusion between the two vertebrae and the inner edge of the acetabulum, is only about 15 mm. A strong bridge on the anterior part of the fourth sacral vertebra leads to the ilium, but is preserved only on the left side; it goes deep in a horizontal direction, so that its underside is only slightly higher than the ventral side of the vertebra, and forms a wall of bone that goes diagonally up and back, with a width of around 2 cm, and a height of at least 3 cm. In addition, the top view shows an upper bridge that rises up and rests on the dorsal wing of the ilium. These upper bridges were very poorly preserved, so that it is not possible to determine how they connect with the centrum they belong to, and if they were connected to the bottom bridge. The posterior two-thirds of the fourth sacral vertebra lacks any processes, so that a 4-1/2 cm opening exists. On the fifth sacral vertebra a connecting bridge rises almost perpendicularly from the upper side edge of the centrum (or body) to the inner margin of the posterior wing of the ilium, that is indented underneath. Because of breaks and distortions, the form of the bridge of this vertebra is not definitely known; its length, measured from front to rear, would be at least 3 cm. There are no sutures on any of the places of fusion between sacrum and ilium.

The spinous processes of the first four sacral vertebrae are fused into one spinal ridge, with no visible segmentation. The dorsal edge is strongly thickened and shows a more or less well developed longitudinal furrow. The spinous process of the fifth sacral vertebra is separated by a hole of 12 mm width from the spinal ridge, but its dorsal edge is similarly thickened and almost touches the spinal ridge; it is 32 mm long. The spinous process of the dorsosacral is not preserved, but it was probably free, because there is no sign of fusion on the anterior edge of the XX that of the first sacral vertebra. The entire length of the spinous ridge from the first to the fourth sacral vertebra is 22 cm and including the free process on the fifth sacral vertebra it is 27-1/2 cm. The height from the ventral surface in the middle of the centrum to the dorsal surface of the spinal ridge is 110 mm on the first and fifth sacral vertebrae, whereas the height from the bottom of the caudal surface on the fifth vertebra to the posterior corner of the upper edge of the spinous process is 125 mm.

OSBORN (1917, p. 747) thinks the same number of five sacral vertebrae is probable for *Struthiomimus*, whose number is not possible to determine exactly. GILMORE (1920, p. 132) gives five as the number for *Ornithomimus sedens* MARSH, whereas OSBORN only gives *Ornitholestes* four. With respect to *Ornithomimus sedens*, the ventral view by GILMORE (1920, p. 67) shows that the posterior sacral vertebra is much more elongated than on *Elaphrosaurus*.

Caudal Vertebrae.

There are 18 caudal vertebrae. The processes are mostly imperfectly preserved, often they are entirely lacking. The posterior half is missing on the two rearmost. The vertebrae are from all parts of the tail and show that changes that take place from front to rear. In the following individual descriptions the vertebrae are successively designated by letters of the alphabet grouped into 4 groups. Although it is possible that in some cases two vertebrae are in reversed order, there appear to be no serious errors in the order.

In the first group, the a n t e r i o r m o s t , the centrum is short in relation to the height, drawn in the middle, and of circular cross-section, upper surface smooth. The end surfaces are circular, “concave-planar” (=?coeloplatyan). The transverse process slants quickly back and a little upward; a strong support follows the same direction. The centrum of the second group, the a n t e r i o r caudal vertebrae, is slimmer, somewhat compressed on the side in the middle; ventrally there are two corners (or faces, sides, edges, etc.) that are bordered by furrows. The posterior end surface is weakly concave. The transverse processes are set in deeper, extend more to the sides, as do likewise the supports which are becoming flatter. On the m i d d l e caudal vertebrae, the third group, the centra and their end surfaces become lower and broader. The spinous processes become shorter and narrower and bend back on the centrum, and disappear altogether in the posteriormost group. The prezygapophyses become longer and reach past the articulating surface like a spur. The r e a r caudal vertebra assume an elongated form, the centra become lower, then also narrower and slimmer. The end surfaces are concavo-planar (=?coeloplatyan) and finally "bi-planar" (=?amphiplatyan); the anterior is markedly smaller than the posterior. The spinous process disappears entirely. The prezygapophyses become much longer, very strong, beam-like, first increasing in height and thickness, then decreasing. The postzygapophyses form a unified plug, which becomes considerably smaller on the posterior vertebrae.

Anteriormost Caudal Vertebrae.

a) (Pl. IV, Fig. 1) The centrum is squashed in the upper parts, which affects the entire shape. The end surfaces are parallel, the anterior is very concave, the posterior flat; both approach sphericity. The base of the broken transverse processes reach from the prezygapophyses to a point immediately above the spot where the postzygapophyses depart from the neural arch. Apparently the transverse processes were to some extent wing-like. A large support runs along its ventral side, climbing weakly, diagonally towards the rear, forming an angle of less than 45 degrees with the long axis. The prezygapophyses reach past the anterior end of the centrum. The postzygapophyses, as in the dorsal vertebrae, together form a "hyposphene"-like (=?) keel that projects downward, and has shallow trenches on the side for the articulation with the following prezygapophyses. The spinous process is almost entirely lacking; but it is apparent that its rear edge reached past the posterior edge of the centrum. The neural canal has an opening anteriorly with a diameter of 11 mm.

b) Transverse processes, postzygapophyses, and spinous processes are gone. Very similar to the previous one. The middle of the centrum is not distorted but does show a narrowing with a circular cross-section and a minimum thickness of 34 mm. The ventral and left side in front of the posterior articulating end has a growth of bone, so that accurate measurements are difficult to make.

The two vertebrae just described are so similar, as far as is preserved, that it is impossible to tell which is the anteriormost; I assume that the first one described is in the correct order because it was found closest to the sacrum, and so the next one follows it. Both vertebrae belong to the anteriormost portion of the tail. The transverse process and postzygapophysis are still strongly reminiscent of conditions of the dorsal vertebrae. Judging by the form and dimensions, they might directly follow the sacrum. In the reconstruction I placed it directly behind the sacrum.

Anterior Caudal Vertebrae.

c) Very incomplete; the neural arch is completely missing except for a small piece near the prezygapophyses. The centrum is thicker on the posterior end because of bone growth and is also imperfectly preserved on the upper surface, but in spite of these, it is evident that it belongs with the following two vertebrae because of its size and shape; the middle part is a little thicker because it is not compressed like the other two. A weak corner is hinted at under the very noticeable longitudinal trough on the upper part of the centrum.

d) (Pl. IV, Fig. 2) Centrum very strongly constricted in the middle and has a very narrow cross-section, apparently accentuated by mechanical pressure; in the posterior half there is a sharp median ridge, and next to it on the right, pushed up a little on the flank, is a second weaker one.

The end surfaces are set against the centrum so they slant down and back. The anterior one is round, a little wider than it is tall, rather flat, just slightly depressed in the middle. Around the articulating surface the centrum is deformed by a growth, which makes the form and size anomalous. The posterior end surface is flat and almost round. Above the end on the right there is an irregular growth that reaches past (or above) it. The transverse processes are broken off and detach themselves from the upper arch at about the same elevation as the prezygapophyses, about 13 mm behind the anterior end of the centrum, and continue to just before the postzygapophyses; they are inclined a little bit upward, supported underneath by a flatter support than on the anteriormost caudal vertebrae and much less powerful in the rear, and much more perpendicular to the side. The prezygapophyses project out and very weakly upward. The ends are broken off, they were apparently very short. A sharp ridge runs along each to the anterior edge of the spinous process, enclosing a groove; its length is 43 mm, above the base, its freely ascending part is preserved for 23 mm, and at a point about 40 mm above the base of the neural canal; the top edge is missing. The postzygapophyses possess flat, diagonally-upward directed articulating surfaces, between which runs a deep cleft in the posterior margin of the spinous process. The anterior end of the neural canal is 11 mm high and 14 mm wide.

e) (Pl. IV, Fig. 3) Just like the previous in measurements and relations, but lacking the bone growth. The centrum is tightly constricted in the middle, apparently due to the compression of the very narrow cross-section The centrum is further constricted by a very noticeable long, shallow trough on the left, which has a ridge underneath. Ventrally two ridges (or corners) are well developed anteriorly that envelope a furrow; on the posterior half only a right ridge is visible and the furrow is scarcely noticeable. The end surfaces are oriented a little to the rear; the anterior is shallowly concave, almost round, and the margin is ventrally collar-shaped, probably through bone growth. The posterior end surface is missing the left margin and is slightly depressed across the middle. The prezygapophyses, of which the right one is undamaged, have articulating surfaces that extend diagonally up and out. On the outer edge a ridge (or corner, etc.) runs toward the lateral process. The postzygapophyses are imperfectly preserved. The transverse processes are also not well preserved and possess a broad, flat support, like the preceding vertebra. The spinous process is missing.

f) (Pl. IV, Fig. 4, Text-fig. 9) Centrum thin, constricted in the middle and of highly oval cross-section, but the narrowness has been highly exaggerated by mechanical pressure; a very shallow trough runs across the anterior half, ventrally bordered by a faint longitudinal ridge. The end surfaces are quite strongly concave, the anterior more so than the posterior; the height is almost the same as the width on both. In the side view the edges of the end surfaces slant backward a little on top, then change and turn a little forward. The narrow ventral surface is flattened, especially on the anterior half, and set off by rounded ridges (or corners, etc.) on the flanks. The partially preserved prezygapophyses have a three-sided cross-section. The postzygapophyses carry rather long, narrow articulating surfaces that slant upward and outward. The rather tall spinous process lacks only the upper anterior corner; its upper edge slopes away posteriorly; as far as it is preserved, the spinous process is 43 mm above the base of the neural canal; the posterior edge is short because of the tall postzygapophyses and encloses a deep indentation. The right transverse process is apparently completely preserved; it looks like a large platform (or plate) that reaches a height just under that of the cover over the neural canal, directed horizontally out to the side and is 51 mm from the median plane of the vertebra; the enlargement of the width is preserved for 34 mm and could not have been much more. A bottom support is not there. The neural canal has an anterior opening 9 mm high and much wider, posteriorly the opening is 10 mm in both directions.

g) (Pl. IV, Fig. 5) The spinous process, transverse processes and end of the zygapophyses are broken off, but the vertebra is just like the preceding one, except that the beginning of the transverse processes is slightly deeper.

Vertebra d belongs apparently just before e, because the end surfaces match each other so perfectly that the growth on the upper right of the rear end surface of d matches a similar growth on the same place on e. I think c is the immediate predecessor to d because the growth on the posterior end of c is similar to that on the anterior surface of d. The space between e and f is large enough for at least two vertebrae, whereas I let g and f be consecutive.

Middle Caudal Vertebrae.

h) (Pl. IV, Fig. 6, Text-fig. 10) The centrum is, as is the entire vertebra, lower than the previously described vertebrae; its cross-section would apparently be a little broader, had it not been compressed on its flanks. A narrow ventral field bordered by rounded corners (or edges) is present. The ends of the centrum are considerably wider than tall, the anterior is very concave, the posterior is so only in its upper half; ventrally the edge of the anterior end is bent slightly posteriorly, and the posterior end is bent anteriorly. The anterior end of the horizontal transverse process reaches to the middle of the centrum and to a little bit under the base of the neural canal; the left one is a little out of position because of a fracture and is only 2 cm long; how much is missing cannot be said. The width is about the same. The prezygapophyses slant toward the top and front and then turn to go straight forward. A long, left spur extends laterally over the elongate-oval facet, by which the prezygapophyses retain their elongated form. The postzygapophyses have corresponding elongate-oval facets with a descending angle medially of about 45 degrees. The almost perfect spinous process is low and elongate; it is only 29 mm high from the base of the neural canal and sits above the posterior two-thirds of the body; the horizontal 50 mm long edge is drawn forward both anterior and posterior. The openings to the canal are wider than they are tall, especially the anterior. The total length from the prezygapophyses to the postzygapophyses is 95 mm, the total height is 60 mm.

i) (Pl. IV, Fig. 7) Centrum low, has broad cross-section; ventrally is a narrow flat field bordered by ridges (or corners). Other ridges are about halfway up the flanks and at the height of the transverse processes. The end surfaces are of transverse-oval shape, the anterior lacks part of its edges and is very concave, the posterior is almost flat, with a very minor depression in the middle. Ventrally the edge of the posterior end is slightly bent forward. The prezygapophyses lack their ends. Spinous process and postzygapophyses are broken off. The transverse processes sit directly behind the middle, a little above the height halfway up the flanks and form a small, 15 mm wide platform with its base which extends up and forward; the total length is not retained. The low cross-section of the centrum and the narrow transverse processes indicate a position behind the preceding one. There would more probably be two than one vertebrae missing between them.

k) The vertebra suffered a compression posteriorly, through which the posterior end surface is largely bent forward on the margins, and the rear part of the upper arch, including the spinous process and postzygapophyses, is pushed forward and upward, so that the neural arch has an exaggerated height. The centrum has a rounded cross-section in the middle. An even ventral field is scarcely noticeable. The anterior end is markedly concave, the posterior has been widened in both directions because of the crushing and is rather flat. The prezygapophyses, whose ends are missing, go just barely above the height of the base of the neural canal and leave a rather wide furrow between them that is less narrow posteriorly than on the preceding caudal vertebra. Lateral processes are apparently no longer developed. The lack of the latter and the low beginning of the prezygapophyses indicate the transition to the posterior caudal vertebrae; the vertebra should therefore be placed behind the preceding one. That the anterior end surface is perhaps more extensive than on the previous one does not negate the positioning of this vertebra here, because the next caudal vertebra that is available has an even wider anterior end surface. This vertebra differs enough from the preceding one that at least two vertebrae should be in between them.

Posterior Caudal Vertebrae.

l) (Pl. IV, Fig. 8) The centrum is low, the cross-section wide; a shallow longitudinal furrow runs ventrally along the midline and is bordered by two rounded ridges (or corners, etc.). The anterior end surface of the centrum, whose bottom edge is broken off, is transversely oval and very concave. The posterior end surface is strikingly small, as is true by the following vertebrae, and is almost flat; its outline is not uniformly rounded, but is characterized by a pointed kink on both sides on the top, by which the dorsal, flatly arched contour is separated from a ventral, strongly arched contour. A sharp (corner, etc.) starts at the kink and runs the length of the centrum and passes onto the prezygapophyses as the outer edge. Under this ridge is another ridge, and the distance between the two increases toward the front, and the second ridge almost disappears toward the front and back. The upper arch is very low and has the simple shape of a roof (or dome) and covers over an indentation with its anterior end. The prezygapophyses form strong, diverging beams, of three-sided cross-section where the longest side of the triangle lies in the elongation of the wall of the upper arch. The postzygapophyses form a unified plug 15 mm wide; its cross-section is a low pentagon whose longest side lies over the neural canal, across from a sharp ridge, and runs dorsally along the entire length of the upper arch and is the only remnant of the spinous process. The neural canal has a height of 6 mm posteriorly and a width of 8 mm.

m) (Pl. IV, Fig. 9) The centrum and its end surfaces are less broad than on the preceding vertebra. Because the bottom part of the anterior end is preserved, a side view of the ventral profile clearly shows that it sinks slower to the front than to the back. The prezygapophyses are stronger and have a higher cross-section than on the preceding vertebra, the neural arch does not have the striking roof-shaped (or dome-shaped) cross-section, but is much flatter, the median ridge is much weaker on the anterior half, the depression on the anterior end of the arch is narrower.

n) (Pl. IV, Fig. 10, Text-fig. 11a, b) The centrum is longer and slightly narrower than the previous one. The anterior end surface is rounded, the posterior is definitely six-sided. The dorsal furrow is recognizable only on the postzygapophyses-plug. Anteriorly the roof of the upper arch flattens out and sinks somewhat between the prezygapophyses, covering a circular indentation only 3 mm across. under the side ridge of the postzygapophyses-plug lies an extensive furrow that also overlaps onto the medially flat upper surface of the centrum, which is above the lateral ridge*. The beam of the prezygapophyses of the following vertebra fits in third furrow, which is recognizable quite a ways towards the anterior from a point 30 mm from the posterior end of the centrum.

o) The centrum is again somewhat longer than the preceding one. The dorsal median ridge is no longer recognizable on the somewhat smaller postzygapophyses-plug. The large beams of the prezygapophyses are about 16 mm high where they separate from the centrum and are still that size 1-1/2 cm from the anterior end of the centrum, which is as far as the right one is preserved. The very well preserved grooves on the posterior end of the neural arch extend about 25 mm anteriorly from posterior edge. About 25 mm past the grooves there appears to be a trace of a continuation in the form of a very shallow depression. That leads to the conclusion that the prezygapophyses have thin processes past the articulating facets, as are preserved on caudal vertebra h.

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* This sentence doesn't make much sense – I hope it's not critical. – JDO.

p) (Pl. IV, Fig. 11, Text-fig. 12a, b) The centrum is still weaker than the preceding. The narrower, 8 mm wide postzygapophysis is completely preserved and reaches to the posterior edge of the centrum; it contains a small, shallow, spoon-shaped depression that is bordered by ridges and is on the underside of the postzygapophyses that slant up and back. The prezygapophyses are even taller – 19 mm. The end surfaces of the centrum are six-sided, the posterior lower than the anterior.

q) (Pl. IV, Fig. 12) The entire form is markedly slimmer than the preceding vertebra. The end surfaces of the centrum are smaller, and much less wide, so they are proportionally higher. It is difficult to say if that is due to preservation or at least accentuated by preservation. The prezygapophyses are somewhat shorter; the hole between them has a diameter of 3 mm.

r) (Pl. IV, Fig. 13) Only the anterior half is preserved and it is weaker than vertebra q. The end surface of the centrum is smaller, namely lower; the broken end, almost 37 mm away from the anterior end, has a lower cross-section, with a triangular outline, and a wide, reinforced dorsal point. The break shows a lumen in the neural canal that is 4-1/2 mm wide and 3 mm high. It is apparently separated from the hollow space in the centrum by only a thin skin of bone. The outer wall that encloses both hollow spaces is 1-1/2 mm thick ventrally and 4 mm thick dorsally. The prezygapophyses of this and the other posterior caudal vertebrae lack an inner hollow space, and are therefore solidly built. The original length of vertebra r would have been just a little less than the preceding vertebra, because the narrowing of the dorsal surface is no less than that on the preceding vertebra at an equal distance from the anterior end surface.

s) (Pl. IV, Fig. 14) Only the anterior half is preserved, which is significantly weaker and slimmer than the preceding. The anterior end is almost circular, a little less low than broad. The prezygapophyses are lower and thinner. The broken end is 48 mm from the anterior end and has a lower cross-section. The original length of the centrum could have been a little less than the preceding vertebra.

Dimensions of the Caudal Vertebrae.

Desig-nation	Assumed position	Length of centrum		Anterior end face of centrum		Posterior end face of centrum	
		upper	lower	breadth	height	breadth	height
a	1	77	77	71 (—?)	62	64	62
b	2	78	76	68	61	62	51?
c	5	80	75	60[1] —	58[1] —	—	—
d	6	76	72	60[1] —	55[1] —	49	44
e	7	70	70	49	44 (?)	—	44
f	10	73	72	38	41	37	37
g	11	73	72	42	42	42	39
h	14	71	67 +	42	36	44	32
i	17	70	65 (?)	37 +	30 (+)	40	30
k	19	71	62 +	43	36	46 —	38 —
l	23	82	75 (+)	44	—	36	25
m	25	84	78	34 +	29	32 +	25
n	26	83	80	34	26	30	23
o	28	80	76	29	18 +	27 (+)	20
p	29	77	79	25	20	26	17
q	31	83	79	19	22 (?)	21	16
r	35	—	—	19	16	—	—

s	38	—	—	16	13	—	—

[1] Amount too large due to rampant growth.

Number of the Caudal Vertebrae.

It is not possible to ascertain with certainty the original number of caudal vertebrae. I have attempted in the reconstruction to guess how many vertebrae are missing from those places where differences between vertebrae show there are missing sections. Often I was able to determine more or less certainly that consecutive vertebrae were found. The ordering of the vertebrae and the position of the holes that were assumed in the reconstruction are shown in the first columns of the table on page 30. It probably does not need to be emphasized that these are the results of estimates and do not have claim on exactness. I decided to assign the last one as number 38. Because this one has very strong prezygapophyses, it therefore cannot be the last one, so I estimate there were 4 more, making the total 42.

For comparison and judgement, the number of other carnivorous dinosaurs and the ideas of authors about them are given. The exact number of caudal vertebrae is also not known for the North American coelurosaurs. For *Ornitholestes hermanni*, whose type skeleton has 27 caudal vertebrae, OSBORN (1917, p. 735) gives the total as possibly from 39 to 44, and for *Struthiomimus altus* questionably as 40. On the skeleton of this species in the New York Museum there are 17 anterior caudal vertebrae, then 5 restored (or supplementary) vertebrae, and then 15 vertebrae from two other sources. Whether OSBORN's numbers are correct is not possible to accurately determine. In any event, though, the number of 40 not seem too large. The larger carnivorous dinosaurs have more; *Ceratosaurus nasicornis* has at least 50 and OSBORN (1920, p. 98) says at least 53. For *Allosaurus* (*Antrodemus*) GILMORE (1920, p. 45) estimates at least 45, after a study on skeleton No. 4734 in the Washington Museum. OSBORN estimates 53 on skeleton No. 5027 of *Tyrannosaurus rex* in the Museum of New York which only had 18 preserved. On the other hand, LAMBE (1917) estimates only 36 for *Gorgosaurus libratus*.

Comparison of Caudal Vertebrae.

For a comparison of the anterior caudal vertebrae with *Ornithomimus*, the illustrations of *O. sedens* MARSH by GILMORE (1920, fig. 68) are good. As far as the preservation of *Elaphrosaurus* shows, it is clear that the centrum in relation to the height is shorter, its end surfaces are definitely round, the height of the spinous process is somewhat lower. On the whole, however, there is considerable similarity. The same is true when vertebra f, which is number 10, is compared with the 10th or 11th caudal vertebra from *O. sedens* MARSH. The transverse processes are inclined downward on the American species, whereas they are almost horizontal on *Elaphrosaurus*. The dorsal contour of the spinous process slopes down on the back of this one, and if the preservation is true, in the other case is horizontal. Otherwise the similarity is striking. For a comparison of the posterior caudal vertebrae the best illustrations are of *Ornithomimus* (*Struthiomimus*) *altus* LAMBE by LAMBE (1902, pl. 14, fig. 2-5, pl. 15, fig. 1-5) and of *Ornithomimus affinis* GILMORE (1920, fig. 77) from the Arundel Formation near Muikurk, Maryland. The vertebrae of the first differ from *Elaphrosaurus* by having a connection of the low, broad form of the centrum, which has a very distinct ventral furrow, with extraordinarily strong development of the prezygapophyses. The illustration of a posterior caudal vertebra from the younger *Ornithomimus affinis* by GILMORE shows a narrow centrum, well-developed but incomplete, rather high prezygapophyses and a long, low, but very distinct spinous process. The last two characters indicate that it is placed further forward than the first anterior vertebra (1) of the African saurian and would have a much longer shape than the corresponding vertebra of the latter. From the general view of *Ornitholestes hermanni* by OSBORN (1903, fig. 1 and 1917, pl. 26) it appears that the elongation and strengthening of the prezygapophyses is not as extensive as on *Elaphrosaurus*. MARSH's illustration (1896, pl. 7, fig. 4) of a very elongate caudal vertebra of *Coelurus fragilis* shows no elongated, rather high prezygapophyses, but because of the lack, or near lack, of transverse processes, it is probably from the area of the transition to the posterior caudal vertebra, or perhaps even a proper posterior caudal vertebra. Compared with the vertebrae from *Elaphrosaurus*, the illustrations by Marsh lead to the conclusion about *Coelurus* that either the elongated form of the caudal vertebra starts further forward, or that the striking enlargement of the prezygapophyses starts further back or not at all. If I judge correctly from the cast of *Compsognathus*, the elongation of the centrum enters in far forward in the vertebral column. A lengthening of the prezygapophyses has not yet started on the last – probably the 15th – vertebra.

From these comparisons, it seems that the vertebral column of *Elaphrosaurus* shows more similarity to *Ornithomimus*, particularly *O. affinis*, than to *Ornitholestes*. The differences are also greater when compared to *Coelurus* and *Compsognathus*, which may both be synonyms of *Ornitholestes*. Because *Coelurus* and *Compsognathus* are such small forms, it is possible that the differences may be credited to the differences in the reactions to pressure on such smaller forms.

Ribs.

1. One partially preserved rib is 14-1/2 cm long but is incomplete proximally and distally and has a rounded triangular cross-section near the proximal breakage of 9 mm width; the one surface slopes down proximally, with increasing size, in a shallow trench, which probably is a transition to a proximal broadening. Toward the distal end the cross-section becomes more flattened and is 11 mm wide. The original curvature of the rib is no longer recognizable, due to distortion. Proximally there is a rounded triangular hollow space filled with crystalline chalk-spar. Using OSBORN's illustration of *Struthiomimus* (1917, pl. 24) for comparison, one would probably designate this rib as one of the first trunk ribs because of its narrowness (or slimness).

2. A much stronger, almost straight, very distorted bone is 10-1/2 cm long, 27 mm wide on one end and 14 mm wide on the other end, and is probably a piece of broken rib. Because there is not enough preserved to conjecture about the nature of the missing proximal end, this rib remains unassigned as to position. The rather thick (9 mm) distal cross-section would probably make it a middle to posterior trunk rib.

Haemapophysis.

The only available haemal spine lacks the ends of the two proximal prongs that articulate with the caudal vertebral centrum and also lacks the distal end; how much is missing from the ends is difficult to say. The entire length is 62 mm, that of the anterior prongs is 8 mm. The largest undistorted distal width is 14 mm. The haemal spine shows a rather strong bend when viewed from the side. The sides are flattened, and distally the thickness decreases to about 3-1/2 mm. The width of the bone in the anteroposterior direction is about 15-1/2 mm proximally, 13 mm distally, and 10-1/2 mm in the middle. The flat proximal prongs are only 2 mm thick. A wide, flat depression on the anterior side runs distally for about 33 mm from the point of bifurcation, on the posterior side a deep groove runs for about 26 mm (or is 26 mm wide) and is bordered by sharp edges. In the side view this haemal spine is very similar to those in the anterior part of the tail of *Struthiomimus altus* (OSBORN, 1917, pl. 24). Such a position is very probable because of its staff-like (or rod-like) form.

Humerus.

Text-fig. 13a, b.

The right humerus is completely preserved. Its overall shape is thin, weakly curved in the plane of the widening of the proximal part. Perpendicular to that there is no curvature; but there could have been a slight curvature which was erased by distortion. The proximal end is moderately broadened; it carries the "head" somewhat medially by the middle as an approximately 53 mm wide thickening with a pointed-oval shape. The medial process is preserved as a stronger, pointed projection. The bicipital fossa is a flat depression on the lateral side of the proximal part; it runs distally on the lateral process, which runs along the lateral edge of the proximal end as a rounded corner (or ridge), then as a distinct ridge ("crista") on the anterior surface of the shaft in a slightly diagonal course to a point 90 mm from the proximal end where it reaches its greatest projection, and then runs further distally as a rounded ridge. On the lateral margin of the posterior surface of the humerus, about 6-1/2 cm from the crown of the "head", is a small, round rough knob, which might have served as the insertion for the elevator of the humerus. The cross-section of the bone is flatly elongate proximally, rounded-triangularly on the shaft distally from the lateral process, and once more flattened distally. The latter is a moderately strong widening that is turned about 30 degrees in relation to the proximal portion, in the sense that the medial side is drawn forward. The terminal articulating surface is unclearly preserved; the organization into two condyles is preserved on the anterior side as only a shallow median depression.

Total length	262 mm
Width at the proximal end	71 mm
Width at the distal end	54 mm
Smallest width of the shaft	28 mm

The first comparison is the humerus of *Ornitholestes hermanni* OSBORN that is pictured only on the reconstruction illustration (OSBORN 1903, fig. 1, 1917, Pl. 26). On that one the curvature is greater and the proximal end seems broader. OSBORN illustrates both humeri of *Struthomimus altus* LAMBE (1917, fig. 7A, B) and shows that they are somewhat slimmer and have a narrower proximal end than the humerus of Elaphrosaurus, but they agree in the amount of curvature.

First (?) Metacarpal.

Pl. VIII, Fig. 1.

The elongated cylindrical bone is 31 mm long and its entire shape is somewhat distorted by compression. The end surface is rather flat with a small central groove, the edges are somewhat raised, as far as they are preserved. The middle part of the bone is 15 mm wide and has a rounded-triangular cross-section that becomes higher proximally and flatter distally. On one side just under the middle on the rounded ridge that borders the dorsal surface is an indistinct, protruding prominence. The distal end is somewhat compressed and a little weathered but is a well-developed roll (or spool, cylinder, reel, pulley, etc.) with a broad, flat middle groove and holes on the sides. The roll (or spool, etc.) is 18 mm wide on the bottom and 15 mm tall on the well-preserved side.

Because of the flat shape of the proximal surface it has to be a metacarpal rather than a first phalanx, and I assume it to be the first on the left hand.

Fourth (?) Metacarpal.

Pl. VIII, Fig. 2.

A delicate, gently curved bone, 39 mm long, is assigned to *Elaphrosaurus bambergi* because of the wide, inner hollow space, and has a three-sided end surface that is 12 mm long and 8 mm wide. The shaft tapers distally – while the cross-section becomes oval – to a width of about 5 mm near the distal end. The latter has a long, unclearly preserved end surface 7 mm wide. Because the bone is too weak for a very reduced fifth metatarsal, I assume it to be a greatly reduced fourth metatarsal.

Ilium.

Pl. III, Fig. 1a, b, c; Text-fig. 8.

Both ilia are fused with the sacrum; they are perfectly preserved except for a few unimportant marginal pieces and a few holes in the middle of the surfaces. Both ilia have been broken in the middle, where they have been offset a little bit. The general shape is not seriously affected by this defect and a few other unimportant breaks. Both ilia sit next to the sacrum so that their dorsal margins are as high as the upper edge of the spinous processes and are only 1-1/2–2 cm away from the sacrum at any given point, except near the last sacral vertebra, where they diverge a bit. The general shape is very elongate, the dorsal contour is gently curved, the length is about 38 cm when the breaks and restoration of the anterior part are taken into consideration, and is about 15-1/2 cm wide at the preacetabular process, which is the widest point. It appears significant that whereas the upper flat part is horizontal, the covering over the acetabulum and the posterior wing stick out laterally. The preacetabular process is bluntly rounded and has a narrowing cross-section; its weakly concave acetabular side is about 5 cm across and is bordered by distinct corners (or ridges). The postacetabular process is quite short; on the lateral side it shows a strongly developed ridge. The surface for the ischium faces medially downward. Between the two processes the arched roof is horizontal on the bottom, which widens the acetabular surface to about 7 cm. The postacetabular wing of the ilium forms a strikingly wide, downward facing longitudinal furrow about 8 cm wide; toward the posterior it cuts off in a line that runs diagonally anterior, dorsally it turns into a blunt point that faces up. The bottom edge is fused with the ascending bridge of the fifth vertebra. Directly behind the postacetabular process on both sides are 4 mm wide furrows.

The ilium of *Ornitholestes hermanni* OSB. has, as OSBORN 's (1917, pl. 26) reconstruction shows, a rather similar general shape, but has a shorter preacetabular process. According to the description, the posterior part seems to be of similar form. The anterior wing, because its surface hangs down a little, appears to be higher than on the ilium of *Elaphrosaurus* in its present state. It is not impossible that if the anterior end of the latter were preserved that it would be similar. *Struthiomimus altus*, according to OSBORN 's (1917, pl. 26) reconstruction, has an ilium whose anterior, blade-shaped, downward slanting wing and especially the posterior wing are both much longer when compared to the width of the acetabulum of *Elaphrosaurus*. The whole ilium is markedly longer, if the length of the anteriormost caudal vertebra is any indication. *Struthiomimus* also differs in having a very weak development of the preacetabular process. GILMORE 's (1920, fig. 67) ventral view of *Ornithomimus sedens* MARSH shows a much wider acetabulum. The posterior wing also has a wide ventral furrow, but the wing's lateral edge projects further down on *Elaphrosaurus* as opposed to it being medial on *Ornithomimus*.

Ischium.

Pl. III, Fig. 1a, b; Text-fig. 8.

Both ischia were preserved in place; the left one was partially dislodged from the postacetabular process of the ilium, the right one was positioned correctly on the ilium, but was displaced a little by a break in its proximal part and is also lacking the anterior half of the proximal blade. A short, strong posterior process is separated from the proximal blade by a distinctly inturned sinus. The process articulates with the postacetabular process of the ilium and even takes part in the forming of the acetabulum with a small triangular surface. The anterior main part of the proximal blade is a rectangular, laterally concave platform (or plate), whose anterior edge is greatly thickened and holds a surface, 78 mm long, 34 mm wide on top, that narrows to a point on the bottom. On this surface the pubis was fused apparently with a cartilaginous connection. The stems of both ischia lie together for their entire length. The cross-section of a single ischium stem is a low triangle proximally with a rounded apex and the base drawn out to the side. Both stems together have the form of a rhomboid, whose two angles are situated off the median line, while the two different ends are rounded. This cross-section assumes a low heart-shaped form, whose pointed end faces down. Distally the ischial stems expand to form a strong shoe (or socket), whose anterior end is drawn out. The distal end surface shows a median furrow on the posterior half and has an elongated heart-shaped form 100 mm long and 58 mm wide. The greatest width on the proximal end (distance from the posterior end of the distal broadening to the distal end of the pubic fusion surface) is 134 mm, the greatest length from the anterior edge of the acetabular margin to the distal end is 354 mm.

The ischium of *Ornitholestes* (OSBORN 1917, pl. 26) differs in lacking the distal shoe-like thickening. That of *Struthiomimus* (OSBORN 1917, pl. 26) differs in the curvature of the stems and the apparently significantly weaker proximal surface development.

Pubis.

Text-fig. 14.

The left pubis is preserved for 31 cm; the distal end is missing. The general shape is very slender. The 118 mm wide proximal part is a platform (or plate) whose general shape is triangular, and is even, and on the medial side is unimportantly concave. Its greatly enlarged proximal end is 6 cm long and about 4 cm wide at the widest place and is the point of attachment to the preacetabular process of the ilium. For a length of 3 cm the proximal end surface helps form the acetabulum. The place of attachment to the ischium makes an angle of 60 degrees with the proximal end surface and is preserved only about 3.5 cm long and 3 cm wide but must have reached quite a ways around the posterior side of the subacetabular process in order to meet the appropriate surface on the ischium. The actual subacetabular process is not preserved. The platform-shaped proximal part of the pubis runs distally as an elongated, staff-like distal section. The latter is almost straight, thick on the lateral side – 5 mm in the middle, 18 mm distally –, on the medial side sharpens to a thin ridge that rests against the right pubis, but is imperfectly preserved and the tip of the ridge is broken off along the entire length. Proximally the ridge turns toward the posterior edge. The narrow but rounded anterior edge of the proximal part starts out diagonally downward on the outer edge as a well-marked ridge and ends as an extensive bulky protuberance about 13 cm from the proximal end and can be considered as the lateral process. Only the perimeter of the posterior margin on the proximal platform is preserved of the obturator foramen. The staff-like distal section shows a hollow space in cross-section. The original length could be much more than is presently preserved because the enlargement of the distal end is not preserved.

As opposed to the pubis of *Ornitholestes* and *Struthiomimus* (OSBORN 1927, pl. 26) the anterior contour that projects proximally against the longitudinal direction of the shaft is characteristic of *Elaphrosaurus*.

Femur.

Pl. V, Fig. 1a, b.

The left femur is broken diagonally in places and longitudinally in the middle. Generally, though, the shape of the femur has not been changed. It is slender, the shaft is quite curved, the head piece is shaped like a shoulder (?or an ax) with an evenly arched upper profile, and in such a plane that it makes an angle open to the front of 45 degrees with the plane of curvature in the shaft. Whether and to what extent the proximal and distal parts have been bent toward each other is difficult or impossible to determine; in any event it has not occurred to a great extent. The head has an elongated cross-section and its flanks are only slightly curved, in fact almost parallel. A rather broad fossa proceeds out from the posterior flank to the actual articulating head, so that it looks like the head, which is drawn out in a pointed lobe, is tuned over. The proximal end surface of the femur has a greatest width of 50 mm, laterally it narrows rapidly. The lesser trochanter is barely recognizable at about the height of the neck of the femur as a projecting rough spot. The greater trochanter forms a large projecting swelling that runs along on the midline of the anterior surface of the body for about 7 cm and then runs for 64 mm as a free bar to where the tip is broken off. The fourth trochanter is a narrow ridge of bone about 75 mm long that begins about 13 cm from the proximal end and runs downward in a weak curve along the line of transition between medial and posterior surfaces. The cross-sections of body are not true because of distortion, but are almost true-to-life. The cross-section at the same level as the fourth trochanter is round, on both sides of the posterior surface it is angular, in the middle it is high and rounded-triangular, on the distal end it is like a type of barely sharp-cornered rhomboid, whose sharp-cornered medial, anterior corner is cut off diagonally by a peculiar surface. This surface is bordered on both sides by two prominent, proximal ridges that flow together in an unevenness (or roughness), whose anterior one comes off the median condyle and is rounded, whereas the posterior one remains very sharp for 17-1/2 cm from the distal end over the rough spot and then continues indistinctly to the greater trochanter. Another distinct, but somewhat rounded ridge goes from the lateral distal condyle to the lesser trochanter. The medial distal condyle is narrow – about 30 mm – and high, somewhat weathered, and is missing the point, which is broken off. The lateral condyle is about 39 mm wide, it is bordered by an even surface laterally that is set apart from the lateral surface of the femur by a 12 mm wide step. The intercondylar fossa is narrow, only 12 mm wide distally. The distal end surface of the femur shows a wide, flat furrow that runs across the anterior surface and can be followed to about 16 cm from the distal end. A narrow groove on the distal end surface further sets off the actual lateral condyle.

Total length of the femur	520 mm
Width of the head	106 mm
Width of the distal end	95 mm
Thickness of the distal end measured across the lateral condyle	89 mm

The distinguishing characters of the femur, by which it differs from those of the large theropods, are: strong curvature of the shaft, rounded proximal profile of the head part, thick form of the greater trochanter, weak development of the fourth trochanter, narrowness of the medial condyle as opposed to the width of the lateral condyle, narrow intercondylar fossa.

The medial view of the femur of *Struthiomimus*, shown by OSBORN (1917, fig. 8F), shows about the same relations as in *Elaphrosaurus*, but with somewhat weaker curvature. A more exact comparison is not possible on the basis of the single illustration. The similarity can be quite thorough. Noteworthy is the tuberosity under the middle of the medial condyle, which is not visible on *Elaphrosaurus*. The poorly preserved femur of *Ornitholestes*, according to OSBORN 's (1903, fig. 1 and 1917, pl. 26), is similarly curved but narrower; the possibility is not available for more thorough comparison. With respect to the femur of *Compsognathus* I can only remark that it is similarly curved.

Tibia.

Pl. VI, Fig. 1a, b, c.

The general shape of the available left tibia is very slender and straight; but of course the numerous longitudinal sealed (or cemented) tears (or breaks) could have changed the original form, one part over the middle is a little out of place because of the pressure. The head has a narrow three-sided shape with a weakly convex medial side. The rather strongly swollen lateral condyle is bordered by a depression on the proximal surface, and in a similar manner medially on the posterior side. The proximal articulating surface generally slopes down laterally. The tuberosity is a strong projection, protruding also proximally, about 32 mm thick 4-1/2 cm away from the proximal end; distally it becomes a thin, sharp ridge. Divided from it by a very deep groove (perhaps deepened by pressure), the lateral crista is high and thin, about 16 cm long and runs along the lateral side of the body on the proximal surface in a weakly convex curve toward the bottom. The shaft is flat on the anterior side and bordered by rounded corners (or ridges) – laterally on the bottom the corners (or ridges) are sharper – and on the posterior side the shaft is rounded. The cross-section is a drawn-up half-moon. The narrowest width is 15 cm from the distal end. The latter is broadened very slightly in a lateral-medial direction; the contour projects more sharply medially than laterally; on the lateral edge there is some bone missing, so that it might have projected out more. The shape of the end surface is triangular with blunt corners, with the stem of the blunt corner on the posterior side medially from the middle and the most pointed corner is lateral. The articulating surface is only partially visible because of the medially displaced astragalus. The depression that divides the two processes on the distal surface is visible; both processes project equal distances distally. On the anterior side there is no division visible between the two processes, because the margin generally is a flat, convex (downward) arch, but is pointed in a few places. A distinct groove for the ascending process of the astragalus is not visible on the distal margin; the middle of the surface across the distal margin is weakly swollen, both sides of which are unimportantly weakly depressed. A 2-1/2 cm long shallow depression, which can be followed for a distance of about 8-1/2 cm from the distal end and is bordered by a ridge (or corner) near the lateral margin, could be the end of a groove for the ascending process of the astragalus.

Total length	608 mm
Greatest length of the proximal articulating surface	130 mm
Greatest width of the proximal articulating surface	80 mm
Minimum width of the shaft	45 mm
Thickness perpendicular to the minimum width	37 mm
Greatest length of the distal end surface	95 mm

Greatest width of the distal end surface	44 mm

The tibia of *Elaphrosaurus* differs from those of the large theropods of the Tendaguru Formation by its much more slender general shape, relatively smaller tuberosity, more prominent lateral crista, the wider groove between the two, by the much more slender and less distinctly divided distal end, and the lack of a distinct large groove for the ascending process of the astragalus. OSBORN's (1917, fig. 8, p. 749) medial view of the tibia of *Struthiomimus altus* shows a very similar shape to *Elaphrosaurus*. Neither the cast nor the available literature preserve enough details to compare it with *Compsognathus*.

Fibula.

Text-fig. 15.

The left fibula is preserved for 37 cm, the distal part is lacking; a piece of bone 6 cm long was found near the broken end, but it is strongly curved and was not put with the fibula because it would have given the bone a sharp bend; this piece has been duplicated in plaster-of-Paris without the curvature. A section distal from the middle is bent and distorted because of fractures. The very thin distal third has a width of 19 mm; the thickness distally is only 6 mm. The medial side is even, the lateral side is flatly arched. From about 24 cm from the proximal end, the fibula becomes wider until about 9 cm from the proximal end where it expands rapidly to 100 mm, just under the proximal surface. The latter is a weakly arched, posteriorly pointed, anteriorly straight cornered truncated band, whose width from the anterior edge to the middle is always about 27-28 mm. The lateral surface of the proximal part is flatly arched, but on the posterior edge 4-1/2 cm from the proximal end it is a little indented. The medial side has an extensive, deep indentation that is surrounded proximally in the front and rear by an even, 1 cm wide margin that narrows distally. The 3-1/2 cm wide indentation runs distally into the flat medial surface of the thin shaft. A sharp, medial-projecting crista grows out of the rim around the medial indentation and is traceable for a distance of about 6 cm, starting from about 3-1/2 cm from the proximal end. A second, sharply pronounced, trochanter-like crista sits on the anterior margin from 13 to 16-1/2 cm away from the proximal end.

The fibula on the reconstruction illustration of *Struthiomimus altus* by OSBORN (1917, pl. 26) shows generally very similar relations. The contours of the proximal end are not quite so straight as on *Elaphrosaurus*. The crista on the anterior margin is not recognizable on the illustration. The fibula of *Compsognathus* is very similar to that of *Elaphrosaurus*.

Astragalus.

Pl. VI, Fig. 1a, b.

The astragalus is a low plate of bone 88 mm long and 56 mm wide. The distal end is a well developed pivot point that is divided into two equal parts by the middle depression. On the bottom the pivot facet extends to the proximal surface, where the two form an almost straight, very sharp corner (or ridge). The articulating surface is most deeply indented and curved medially toward the front and meets the proximal surface only for a short distance on the lateral side, and otherwise leaves a narrow, depressed zone free, which is 13 mm high on the medial side and leads to an ascending, thin projection with a low, blunt-angled triangle. The lateral and the medial sides of the astragalus are very concave. The proximal surface has a deep trough that is divided by a raised part in the middle; the lateral half disintegrates into a small posterior depression for the lateral part of the distal end of the tibia and a broader anterior furrow on the distal surface of the anterior margin close to the lateral margin. The furrow is bordered by a narrow surface that runs to point, which might be thought of as the distal surface of the calcaneum. It appears very noteworthy that, in opposition to *Ornithomimus* and also to the theropods, the ascending process of the astragalus is very poorly developed and is so close to the medial edge, whereas it generally sits closer to the lateral margin. As I said in the description of the tibia, there is a weakly developed corner (or ridge) on the anterior edge near the lateral side, which could represent the margin of the rounded end of the groove for the ascending process of the astragalus, which would then reach 8-1/2 cm proximally. Perhaps the already mentioned narrow, depressed zone on the anterior side of the astragalus proximal from the articulating surface represents a surface from which the ascending process was detached or broken off, or a bordering surface to a process that was not completely ossified and therefore was not preserved. In that case, one of the diagnostic characters for *Elaphrosaurus*, as given in my previous notice, would be the weak development of the ascending process of the astragalus.

Metatarsus.

Pl. VII, Fig. 3a, b.

From thc left metatarsus both the 2nd and 3rd elements are completely preserved and the proximal third of the 4th is preserved. The three metatarsals fit together on the proximal end, as the proximal view of the group shows. The proximal articulating surface of Mt II appears to be too large as a result of deformation due to fossilization, while that of Mt IV appears too small because of the loss of the top layer of bone. A reconstruction of the original form of the proximal facet of the metatarsus was undertaken for illustration. The picture, which gives the proximal view, is characterized by Mt II and Mt IV sitting in the side recesses of Mt III, which is narrowed dorsally so that the whole metatarsus is reinforced. Facets for articulation of an unfound Mt I on the posterior side of Mt II, and perhaps also on the narrow medial wall of the posterior part of Mt III, are not visible.

Metatarsal II.

Pl. VII, Fig. 3a, b; 4.

The bone is entirely preserved and is 378 mm long. The very thin shaft is compressed from side to side and now is generally not over 1 cm thick. The proximal end is enlarged by fractures filled with chalkspar and is therefore somewhat larger than the corresponding facet on metatarsal III. As a consequence of poor preservation, it was difficult to establish anything more than an approximate shape for the proximal end during preparation. The form of the articulating surface is distinctly half-moon shaped, 53 mm long, 34 mm wide. The lateral side that meets metatarsal III is almost even (or flat). The distal is curved forward, but it is not possible to determine whether or to what extent that is a product of distortion. The distal pivot apparently is not distorted. Its width of 35 mm and its thickness of 36 mm correspond to the proximal articulating surface of the appropriate phalanx. The pivot sits on the shaft as part of a simple cylinder that extends further laterally than medially. The margin of the distal articulating facet runs in an arch toward the anterior, but on the posterior side it is an asymmetrical indentation that is pushed to the lateral side. Medially there is a circular side hole about 10 mm in diameter, but laterally there is nothing similar, only an extensive, shallow depression. The undistorted or little distorted portion of the shaft, which joins immediately onto the pivot part, is swollen (or arched) on the medial side and on the lateral side has a rather even surface enclosed by two ridges (or corners). This flattening and likewise the anterior corner (or ridge) are traceable to the proximal end; the posterior one is recognizable at least halfway to the proximal end. Apparently the shaft was originally constricted from side to side, as the form of the proximal part would suggest, but the exact shape cannot be discerned because of distortion.

Metatarsal III.

Pl. VII, Fig. 3a, b; 5a, b.

The bone is preserved completely, the form is changed a little by a few fractures, but is very slender and straight, 39 mm long. The proximal third is bent a little forward when compared to the rest of the bone; it appears that is a natural curve. The distal fourth is also very slightly bent forward. The shaft is flat in the rear on the proximal half, and rounded in the front, on the distal half it is opposite, flat in front and flatly rounded in back. The proximal, even section of the posterior surface is enclosed by ridges (or corners) that are traceable quite a ways distally across the flatly arched distal section. Likewise, the ridges (or corners) that enclose the flat distal section of the anterior side are visible quite a ways proximally. About 9 cm from the distal end there is a flat, swollen thickening. The minimum width of 25 mm is a little proximal from the middle, the thickness is about the same here. Proximally the width increases slowly but the thickness increases a little faster. Just before the proximal end the increase is great. This proximal articulating section projects forward and rearward with an even (or flat), capital-like* surface bordered on the bottom by a sharp ridge (or corner) that is parallel to the proximal margin; the surface is 17 mm high anteriorly, and 21 mm high posteriorly. The proximal cross-section has the shape of an irregular "T" whose corner is rounded off; a projecting cross-bar that is narrower on the medial side than on the lateral side, sits on a pillar (or prop) that is about 26 mm wide, widens to about 33 mm anteriorly and diagonally terminated. The articulating surface has a 65 mm anteroposterior measurement and is 51 mm perpendicular to that. On the proximal surface a shallow depression divides the cross-bar from the anterior part of the articulating surface. Except for this depression, the surface is flatly convex and pitted (or grooved). The distal pivot is directed somewhat posteriorly; its distal contour slants slightly down medially. The shape of the pivot is a simple, undivided cylinder surface, the margin of the facet forms a simple arch on the underside, on the upper side the arch is not recognizable. The width of the pivot is 52 mm, the thickness medially is 42 mm, laterally 33 mm. The side surfaces are funnel-shaped depressions. Medially there is a kidney-shaped side hole, 20 mm wide, laterally oval, and 14 mm long.

Metatarsal IV.

Pl. ,VII, Fig. 3a, b.

The proximal end is 132 mm long, and that is all that is preserved. The proximal part, whose outer, smooth bone layer is largely missing, is flat, its lateral wall quite even, the medial surface, which fits well with metatarsal III, is flatly arched, with a weak, median, longitudinal indentation. The proximal articulating end in the present condition is 44 x 19 mm. Distally from the proximal end the shaft is narrow, only 15 mm across. At the distal point of breakage, however, it has a thicker, rounded-triangular cross-section of 26 mm maximum thickness and 22 mm diameter perpendicular to it.

First Phalanx of Pedal Digit II.

Pl. VII, Fig. 3a; 6.

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* I don't know what he means by "capital" – JDO.

Slender and elongate, 100 mm long. The proximal articulating surface is a uniformly deeply depressed, key-shaped cavity 38 mm wide and 41 mm high. This articulating depression is apparently widened by filled clefts. The body is strongly contracted, it has a triangular cross-section, which, at the narrowest place, about in the middle (lengthwise), is 17 mm wide and 20 mm tall. On both sides of the “plantar" side there are well-developed longitudinal swellings, the lateral one reaches to 36 mm from the proximal end. On the medial flank, above the medial swelling, is a 2 cm long depression. The distal pivot is 31 mm wide in the "plantar" direction, then narrows to 17 mm dorsally; on the medial side the pivot is 23 mm tall, and 28 mm on the lateral side. The middle sulcus is flat and lies just a little bit medially of the midline. There is a shallow depression on the dorsal side, proximally from the end. The side depressions of the pivot are deeply sunk in, short oval in shape and have their greatest length of 9 mm close to the long axis of the bone. The proximal articulating surface fits very nicely on the distal end of metatarsal II, so that the identity does not seem doubtful, whereas it would be much too small for metatarsal III.

Second Phalanx of Left Pedal Digit II.

Pl. VII, Fig. 3a; 7.

Of moderately pressed form, 60 mm long. The distal, very flat saddle-shaped articulating surface is 26 mm wide, 29 mm high; a flat middle ridge divides it; the dorsal side projects proximally forward with slightly blunt corners. The body is only slightly narrowed, it is about 21 mm wide at the narrowest place. The distal pivot is divided deeply and symmetrically by a median groove; the width is 26 mm on the "plantar" side, 14 mm dorsally, 20 mm high laterally and 22 mm medially. On the medial side is a round depression about 8 mm in diameter, on the lateral side is a similarly shallow depression that is less sharply bordered. The body has an oblique, rounded-triangular cross-section; to what extent the obliqueness is a product of pressure is not possible to decide. The proximal articulating surface fits so well with the preceding phalanx that it is very probably the second phalanx.

Fourth (?) Phalanx of Left Pedal Digit IV.

Pl. VII, Fig. 3a; 8.

Short, small phalanx 36 mm long. The proximal, saddle-shaped articulating surface has a triangular shape, is 21 mm wide, 23 mm high, very concave with a rather sharp ridge on the midline. The body is very short. On the distal pivot the medial side is strongly drawn forward. The height on the sides is 18-1/2 mm medially and 17 mm laterally. There are distinct holes on both sides of the pivot. The pivot has a width of 20 mm on the "plantar" side, it narrows rapidly dorsally to about 10 mm. The short form and small size in comparison to the phalanges of digit II show that it is a phalanx of digit IV, probably either the third or fourth, and probably from the left foot because of the obliqueness of the distal pivot.

Remains from the *Dysalotosaurus*-Quarry.

At the area (Ig. and W. J.) that delivered such large amounts of a great herd of *Dysalotosaurus lettow-vorbecki* Pomp., the preparation of the raw material yielded a dorsal vertebra and a manual phalanx. The former certainly belongs, and latter probably belongs, to *Elaphrosaurus bambergi*. The place of discovery lies about 800 m from that of the type skeleton in the same horizon, in the Middle Saurian Bed. These two bones are the only ones other than the skeleton that have been found. It is certainly possible, however, that further work with the extraordinarily rich material from the *Dysalotosaurus*-quarry will bring more to light.

Posterior Dorsal Vertebra.

Text-fig. 16.

The vertebra is missing the upper section of the spinous process, most of the left diapophysis, and the outer end of the right diapophysis. These are partly pushed out of place and distorted by pressure. The fractures (or clefts, cracks, etc.) are very well preserved and not filled with chalkspar, as on the skeleton, and allow some new details to be noted. The vertebra corresponds in all aspects with the ninth vertebra of the skeleton; but it is only 3/4 the size, the centrum is 70 mm on top and 68 mm on the bottom, the distorted (or crooked, bent, slanting, etc.) end surfaces are 44 mm wide and 41 mm tall anteriorly and 42 mm tall posteriorly. The suture of the neural arch with the centrum is still generally distinct. The centrum is constricted to about 19 mm in the middle section, that is, less than half the width of the ends; the axial part of the centrum is symmetrically round and stands out over the middle depression[*]. The very well preserved facet of the left prezygapophyses is egg-shaped, 12 mm long and 10 mm wide; it is clearly convex in a lateral direction. The sharp lateral margin of the postzygapophysis is offset to the front by an interruption in the posterior edge of the diapophysis. The descending ridge formed from the two postzygapophyses broadens toward the underside in a wedge shape and has a hole-like indentation on the underside near the posterior end. The free part of the right diapophysis looks like a plate about 30 mm across. The greatest length from prezygapophysis to postzygapophysis is 92 mm.

Second (?) phalanx of Manual Digit II (?).

Pl. VII, Fig. 9a, b.

The extremely well-preserved bone is very slender, almost straight, and 55 mm long. The proximal articulating surface is saddle-shaped, 14 mm high, 12 mm wide, dorsally somewhat narrowed, and finally with a blunt point; the middle ridge is very noticeable, it shows a strong concave indentation from the side view. The shaft of the bone has a high triangular cross-section proximally with dorsal rounding but a plantar surface with corners (or ridges, edges, etc.) bordering it. Distally the plantar edges become rounded and just before the distal pivot joint the cross-section is quadrangular. The smallest width is 6-1/2 mm. The almost asymmetrical, 10-1/2 mm tall pivot is deeply indented in the middle, and is drawn toward the plantar side quite a ways proximally, becoming slowly broader – from 7 mm to 9 mm – and more deeply indented. The well-developed holes on the sides sit right under the dorsal margin of the pivot.

Because of the great slenderness one can only compare it with the 2nd or 3rd manual digit of *Ornitholestes hermanni* OSBORN. It is reasonably certain that it comes from the same individual as the previously described vertebra from the same quarry, so one must imagine the phalanx as about 1/3 larger to bring it into the range of metacarpal I of the skeleton. Because it would then be too weak for a phalanx of the first finger, I would rather designate it as belonging to the second digit, probably as the 2nd phalanx and, because of the only very slight divergence from the symmetry, as one on the right manus.

Summary of Diagnostic Characters of *Elaphrosaurus* and Comparison with Other Coelurosaurs.

[*] This last part after the semicolon didn't make sense to me – it didn't have a subject, all the nouns were in the wrong case – JDO.

The following are the diagnostic characters of *Elaphrosaurus bambergi*: the relatively elongated form of the cervical vertebrae and the dorsal vertebrae, the biconcave form of the cervical vertebrae and the strong emphasis of the pleurocentral indentation of the same, the ossification of the fusion of the cervical ribs, the wing-shaped widening of the diapophyses on the neck and trunk, the presence of a presacral vertebra in the sacrum, elongated form of the posterior caudal vertebrae and a strong development of their prezygapophyses, the distinct shortening of the upper arm and probable lengthening of the manual digits or at least a part of them, great length of tibia, fibula, and metatarsus, compression of the proximal ends of the metatarsals by the start of the dislodging of the third out of the dorsal surface of the middle foot by the second and fourth metatarsals.

The elongation of the cervical vertebrae appears to be an instance of higher specialization as compared to *Struthiomimus* and *Coelurus* or *Ornitholestes* and *Compsognathus*. The strengthening of the prezygapophyses on the posterior caudal vertebrae is even more extreme on *Struthiomimus* or *Ornithomimus* than on *Elaphrosaurus*. The humerus on *Elaphrosaurus* is less well developed (or less specialized?) when compared to the femur than on the other genera. The length of the tibia and metatarsus to the femur is the same as on *Struthiomimus*, smaller than on *Compsognathus*, and much greater than on *Ornitholestes*; the table shows that (see page 47) with the measurements and the ratios (femur = 100%), but I had to omit *Compsognathus* because of lack of exact figures. The hind limb of *Elaphrosaurus* is definitely to be considered as a running appendage, the joining of the proximal sections of the metatarsus is a firm column; but the anchoring of the three middle foot bones is not as extreme as on *Ornithomimus* and *Struthiomimus*, where the third bone is pushed completely out of the dorsal surface toward the rear, in a bird-like manner, by its neighbors.

	Humerus	Femur	Tibia	Metatarsal III
Elaphrosaurus	262 [50]	529 [100]	608 [115]	391 [74]
Ornitholestes[1]	127 [61]	207 [100]	159 [77]	117 [57]
Struthiomimus[1]	310 [65]	480 [100]	540 [113]	370 [77]

[1] Dimensions inferred from OSBORN's [1916] work.

The Articulation of the Vertebrae.

The incompleteness and often poorly preserved condition of the articulating processes of the presacral vertebrae regretfully does not allow an exact and exhausting inspection of the articulation and the possibilities of movement. The biconcave build of all the presacral vertebrae naturally allows possible movement of two neighboring vertebrae in all conceivable directions. The degree of movement of two neighboring vertebrae is in no way determinable from the nature of such concave end surfaces, but one could not go too far wrong, if one assumes a greater degree of movement possibilities for deeply concave end surfaces than for those with less concave end surfaces, that is, more for the centra of the cervical vertebrae than for the dorsal vertebrae, but of course only in those directions allowed by the connection of the zygapophyses. Of all the cervical vertebrae, only vertebra b, which I regard as the 4th, shows a prezygapophysis that has retained a facet; it is narrow and distinctly convex longitudinally. But because the entire prezygapophysis is apparently shifted from its position in relation to the neural arch, nothing definite can be said about the position of the facet in relation to the axis of the centrum. The facets of the short postzygapophyses of vertebra a, which I assume immediately precedes vertebra b, make an angle of about 45° with the median plane and show a very weak convexity in the anteroposterior region. The steepness of the postzygapophyseal facets enables an abundant sagittal movement; it provides an obstacle to lateral movement that could perhaps, by the convexity of both facets in connection with the shortness of the postzygapophyses, be overcome to the extent that a weak lateral movement was possible, but the extent is not determinable. Of the posterior cervical vertebrae, vertebra f is the 9th vertebra and has a complete right prezygapophysis; the postzygapophyses are both perfectly preserved, as is the left one on vertebra e. Prezygapophyses and postzygapophyses of this region both project quite a ways past the end surfaces of the centrum and therefore touch each other for quite a distance. The flat curvature of the facets toward the inside is not suited for sagittal movement, the medial, downward-projecting ridge on the rectangular (in cross-section) postzygapophyses almost excludes any lateral movement; however, this lateral hindrance is apparently strongly reduced in its effectiveness and the sagittal flexion is also favored, in that the facets of the postzygapophyses are markedly convex and with some approximation could be designated as sections of a rotation body with the rotation axis running up and outward. On such convex surfaces the facets of the prezygapophyses could perhaps roll off, whereby both lateral and sagittal movement could be accomplished, even if only very limited movement. The curvature of the prezygapophyses toward the inside (or curve is open to the inside) would be good for this type of movement, as it would favor the contact in lateral movement. The postzygapophyses of all vertebrae from the transition vertebra g to the sacrum, which separate on the first two and fuse together on the others, exclude all lateral motion because of the downward slant of their medial margins. Motion in a sagittal direction must have been possible to some degree, probably to a greater degree in the anterior section of this group, where the groove has a definite curve about a ventral pivot point, than in the posterior section, where the groove is straight. The surface of the facet of the prezygapophysis is preserved on the 15th vertebra, is convex in a lateral direction, and fits the trench of the postzygapophysis.

In summary it can be said that, in spite of the poor preservation of the parts in question, the articulation in the anterior part of the neck allowed abundant sagittal and a limited lateral movement, in the posterior part allowed weaker movement in both directions, whereas in the trunk only sagittal movement was possible.

In the anterior section of the tail the facets of the articulating processes are curved strongly in a medial direction and allow abundant sagittal flexion, and because the facets of the postzygapophyses are short, they allow some lateral motion. The latter ends soon toward the rear, because the 14th caudal vertebra has projections protruding anteriorly past the facets of the prezygapophyses that do not allow lateral flexure; but a weak sagittal motion is still a possibility. This must have been steadily decreased toward the posterior as the prezygapophyses grow together and perhaps by the 20th vertebra was practically gone. It is, however, inconceivable to picture the rear half of the tail as an unbendable rod, with at most a slight sagittal springiness. Whether the flexure possibilities increased again in the rearmost part of the tail is not possible to determine because the necessary vertebrae are missing. The function of the tail was certainly that of a balancing organ, as is assumed for most bipedal dinosaurs. In this assignment it would have been aided to a certain degree by the stiffness of its posterior half, in that the influence of the position of the center of gravity of the entire body during sudden changes of direction or of speed of motion by definite and measured changes of position of a stiff tail could be better regulated than with whip-like movements. The efficiency of the balancing organ, the tail, was increased by the increase in weight that resulted from the strengthening of the prezygapophyses and their compact, thick nature, as well as through the thick-walled structure of the posterior caudal vertebrae in general, that is, in marked contrast to the light build and thin walls of the presacral vertebrae and even the anterior vertebrae.

Reconstruction.

The attempt to reconstruct *Elaphrosaurus bambergi* is justified in spite of the lack of important parts, especially the skull, because the available material shows important size relationships and a fairly good representation of the animal. Because the build of the hind limb gives the animal the appearance of a fast runner, I chose a running position for the reconstruction, with gradually ascending dorsal vertebral column, head held moderately high, and tail elevated off the ground in order to best show the running characteristics. Coinciding with the elongated shape of the dorsal vertebrae, I also believe the body (or trunk) was slender, which appears to me to agree with the small length of the ischium in relation to the length of the vertebrae. The dorsal vertebral column has a slight curvature open to the bottom appropriate to the weakly developed wedge shape of the body. At the transition to the neck, where the end surfaces of the centra diverge somewhat ventrally, the vertebral column is bent in the other direction, but changes again in the anterior cervical area so that a strong curvature in the other direction brings the skull to a forward pointing direction. Of the hind limbs, the left retains the posture that would have resulted in lifting the foot off the ground, that is, with strongly flexed (bent) ankle. I chose this position after the example of the ostrich, which has a similarly strongly bent ankle, that reaches almost 90 degrees on *Casuarius*. The tail has a weak curvature (open to the bottom) in the anterior part, which soon changes to a reversed curve. The posterior half of the tail is almost straight and is shown as lifted off the ground. The skull on the reconstruction is purely hypothetical because none was found. The only clues to the skull are from the teeth that I place with *Elaphrosaurus*. The size of the maxillary and lower jaw teeth give an approximate size of the anterior cervical vertebrae. Stomach ribs (gastralia) were not found and are not shown. The length of the presacral vertebral column, with the missing vertebrae calculated into the empty spaces, is about 210 cm, which probably is not too far wrong. The length of about 305 cm for the tail is a bit hypothetical. The reconstruction would have a length of about 535 cm, with the head about 225 cm off the ground and the pelvis about 145 cm off the ground.

With these measurements from a side view, its thinness is noteworthy, the pelvis is only 20 cm wide. Its size relations, as well as the build of the hind limbs, stamp *Elaphrosaurus bambergi* as a very lightly built and fast runner. One can imagine that it preyed on the weaker elements of the dinosaur fauna, on *Dysalotosaurus,* juveniles of *Kentrurosaurus* and the sauropods, while at the same time relying on its agility and speed to escape the larger t h e r o p o d s .

Systematic Position.

The available skeletal material clearly shows that *Elaphrosaurus* is related to the lightly-built, more or less long-necked c o e l u r o s a u r s that are represented in the Jurassic by *Coelurus* and its possible synonyms *Ornitholestes* and *Compsognathus*, and in the Cretaceous by *Thecospondylus, Coelosaurus, Ornithomimus,* and *Struthiomimus*. The family Ornithomimidae that MATTHEWS and BARNUM BROWN (1922) give as including last 3 genera mentioned above, has been characterized, due to *Struthiomimus*, as being toothless and having jaws perhaps covered with a horny beak, a bird-like skull, and a bird-like metatarsus. In the build of the metatarsus of *Elaphrosaurus* one could see the beginning of a development that would lead to *Struthiomimus*. But the week approach in this one character is not sufficient evidence to place *Elaphrosaurus* as the ancestor of the Ornithomimidae. It could be a product of convergence through similar function. One must also be careful in the consideration of this character as a phylogenetic key because *Gorgosaurus* is a very differently structured animal, but has the same type of metatarsus as *Struthiomimus* and *Ornithomimus*. If the teeth I have assigned to *Elaphrosaurus bambergi* actually do belong, which I consider very probable, that would stand in opposition to the toothlessness of the skull of *Struthiomimus*. The difference between *Elaphrosaurus* and *Struthiomimus* and the Ornithomimidae is at any rate large enough and unestablished that it cannot be added to the family. The investigation of any relationship to *Coelurus*, *Ornitholestes*, and *Compsognathus* would need to rely heavily on the skull, which is not known in *Elaphrosaurus*. As far as vertebral columns can be compared, close affinities to those genera or to *Thecospondylus* are not visible. The similarity is noteworthy that *Elaphrosaurus* shows to the lamella-like, wing-shaped form of the transverse processes that are already developed on the coelurosaurs of the Triassic, as shown on *Procompsognathus* from the Württemburg Keuper (v. HUENE 1921b), on the former's possible synonym *Pterospondylus* from the Keuper of Halberstadt (JAEKEL, 1914; v. HUENE 1921a), and on *Podokesaurus* from the Triassic of North America (v. HUENE, 1914, 1921a). More exact and extensive results concerning *Elaphrosaurus*'s relation to contemporary, older, or younger forms cannot be reached because of lack of sufficient data. Tentatively I am placing *Elaphrosaurus* in the family C o e l u r i d a e .

Tibiae of other coelurosaurs.

Small Right Tibia of Coelurosaur A from the Stegosaur-Quarry (St) of the Middle Saurian Bed at Kindope, Tendaguru.

Pl. VI, Fig. 2a, b, c.

The generally complete bone (*St* 661) is flattened in its proximal and distal sections, but the proximal end surface is only slightly affected and the distal end is not affected at all. The general shape is very narrow. The shaft shows a triangular, posteriorly rounded cross-section on its middle, undeformed section. The proximal two-thirds of the tibia are almost straight, the distal third curves toward the front but it is either mostly or entirely due to pressure. The tuberosity projects relatively weakly anteriorly. The very distinct lateral condyle dips toward the outside and rear with a strong convexity quite a ways to the bottom, and because of a weak indentation of the side, has an indistinctly segmented, particularly small, anterior, knob-shaped projection. The lateral crista, whose outermost margin is broken off, grows distally out of a rounded edge (or corner) of the anterior knob of the lateral condyle as a ridge, which becomes indistinct again about 44 mm from the upper surface of the lateral condyle. From about this same point a lateral edge (or corner) can be followed distally to about 33 mm from the distal end, and along with the lateral corner of the shaft, borders a weakly indented surface that narrows from 5 mm to 3 mm . Between this and the tuberosity is a moderately wide, 7 mm wide trough (or basin). Toward the posterior, the lateral condyle is separated by a narrow notch from the sharply projecting, pointed, and laterally curved posterior end of the head of the tibia. The proximal articulating surface is excellently preserved, only the medial margin is slightly peeled off, which created a shallow indentation on an otherwise flatly convex contour. The broadening of the distal end is not important; it is stronger on the lateral than on the median side; the lateral wing also projects more distally forward. The distal end can be described as a right triangle, whose right angle lies posterior and whose lateral sharp edge is long and narrow and makes a flat arch open to the rear. In the region of its greatest width, the end surface is indented. The thicker medial wing has an enlarged articulating surface on its anterior edge for the astragalus, which reaches 5 mm up the anterior wall. The medial margin of the medial wing is a straight, 7 mm long, proximally sharply dropping edge. The groove for the ascending process of the astragalus is a depression 7 mm wide and 16 mm long; its lateral border forms a ridge (or corner) and the medial border forms a sharper one that runs for a distance of 11 mm from the medial outer ridge (or corner) of the distal edge, quite exactly in the middle of the anterior surface of the latter.

Length	163 mm
Greatest length of the proximal articulating surface	30 mm
Greatest width of the proximal articulating surface	17 mm
Minimum width of the shaft	11 mm
Thickness perpendicular to the minimum width	11 mm
Greatest length of the distal end surface	25 mm
Greatest width of the distal end surface	11 mm

The very thin general shape, the small width of the head and distal end assign the tibia to a coelurosaurian. Of course it could be suggested that it is the bone of a very young theropod. It would not be the bone of a young *Elaphrosaurus bambergi* because it differs from the tibia of *Elaphrosaurus* in the profile of the distal end and in having the distinct groove for the ascending process of the astragalus. The small tibia is apparently a second coelurosaurian species, which I refrain from naming.

Right Tibia of Coelurosaur B from the Stegosaur-Quarry (St) of the Middle Saurian Bed at Kindope, Tendaguru.

Pl. VI, Fig. 3.

The undeformed tibia (*St* 904) is 21 cm long but lacks the proximal end which is estimated to have been about 3-1/2 cm. The shaft is almost perfectly straight, with almost unnoticeable curvature open to the rear, its cross-section is triangular, rounded in the rear. The posterior, broadly rounded edge is shifted proximally toward the lateral side and distally under the flattening toward the medial side. The lateral crista grows out of the anterior surface near its lateral margin as a narrow ridge and is preserved for 36 mm. Behind the crista, about 1-1/2 cm from the proximal break is the large foramen that is 1 mm wide. A narrow, shallow zone 4 mm wide runs immediately next to the lateral margin of the crista distally to the start of the distal widening. The latter is minimal, very unimportant on the medial side, especially when one mentally adds the outermost margin; laterally the contour projects a little more. Distally the lateral wing projects forward somewhat. The distal end surface is narrow; posteriorly right-angled, laterally narrowly drawn up, and curved in an arch open to the rear. In the area of the posterior right angle is a rather deep, longitudinal groove. The indentation for the ascending process of the astragalus is relatively broad, 16 mm, by 23 mm long, and distinctly bordered, its medial margin is only 5 mm from the outer edge.

The thickness of the bone wall is minimal, only 3 mm under the start of the crista.

Preserved length	209 mm
Width of the shaft in the middle part	17 mm
Thickness of the shaft in the middle part	14 mm

Length of the distal end surface	29 (+) mm
Width of the distal end surface	12 mm

The extraordinary narrowness of the tibia shows the affinities to the coelurosaurs. It is not *Elaphrosaurus bambergi* for the same reasons as discussed in the previous section. It is not conspecific with the other small tibia, though, because the groove for the ascending process of the astragalus is almost twice as wide, relatively, and its medial margin is pushed much wider medially. The tibia is therefore a third coelurosaur*.

Left Tibia of Coelurosaur C from Quarry H of the Upper Saurian Bed at Tendaguru.

Pl. VI, Fig. 4a, b.

The 81 mm long proximal part of the tibia (*H* 24) does not appear to match the 174 mm long distal section. A piece about 2 cm long was made out of plaster-of-Paris to bridge the gap. The uniformly slender shaft shows a weak curvature, open to the medial side; it is at least accentuated by mechanical bowing. The cross-section of the shaft, like the other tibiae, is triangular and rounded posteriorly. The marginal, indented longitudinal zone on the anterior surface in the middle section of the shaft has a relatively broad width of 7 mm. On the proximal end all the marginal parts are weathered, especially the lateral condyle. The measurement figures for length and width are therefore somewhat small. The tuberosity projects quite strongly; the hollow between it and the lateral crista is rather wide and shallow. Under the lateral condyle the lateral surface rounds into the narrow posterior surface. The lateral crista is formed as a sharp ridge from the lateral condyle. The distal end is only moderately expanded, and is weathered on its projecting ends; its end surface has a posterior blunt angle, its groove is indistinct. The surface for the ascending process of the astragalus reaches notably far medially and is bordered medially by a very narrow, marginal ridge; the rest of the bordering is indistinct, it appears to extend 32 mm proximally.

The thickness of the bone wall is 3-1/4 mm at a point 3 cm from the proximal end of the distal part.

Length	255 (+) mm
Greatest length of the proximal articulating surface	46 (+) mm
Greatest width of the proximal articulating surface	25 + mm
Minimum width of the shaft	19 mm
Thickness of the shaft in its middle section	15 mm
Greatest length of the distal end surface	35 (+) mm
Greatest width of the distal end surface	15 mm

The tibia shows great similarity to the previously described tibia without the head. The medial zone of the indistinctly bordered surface for the ascending process of the astragalus is still somewhat narrower and differs by running further upward as a sharp ridge; distally the lateral wing protrudes less; the shallow depressed zone that borders the lateral margin of the shaft is much broader. It seems quite doubtful that they are the same species, particularly because they are from different horizons. The small tibia from Quarry St shows the same differences from this one as mentioned in the comparison between the other two tibiae. In addition is the much flatter rounding below the lateral condyle and the flattening of the crista on its proximal section below the condyle.

* Originally “coelosaur”. – JDO.

As compared to *Elaphrosaurus bambergi*, the last mentioned deviation is true, plus the difference on the distal end is the marginal parts that strongly project from the surface and medially enclose the surface for the ascending process of the astragalus. So this tibia probably represents a fourth species of coelurosaur in the Tendaguru Formation.

Theropods.

Preliminary Remarks.

The less abundant supply of larger t h e r o p o d bones is divided in the following manner into groups from the Middle and Upper Saurian Beds.

a) M i d d l e S a u r i a n B e d .

1. S t e g o s a u r – Q u a r r y (*St* and *E H*; the material collected by Dr. H. Reck in 1912, the 4th year of excavation, from Quarry *St* is marked by *E H*).
   6 vertebrae, 1 ilium.

b) U p p e r S a u r i a n B e d .

2. Quarry *Mw*, northeast from the Tendaguru summit (or knoll).
   1 quadrate, 3 vertebrae, 1 fibula.
3. Quarry *LT*, south of the Tendaguru summit (or knoll). It encompasses 1-1/2 hectares. Also in this area are individual finds 68 and 69.
   8 vertebrae, 3 femora, 2 tibiae, 1 pedal phalanx.
4. Individual find 67, west of the Tendaguru summit (or knoll).
   1 tibia.
5. Individual find 37, north of the Tendaguru summit (or knoll).
   1 tibia.
6. Quarry *H*, northeast of the Tendaguru summit (or knoll).
   1 manual phalanx.

From the 6 sites there have been 29 bones found, of which the vertebrae are largely incomplete.

Material from the Stegosaur-Quarry (St).

In good preservation, there are a cervical vertebra without the centrum, a posterior dorsal vertebra, the centrum of an anterior caudal vertebra, a middle caudal vertebra, two fused caudal vertebrae from the posterior half of the tail, and an ilium.

Cervical Vertebra.

Text-fig. 17.

The vertebra St 297 is lacking the centrum that was not fused with the bone of the upper arch; it did not come from a full-grown animal. The suture surfaces curve strongly outward toward the rear, the left surface is complete and is 74 mm long; its falling-down is more pronounced toward the rear. The broad prezygapophyses point up and forward; their bottom contour rises steeply in the side view. The facets of the prezygapophyses make an angle of less than 30 degrees to the inside. Its only partially complete anterior margin appears to be broadly rounded. The distance of the incomplete outer margins of the prezygapophyses is estimated to have been about 95 mm[*]. Underneath the anterior edge of the prezygapophysis forks into two small supports; of these, the medial one runs vertical to the bottom, whereas the other one curves weakly under and runs to the anterior edge of the diapophysis. The latter – almost complete on the right – is a rather long, anteriorly thin, posteriorly thick projection with a triangular outline, whose incomplete outer tip reaches 75 mm from the median plane of the vertebra. Underneath the transverse diapophysis is strengthened by two thin supports, the anterior one rises steeply up and the posterior one curves slightly to the rear. The two supports form the walls that separate three deep indentations. The postzygapophyses are completely preserved; between them lies a rather broad gap (or fissure, chasm) that reaches up over the neural canal. All that is left of the spinous process is a short, thick, anteriorly steep stump, which indicates nothing of its height and width. At the base of the spinous process lies a deep, large, round depression (or groove). The distance between the two outer edges of the facets of the prezygapophyses and postzygapophyses is 92 mm in its present state, but could have been 15 mm more originally. From the steeply ascending prezygapophyses and the diagonal position of the facets, it is apparent that it is one of the posterior cervical vertebrae.

The question whether the cervical vertebra comes from the same animal as the middle caudal vertebra (*St* 270) and the fused posterior pair of caudal vertebrae (*St* 757) from the same quarry, can be handled with a comparison of sizes. Based on GILMORE's work (1920) on *Ceratosaurus* and *Allosaurus* (*Antrodemus*), the caudal vertebrae are much too large to belong to the same animal as the cervical vertebra. The fact that the neural arch on the cervical vertebra is not fused to the centrum, but the caudal vertebrae are so well fused that a suture is not even visible, is even better evidence that they are from separate individuals, even if fusion takes place earlier in the caudal region than the dorsal or cervical areas in some dinosaurs, as in the sauropods. The possibility of the cervical vertebra and the dorsal vertebra *E H* 103 belonging to the same individual appears very unlikely because of the different shape and much finer construction of the entire neural arch of the latter. The cervical vertebra's belonging with the anterior caudal vertebra *E H* 129 would be possible size-wise, but not in any other way. The specific designation is therefore not achieved by matching it with any of the other remains from the same or other quarries.

The comparison with *Ceratosaurus nasicornis* is impeded because the latter has no illustrated posterior cervical vertebra; I must therefore use the side view of the sixth by MARSH (1896, Pl. 9, fig. 4) and an illustration by GILMORE (1920, Pl. 20, fig. 5). It is unfortunate that the facet of the postzygapophysis is not visible in the figure, because it must have been visible in order to meet the medial-ward curved facet of the prezygapophysis. Whether or not this is a result of preservation or illustration, cannot be determined from the figure. The vertebra of *Ceratosaurus* differs in that the diapophysis is notably more slender and its ends slope further down: these are two differences that are to a certain extent a result of the more anterior placement in the throat. The facets of the prezygapophyses project further medially than is evident on MARSH's figure. The anterior profile of the spinous process ascends vertically from the base on the African specimen, whereas it is diagonal on *Ceratosaurus*. If and to what extent these differences are valid when compared to vertebrae of similar position, is impossible to discern. Much better comparisons are possible with GILMORE's illustrations of cervical vertebrae of *Allosaurus* (*Antrodemus*). The prezygapophyses of the last cervical vertebra, the 8th or 9th, are similarly shaped, but project somewhat higher than on the African vertebra. The latter also differs by having an extensive

[*] Originally "m". I don't know whether he means 95 mm or 95 m between the two outer margins. – JDO.

depression on the anterior wall of the prezygapophyses. The diapophysis of *Allosaurus* is more strongly directed toward the rear and leaves less of the posterior wall of the neural arch freer than on the Tendaguru vertebra. Unfortunately the preservation does not permit comparison of the height of the spinous process. From *Gorgosaurus libratus* of the Belly River Formation in A l b e r t a , LAMBE (1917, fig. 14) gives the side view of a series of neural arches from cervical vertebrae. It agrees with GILMORE's illustration of *Allosaurus*, in that the prezygapophyses on the 4th cervical vertebra are directed forward and on the posterior ones are steeper, even more so than on *Allosaurus*. Our cervical vertebra is very similar to the 6th one on *Gorgosaurus* in respect to the length and position of the prezygapophyses. I believe I can determine from Lambe's picture that the pocket below and in front of the postzygapophysis is less developed on the 6th vertebra of the American specimen than on the cervical vertebra from T e n d a g u r u . Because of the inadequacy of the comparison basis, the comparison with the American forms does not give positive results. The question remains as to which of the various forms the T e n d a g u r u vertebra belongs, or if it is entirely new. In any event it would be a large species. Even if it is not as large as those of *Allosaurus* and *Gorgosaurus* pictured by GILMORE and LAMBE, it must be remembered that it is not from an adult.

Posterior Dorsal Vertebra.

Pl. VIII, Fig. 1a, b, c.

The undistorted vertebra (*E H* 103) is missing the entire left transverse process and the distal half of the right one. The very constricted middle part of the rather elongated centrum has a ventrally rounded cross-section; across the middle the flanks are only shallowly depressed. The end surfaces are somewhat taller than wide and are very weakly concave; very distinct, fine grooves and ridges run from the edges on the outer walls of the centrum and form a 2 cm wide rough zone that stands out from the rest of the smooth surface. The fused suture between centrum and upper arch is a line that is weakly convex, open to the top. Behind and above the middle there is a very narrow 1 mm wide foramen on the left flank and a very narrow 2 mm wide foramen on the right flank. The transverse process is only 44 mm wide at the base and becomes narrower distally and rises weakly upward; it is supported by a strong support near the posterior margin, which separates an anterior wide, deep indentation from a posterior, narrower one. The anterior margin of the transverse process is split near its roots and thereby makes a small indentation that opens to the front between the prezygapophysis and the parapophysis. The latter is a short process with a round, slightly elliptical, shallowly indented facet, whose upper margin is slightly higher than the cover of the neural canal. The prezygapophyses are narrow, massive projections that barely extend past the anterior end of the centrum. The facets make an angle of less than 25 degrees toward the middle, have a width of 13 mm, and a length of 22 mm; the somewhat rounded inner edges are 6 mm apart, and the facets continue with the slope of the inner walls of the processes, which slope diagonally down and diverge outward. The broad spinous process is thin, only 6-7 mm thick, and of moderate height; it extends 131 mm above the base of the neural canal. The anterior margin is deeply split and rises with very little curvature toward the rear, the posterior margin rises halfway with a slope to the front and then the rest of the way sloping to the rear. The minimum width is halfway to the top and is 50 mm, the upper margin rises toward the rear in a weakly convex arch, is 68 mm long, and anteriorly and posteriorly is thickened. The postzygapophyses grow uniformly thicker from the very thin double walls of the deeply split lower half of the posterior margin of the spinous process. Their facets are horizontal grooves that are not uniformly rounded, but are more like two weakly concave surfaces that would meet each other at a rounded right angle and have the same slope as the corresponding surfaces of the prezygapophyses. The walls of the articulating grooves are very thin-walled and divided posteriorly by the continuation of the split in the posterior wall of the spinous process. The neural canal is sunk in anteriorly and posteriorly from the upper margin of the end surfaces of the centrum; its width is about 16 mm, its height a few millimeters more.

Total height	193 mm
Greatest length (from prezygapophyses to postzygapophyses)	105 mm
Upper length of the centrum	80 mm
Lower length of the centrum	79 mm
Width of the anterior end surface of the centrum	59 mm
Height of the anterior end surface of the centrum	65 mm
Width of the posterior end surface of the centrum	61 mm
Height of the posterior end surface of the centrum	about 65 mm

Characteristic of the vertebra are the elongated form of the centrum, the thin lamellar build of the transverse process, spinous process, and postzygapophyses, the and the broad and relatively low outline of the spinous process. It is apparently a lightly built type that cannot belong to the heavier Northern Hemisphere t h e r o p o d genera like *Allosaurus, Megalosaurus, Gorgosaurus*, or *Ceratosaurus*. Connections with *Elaphrosaurus* or other c o e l u r o s a u r s come even less into consideration. The dorsal vertebrae of *Allosaurus* (*Antrodemus*) pictured by GILMORE (1920) are very much bulkier in all parts of the upper arches, spinous process, prezygapophyses and transverse processes. In addition *Allosaurus* has much shorter vertebral centra and differs by having more definite indentation in the middle. The parapophysis on GILMORE's illustration of the 9th and 14th dorsal vertebrae sits a little deeper than on the vertebra from T e n d a g u r u . At least the position in the posterior half is assumed for the latter. The anterior view of the sacrum and pelvis of *Ceratosaurus nasicornis* by GILMORE (1920, pl. 21, fig. 2) shows a good view of the last presacral vertebra, the anterior end of the centrum is circular on the third to the last presacral, and somewhat taller on the African vertebra; however this difference could be a matter of positioning it further forward. *Ceratosaurus* differs greatly in that the entire neural arch, in relation to the vertical diameter of the anterior surface of the centrum, is much higher and becomes much broader toward the bottom.

Anterior Caudal Vertebra.

Only the rather elongated centrum (*E H* 129) is extant. The weathered margins of the end surfaces may have been somewhat oval; one is very weakly indented, the other, presumably the anterior, is very strongly indented; the deepest place is a short transverse furrow that is in the middle of the deepest end and just above the middle on the other one. The middle of the centrum is strongly constricted, the flanks and ventral side are flattened and divided by blunt edges (or corners). In the middle the flanks are sunken in to the point of being definite trough (or bowl) shaped depressions. The ventral contour shows that the margins of the end surfaces on the underside were thickened to form a place of attachment for the haemapophyses. Ventrally the centrum is 77 mm long; the anterior end surface in its present state is 57 mm wide and 60 mm tall.

With respect to size and form this caudal vertebra could belong to the same individual as the previously described dorsal vertebra. Then the elongated form would not prohibit placing it with the anterior caudal vertebrae, where the size of the end surfaces would place it.

Middle Caudal Vertebra.

(*C e r a t o s a u r u s* (?) *r o e c h l i n g i* n. sp.)

Pl. VIII, Fig. 2a, b.

The centrum of this vertebra (*St* 270) has an elongate shape. The end surfaces form a right angle on top, are rounded on the bottom, and slope slightly forward from bottom to top, and are very concave so that there is a particular, smaller trough inside a bowl-shaped indentation just above the middle of the surface. The middle part of the centrum is very constricted; its lower contour is a rather high arch; the flanks are rather flat here, and converge toward the bottom; so that a narrow, ventrally tapering cross-section is the result; ventrally there is an 8 mm wide field enclosed by fine keels, on the posterior end of which is a narrow, deep indentation. On the swollen ventral margin of the posterior end surface are facets for haemapophyses; the better preserved left one has a rounded outline, with a 1-1/2 cm diameter. On the flanks about midway to the top is a long, shallow groove. Only the left transverse process is preserved and is a 3-1/2 cm long incomplete platform about 3-12/ cm wide and 12 mm thick; it is about the same height as the roof of the neural canal and is horizontal and directed to the rear. The left prezygapophysis is preserved and projects up and out; its facets sue sunken in about 45 degrees. The cross-section is shaped like a T-beam with a bulky, outward and downward projecting middle bar. A sharp, horizontal keel runs from the transverse process to the prezygapophysis. The spinous process is missing. About 2-1/2 cm from the anterior end of the centrum, the neural canal is 15 mm high and 12 mm wide. The sides of the centrum have very asymmetrical foramina; on the left there is one above the middle, a narrow one just in front of it, and a large one posterior to it, on the right there are two narrow ones in front of the middle, four narrow ones behind it and two wider ones further back. The vertebra may have sat on the border between the first and second quarters of the tail. The upper length is 123 mm, on the bottom it is 115 mm, the width of the anterior end surface of the centrum is 70 mm, its height is 78 mm, the width of the posterior end surface is 67 mm, its height is 69 mm.

The striking ventral furrowing of the centrum and its strongly compressed sides are characters that show a remarkable similarity to the caudal vertebrae of *Ceratosaurus nasicornis* MARSH, shown by GILMORE (1920, pl. 22) and by MARSH. The centrum form of the 9th or 10th caudal vertebra would correspond with our vertebra. It apparently belongs to the same species or at least the same genus as the middle caudal vertebra from Quarry Mw, which is also designated *Ceratosaurus* (?) *roechlingi*.

Posterior Middle Caudal Vertebra.

(*Ceratosaurus roechlingi* n. sp.)

Plate VIII, Fig. 3.

The ends of two vertebrae (*St* 757) are so anomalously grown together they make a definite bend. The line of fusion on the bluntly cornered side is distinct and in normal position; on the inside the fusion is stronger and the suture, as far as it is recognizable, is not straight, but instead is drawn quite a ways anteriorly. The centrum is elongated. The shape of the end surfaces is low, approaching roundness; the anterior is funnel-shaped and indented; the part of the indentation is just over the middle and forms a narrow, flat base; the posterior, ventrally incomplete end surface is shallower; above its middle is a convex swelling about half as wide as the end surface. The moderately constricted middle section of the centrum has a low rounded cross-section about 36 mm across. On the ventral side, apparently in connection with the bent fusion of the vertebrae that is displaced out of the median line, is a shallow indented longitudinal field, which is somewhat wider and less sharply bordered than on the previously described larger caudal vertebra. In front of the posterior end the field is deeper than the previously described one, but by no means very deep. On the flanks, just over the middle, are shallow, longitudinal furrows. The incomplete transverse processes are about in the middle of the elongation, at about the height of the base of the neural canal on the posterior vertebra, and a little higher on the anterior one; on the latter they could have had a width of 2 to 2-1/2 cm, based on the remaining stump. The intact prezygapophyses on the posterior vertebra rise at an angle of less than 45 degrees, have a narrow triangular cross-section, and facets that slope down very steeply toward the inside. Only the basal part of the spinous process is preserved; its anterior edge lies about 1/3 of the length of the centrum*. The postzygapophyses have sharp-edged (or cornered) facets, that are very steep and on the posterior vertebra have a height of about 17 mm and a width of about 13 mm. A ridge runs forward and diagonally upward from the transverse processes to the prezygapophyses, and a less distinct ridge runs toward the posterior. On both sides of the posterior end of the centrum is a striking, several millimeter thick plate of bone, out of which the upper arch grows. The neural canal has a round cross-section about 10 mm in diameter that broadens toward the rear. It should be noted on the illustration that the postzygapophyses on the rear vertebra are without definite fitting (or passable, suitable) surfaces, so a missing piece is restored.

In its size relationships, in the forming of its ventral furrow, and in the fine details of the upper surface sculpture they match the previously described middle caudal vertebra so well that I believe it comes from the same animal.

	Anterior vertebra mm	Posterior vertebra mm
Total length (pre- to postzygapophyses)		about 108
Upper length of centrum	about 91	85
Lower length of centrum	about 90	about 90
Width of anterior end surface of centrum	61	
Height of anterior end surface of centrum	55	
Width of posterior end surface of centrum		60
Height of posterior end surface of centrum	47	

Ilium.

Text-fig. 18.

The right ilium (*St* 233) is undeformed, with only unimportant defects, and is generally elongate, drawn out to the rear, and narrow uniformly. The dorsal margin is almost straight, above the acetabulum it thickens, and suddenly drops toward the front. The preacetabular wing has its greatest height above the preacetabular process and shows the concavity that is characteristic for the entire middle part of the ilium, whereas further forward a convexity is evident. The anteriormost part is unusually folded (or creased, bent, flexed, wrinkled), the steeply downsloping anterior edge is jagged (or crenulated) and has grooves running perpendicular to it. The postacetabular wing exhibits a groove on the bottom that becomes deeper and widens toward the rear and forms an upside-down Y-shaped cross-section. The medial wall of this trench (or groove) hangs further down than the lateral wall. The preacetabular process is a moderate process projecting forward and down with a cross-section in the form of an unequal sided right triangle, whose point is forward and whose right angle lies in the lateral margin of the acetabulum. The

* I presume he means the edge is 1/3 of the total length from the end (?).– JDO.

place of attachment for the pubis is broken down into an anterior convex and a posterior concave section. The postacetabular process is short, its rear side is strongly convex; the place of attachment for the ischium is not clearly preserved, but it was not very extensive. The acetabular surface of the ilium is about 1 cm wide, and anteriorly and posteriorly diminishes but in the middle is broadened by a rather distinct supra-acetabular crest. The entire acetabular area becomes narrower in the medial direction. The total length is 537 mm, the greatest width across the preacetabular process is 280 mm.

In general outline the ilium is very similar to that of *Allosaurus* (*Antrodemus*) *valens* Leidy by GILMORE (1920, pl. 13). On it the medial wall of the groove on the posterior wing extends farther down than the lateral wall only at the beginning, or in other words, not nearly as much as on the Tendaguru form. The preacetabular process is more anteriorly directed and the split between it and the lower margin of the anterior wing is narrower. The last two differences are even more pronounced on ilia from *Ceratosaurus*, and are also valid for *Megalosaurus* from Stonesfield. *Ceratosaurus'* ilium is much more elongate. The ilium of *Gorgosaurus* is much longer and taller in relation to the width of the acetabulum and is differentiated by its hook-shaped, downward pointing anterior wing. The much blunter, and anteriorly hook-shaped and downward pointing ilium of *Tyrannosaurus* is very different.

Quarry Mw of *Ceratosaurus* (?) *roechlingi* n. sp.

The Quarry Mw, northeast of T e n d a g u r u , in the Upper Saurian Bed delivered bones that were weathering out, namely a quadrate, a fibula, one whole and two half caudal vertebral centra, other pieces of vertebrae, parts of ribs, and other indeterminate broken pieces, all from a large theropod. Because of the manner of burial it was evident that they all belong to one individual. In my earlier communication (1920) I indicated the centrum from Quarry *T L* was a *Ceratosaurus* sp. and even from the same species as the material from Quarry Mw. I now prefer, however, to leave the affinities of that vertebra open to debate.

Quadrate.

Text-fig. 19.

The three-sided, incomplete piece of the left quadrate (*Mw* 2) is the distal portion and is 12-1/2 cm long in the proximodistal direction. The well-preserved distal articulation (or joint) is 13 cm wide; fused to its lateral end is still a piece of the quadratojugal that is curved almost 90 degrees. The articulating end carries on its medial end a very distinct, very oblique (or transverse) (in relation to the long axis of the entire joint) ridge, with a weakly curved longitudinal profile and rounded-pointed transverse profile and is very comparable to the condyle of a well-developed pivot point. The narrow lateral half of the joint has a rather flatly arched profile and narrows distally from about 40 mm to about 22 mm. The two sections of the joint are divided by a very shallow indentation that follows the lateral descent of the high crest-like medial part the indentation is therefore sharply diagonal to the long direction of joint. The greatest thickness of the distal end is about 1/3 of the width away from the distal end and is about 47 mm in its present condition. The plate of bone that ascends from the distal articulating surface is only visible on the medial side about 7-1/2 cm from the medial angle of the triangular outline and about 5 cm is preserved; it rises straight at an angle under 60 degrees with the distal margin and is thickly rounded. The posterior surface is very weakly concave in the direction from top to bottom, the anterior surface is shallowly concave for as much as is visible due to the state of preservation. About 11 cm over (or above) the deepest point of the distal margin, the ascending medial margin forks, so that a thick plate (or platform) proceeds anteriorly, which is definitely depressed like a bowl, but nothing can be said about its extent because all margins (or edges) are missing.

An exact comparison with the quadrate of other large theropods can only yield unimportant results, due to the incompleteness of the piece and thc scanty material illustrated in the literature. The illustration of the quadrate of *Allosaurus* (*Antrodemus*) by v. HUENE (1914, pl. VII, figs. 1, 2) and GILMORE (1920, fig. 13) show that it differs from this genus. The forking of the ascending medial margin, visible from the medial view, is shown by GILMORE 's illustration and text to be closer to the distal end in relation to the width of the distal end on *Allosaurus*. Perhaps one can conclude that the entire is relatively lower constructed. The sharp build of the medial section of the joint that is so characteristic of the African quadrate is not discussed by GILMORE and is not shown in v. HUENE 's rear view illustration and therefore is probably not present. Judging by OSBORN's illustration, the joint of *Tyrannosaurus* is thicker, its distal end is very differently, slightly obliquely truncated. The quadrate of *Ceratosaurus*, according to GILMORE, is very similar to that of *Allosaurus*, only considerably higher. Of interest also is the comparison with respect to the size of the quadrates from skulls of the American forms. The width of the distal end of the quadrate of *Allosaurus valens* LEIDY from skull no. 4734 in the National Museum in Washington is given by GILMORE (1920, p. 23) as 89 mm. Because this skull, from the posterior main condyle to the end of the premaxilla, is only 605 mm and the skull no. 666 of the New York Museum of Natural History is 885 mm long, one must assume a distal width of about 13 cm for the quadrate of the latter skull, which is scarcely less than the Tendaguru quadrate.

I find no statement by GILMORE about the distal width of the quadrate of *Ceratosaurus nasicornis*. Fig. 6 by OSBORN (1912) shows a distal width of 18 cm on the quadrate of *Tyrannosaurus*, that is, a much greater measurement. The saurian from Tendaguru from Quarry Mw would probably have been smaller than *Tyrannosaurus*. LAMBE's (1904, Pl. 7, fig. 19) anterior view of the distal part of the left quadrate of *Dryptosaurus incrassatus* (COPE) shows an articulating surface that is very, similar to the piece from Tendaguru. Further comparison is prohibited by the incompleteness of both bones. The greatest width of the quadrate of the Canadian species, that belongs to a 97 cm long lower jaw, is about that of the African species, as far as can be determined from the illustration (drawn to 1/2 scale). A discussion of relationship based on the quadrate is not possible.

Fibula.

Text-figs. 20a, b.

The proximal part of the left fibula (*Mw* 1) is preserved for 50 cm. The proximal end shows the typical, strong widening. It grows out of the shaft, that already at 32 cm from the proximal surface starts to broaden and then increases steadily in such a manner that the posterior contour continues to curve while the anterior remains straight due to an enlargement of a missing marginal piece. The proximal end is strongly arched (or swollen on the lateral side and falls away more flatly in the rear than in the front; medially it exhibits only a shallow, gradually developing longitudinal furrow; it is possible though, that it originally had sharper margins that have been lost through weathering. The longitudinal furrow is quite faded out about 25 cm from the proximal end. Further distally it becomes pronounced again. The 167 mm width of the proximal end should be added to a little bit because the posterior point is not quite complete. Just above the distal broken end the width is 55 mm, the thickness is 36 mm; the cross-section has a low, rounded triangular form. The outline of the proximal end surface is in the shape of a sickle, pointed toward the front. Somewhat distal from the middle of the present length, the rough bulge on the anterior section of the lateral side is well developed.

Based on the available cast and the illustrations by GILMORE (1920), the fibula differs from that of *Allosaurus* (*Antrodemus*) in that the proximal surface is more drawn out to an angle, and that the shaft begins to broaden much sooner in the proximal section, so that the proximal end appears to be less differentiated from the shaft. This same condition is cited by GILMORE as a distinguishing character for *Ceratosaurus nasicornis* MARSH as is pictured in his illustrations. The fibula from the T e n d a g u r u is very similar in outer shape to the American species.

Anterior Caudal Vertebra.

Half of centrum (*Mw* 3) has a very shallowly indented end surface with highly elliptical outline, whose height is 106 mm and width 94 mm. Toward the middle the centrum is strongly constricted. On the ventral side a narrow, shallow furrow is recognizable. Above the middle of the side surfaces lies a very weakly pronounced longitudinal depression. The bulging thickening of the ventral part of the margin of the end surface and its slope indicate that it is a caudal vertebra with a haemapophysis, and to judge from the outline, it is an anterior one but not one of the most anterior.

Middle Caudal Vertebra.

The posterior half of a vertebral centrum (*Mw* 4) that is compressed from side to side in its middle part shows a marginally incomplete, very concave end surface, whose most deeply indented spot is a short, transverse furrow above the middle. Above the middle of the flanks are broad and rather deep depressions. The narrow ventral surface exhibits a very distinct furrow that is deepened even more by weathering. The greatest measurable width of the end surface is 78 mm, the height is about the same. If completely preserved, the number would be a number of millimeters more. In the succession this vertebra precedes the following vertebra.

The incomplete vertebral centrum matches very closely the middle caudal vertebra (*St* 270) from the Stegosaur-quarry; the discussion (p. 59) comparing that vertebra to *Ceratosaurus* applies here also.

Posterior Caudal Vertebra.

Pl. VIII, Fig. 4a, b.

A vertebral centrum (*Mw* 5) with an upper length of 119 mm and a bottom length of 113 mm shows almost circular outlines for the end surfaces, of which the anterior is shallow and the posterior more deeply concave, with the greatest depth just above the middle. The width of the anterior articulating end of the centrum is 84 mm, its height is 79 mm, the width of the posterior is over 70 mm, its height is 77 mm. The middle part of the centrum has a circular cross-section; ventrally there is a shallow, depressed median field that broadens slightly to the rear and is the weak development of the furrowing that was so strongly pronounced on the previously described middle caudal vertebra. The facets for the haemapophysis are indicated by a somewhat weathered, obliquely truncated surface of the ventral margin of the posterior end surface. Across (or above) the middle of the flanks is an elongated, shallow depression that appears to be deeper on the left than on the right.

Summary of Quarry Mw.

Of the described material from Quarry *Mw*, the caudal vertebrae as well as the fibula appear so similar to those of the North American genus *Ceratosaurus*, that I do not deem it justified to create a new generic name, and I believe, with reservations, that I can assign them to the genus. I am naming the species, which is significantly larger than *C. nasicornis* MARSH, after the patron of the Tendaguru Expedition, Mr. Home-Commerce-Councilor Aug. Röchling, *Ceratosaurus* (?) *roechlingi*. As type of the species I designate the described skeletal elements from Quarry Mw.

Quarry TL (Including the Individual Finds 68 and 69)

Anterior Dorsal Vertebra.

Text-fig. 21.

Short vertebral centrum (*T L* 8) with straight anterior end surface and a slightly oblique toward the bottom posterior end surface; the anterior is shallowly depressed, the posterior is deeper and wider. The margins of the ends are incomplete but the ends appear to be almost circular. In the middle the centrum is strongly compressed from side to side and is 36 mm thick. The flanks converge ventrally and are seen together in a sharp median keel that may have projected down a bit toward the front, where a piece is broken off. In front of and over the middle on either side is a deep pleurocentral depression, whose lumen represents a cone pointed toward the inside and somewhat forward. The depression on the left is somewhat wider than on the right. Immediately behind the anterior margin and just above mid-height sit the facets of the parapophyses; the left is better preserved and has the shape of a strongly concave, round depression about 18 mm across. Short, superficial grooves run out from the margins of the end surfaces, as far as they are preserved. The lateral, downward curved suture surfaces for the disarticulated neural arch are bordered along their length by margins, whose medial one, at a distance of 11 mm from the middle of the centrum, is unimportant anteriorly and diverges posteriorly, and whose lateral describes a very strongly curved, open to the outside arch. The position of the parapophysis and the ventral keel show that the vertebra is one of the anteriormost of the dorsal vertebrae. The upper length is 65 mm, the lower is 73 mm, the height of the anterior end surface is 89 mm, that of the posterior is 68 mm.

Middle Dorsal Vertebra.

The centrum (*T L* 44) is rather short, the form of the incomplete, ventrally converging, weakly concave end surfaces is highly elliptical, that of the cross-section of the centrum in the center is likewise highly elliptical. Ventrally a sharpening* is scarcely indicated. Over the middle of the flanks lies a wide, shallow trough with the definitely deepest spot in front of the center. The suture surface for the upper arch runs weakly convex upward from side view, but in the top view is moderately concave toward the outside. The vertebra could be out of the middle dorsal region. The upper length of the centrum is 89 mm, the lower is 77 mm. The latter measurement must be adjusted to account for the loss of the ventral margin.

Posterior Dorsal Vertebra.

The almost circular end surfaces perpendicular (or straight) on the rather short vertebral centrum (*T L* 43). The anterior is uniformly concave, the posterior is very weakly concave but is

* Of a keel, I imagine he means. – JDO.

deeper toward the upper margin. The central part of the centrum is very constricted and has a circular cross-section 41 mm across. Over the middle lies a longitudinal, very indented depression, whose deepest point on the left is a narrow hole and on the right is destroyed by a fracture; on both sides the deepest point is just anterior from the middle. The grooving that runs out from the margins of the end surfaces is particularly well developed. The sutural surfaces for the neural arch are almost horizontal. The vertebra could belong to the posterior dorsal half. The upper length of the centrum is 86 mm, the lower is 84 mm, the width of the anterior end surface of the centrum is 83 mm, its height is 85 mm, the height of the posterior end surface is 87 mm.

This one and the two previous vertebrae should be considered as belonging together because of their size relationship and similar preservation, and as being from the same juvenile animal because the sutural surfaces are not fused to the neural arch. In my earlier publication (1920, p. 231) I compared the anterior dorsal vertebra with MARSH's picture of *Ceratosaurus nasicornis* and together with the other two here described, tentatively included them in that genus. The definite, even if not prominent, biconcavity of all three vertebrae could support this conclusion. However, GILMORE 's new work on the carnivorous dinosaurs of the National Museum in Washington regretfully illustrates no new individual vertebrae of *Ceratosaurus*, but does for *Allosaurus* (= *Antrodemus*), and of both important allegations. With the illustration of the third dorsal vertebra (1920, fig. 22) of *Allosaurus,* the anterior dorsal vertebra from Tendaguru appears comparably quite similar, even if on the former the ventral keel has a strongly projecting process whereas on the latter it is only indicated. The other two dorsal vertebral centra differ greatly from the dorsal vertebrae of *Allosaurus* in that the width the end surfaces, as far as they can be measured or estimated, are considerably less than the length of the centrum, whereas it is exactly opposite on *Allosaurus*. The centra from Tendaguru are apparently relatively longer, also in comparison to the height. The strongly concave ventral contour of the centrum is a character that GILMORE uses to differentiate the dorsal vertebrae of *Allosaurus* and *Ceratosaurus* and would also serve to separate the present vertebrae from the last mentioned genus. The new information from GILMORE 's work, the incompleteness of the described East African vertebrae, and the difficulty in determining how much the form is altered in juveniles all cause me to leave the matter open, whether the vertebrae belong to *Ceratosaurus* or *Allosaurus* or to one of the Tendaguru types.

Large Anteriormost Caudal Vertebra

Text-fig. 22a, b.

The vertebra (*T L* 45) has a short and massive centrum. The complete posterior end surface is almost circular, a bit narrow at the top, the middle part of the centrum is relatively slightly constricted; a very weak longitudinal bulge is indicated medianally on the ventral side. The flanks are without noticeable trough-shaped depressions. The anterior end surface represents a transverse, moderately deep hollow surface, only the upper part is convexly bulged. The convexity relationships are reversed on the posterior end surface, which is obliquely truncated and whose lower half is bordered by a sharp furrow near the outer margin. The lower length of the centrum is 105 mm, the height of the anterior end surface of the centrum is 113 mm, the width of the posterior end surface is 115 mm, the height is 117 mm. The zygapophyses are missing. The transverse processes, of which the right one is almost perfectly preserved and is 18 cm long, are directed strongly back and somewhat outward and are flat, about 5 cm wide, almost straight branches of bone, on whose upper side a bulging crista runs near the root from front to rear, and slightly further upward a second bulge runs from the anterior margin more in the long direction of the transverse process. The tall, strong, somewhat posteriorly curved spinous process, which is lacking only a slight amount on its dorsal end, is 30 cm long from the base of the neural canal and gives the vertebra a total height of 412 mm. A crista rises on both sides of the base of the anterior end of the spinous process and they curve back to the midline of the side surfaces and here rise halfway up the side of the free part of the spinous process. Between the transverse processes two longitudinal depressions lie on the base of the anterior surface of the spinous process and are separated by a crista. Two round depressions lie also on the posterior side right above the neural canal, divided by a piece of bone that can be visualized as the remnant of a more or less well-developed hypapophysis. The narrow neural canal is 20 mm high and about 14 mm wide. Because the lower margin of the anterior end surface shows no sign of a facet for a haemapophysis, the vertebra can only be one of the anteriormost caudal vertebrae; probably the first.

The anteriormost caudal vertebrae of *Ceratosaurus nasicornis*, as shown by GILMORE (1920, fig. 22), have much lower centra and a spinous process curved very strongly toward the rear. The first two caudal vertebrae of *Allosaurus* (*Antrodemus*), as illustrated by GILMORE's table (1920, p. 46), correspond very well with the vertebra from Tendaguru in respect to size relationships. GILMORE made no estimations about the height of the spinous process. According to the representation of the skeleton in the New York Museum, the American species has relatively low spinous processes. I lack sufficient evidence to decide whether the differences are sufficient to exclude generic relationship.

Posterior Caudal Vertebrae.

Text-fig. 23.

On hand are the rear half of a vertebra with an attached right prezygapophysis of the one that follows it, a vertebra with a complete centrum, a caudal vertebra whose middle centrum section is restored, and the anterior end of a fourth vertebra. The vertebrae decrease in size in that order and are designated with the letters *Tl* a–d. The last two were still connected with rocks. The measurements of a are too large to immediately precede b, but b could be the immediate predecessor to c. The complete but partially weathered centrum of b is 105 mm long on top and 101 mm long on the bottom; it is constricted in the middle in such a manner that a side view of the ventral view shows an arch that rises more steeply anteriorly than posteriorly. The anterior end surface has incomplete margins; the posterior surface is almost complete on the left and has a rounded, right-angled outline. Both end surfaces are very concave. On the ventral side a shallow depression in the midline is more distinct than anteriorly. Vertebra c, with the restored piece, is about as long as vertebra b, and in addition shows that the anterior surface is more deeply concave than the posterior, and that a longitudinal ridge (or corner) lies halfway up the side. The anterior end surface on c is 33 mm high, on d about 28 mm, the posterior end on a is 40 mm high, and on b is 38 mm wide and 31 mm tall. The neural arch is best preserved on c and is compressed on the sides of the posterior half, dorsally rounded, and lacks any trace of a spinous process; in the front it runs into the extraordinarily long prezygapophyses; the right prezygapophysis projects as a thin, flat bar for 72 mm over the front margin of the centrum and reaches its tallest height of about 19 mm in the middle. Between the prezygapophyses a shallowly depressed, anteriorly expanding field lies on the neural arch. In the rear the neural arch extends into a short projection that runs into the two postzygapophyses. These project more steeply than the prezygapophyses; they are 16 mm tall in the center and diminish to a point, about 31 mm out from the upper edge of the centrum. On vertebra a the prezygapophyses are much taller, rise more steeply, and are apparently much shorter.

The vertebrae have considerable similarity to those that GILMORE (1920, fig. 31) illustrated from the posteriormost region of the tail of *Allosaurus* (*Antrodemus*), but are more elongated. The last caudal vertebra of *Gorgosaurus* that LAMBE (1917, fig. 18) pictured, the 28th, is much bulkier than the one from T e n d a g u r u . Because the latter, based on their shape, are apparently from the posteriormost part of the tail, they come from a very large animal.

Femur 68.

Pl. V, Fig. 2a, b, c.

The femur, a right one, was found alone in the Upper Saurian Bed at Tendaguru in the same spot as tibia 69. Its general shape is relatively bulky, the shaft is weakly curved, the moderate head curves strongly forward. The plane of the main expansion of the proximal section makes an angle of 25 degrees with the anterior surface of the distal section. It is not certain if or how much the present position is due to distortion. The lateral side of the head is strikingly even, which may be partly due to loss of substance; on the medial side the head is weathered. The neck is 73 mm thick. The greater trochanter is broken off, it started 13 cm from the proximal end. The lesser trochanter is indistinct. The partially expanded fourth trochanter sits on the medial margin of the posterior surface of the shaft like a protruding edge about 15 cm long, whose middle is about 30 cm from the proximal end. Distally from the fourth trochanter the shaft has a rounded-triangular cross-section, with one side facing posteriorly. The distal end attains a considerable width because of strongly diverging condyles. The intercondylar fossa is broad on the distal end and on the posterior side. As the broken surface shows, the projecting broken part of the lateral condyle is considerably narrower than the medial condyle and is directed diagonally outward on the proximal part. A sharp ridge runs proximally from the medial condyle to about 22 cm from the distal end; from there on there is a very indistinct, rounded ridge that extends to the greater trochanter

Total length	773 mm
Width of the head	209 mm
Minimum width of shaft	103 mm
Thickness at the point of minimum width	89 mm
Width of the distal end	213 mm
Thickness measured across the medial condyle	186 mm

It differs immediately from the femora of the nearby quarry *T L* by its much bulkier shape; that is valid for the head, the neck (which is much thicker), for the body, and also especially for the distal articulating part. The lateral view shows that the neck curves more anteriorly above the fourth trochanter. The outer surfaces of the distal condyle diverge more strongly, thereby making the entire distal end much broader. The fourth trochanter sits on the margin of the posterior surface instead of being set off from it, as on the other femora. A specific relationship is therefore ruled out and a generic relationship is improbable. As compared with GILMORE's (1920, pl. 14) North American *Allosaurus* (*Antrodemus*) and with the cast of the femur of the hind limb no. 290 of the Natural History Museum of New York, the femur 68 has a bulkier and higher head section, the neck curves more deeply and sharply, the distance between the two distal condyles on the posterior side is greater, and the posteriorly projecting part of the lateral condyle extends proximally and diagonally outward, instead of longitudinally, as in *Allosaurus*. In these last mentioned characters of the distal end there is agreement with the femur of *Ceratosaurus nasicornis* MARSH, as GILMORE's (1920, fig. 64) illustration shows; that the medial condyle on the figure is unnaturally narrow could be the result of the distortion mentioned in the description. The similarity of the head region is also considerable to the American form, much more so than to *Allosaurus*. The described femur from Tendaguru appears to me to be so similar to *Ceratosaurus* that a generic relationship is thoroughly possible. To complete the comparison it should be mentioned that the much sharper curvature of the head and the bulkier general shape of our form serve to distinguish it from *Megalosaurus* from Stonesfield by OWEN (1857, pl. 7). The second characteristic further distinguishes it from *Megalosaurus superbus* SAUVAGE (1882, pl. 29, fig. 1) from the "Gault" of the eastern Paris Basin; also distinctive for the French form is the strong saddle height near the distal end, between the head and greater trochanter.

Tibia 69.

Pl. VI, Fig. 5a, b,

The tibia was found in the same quarry as the femur No. 68 and like it, belongs to the right side of the body. Considering the width of the proximal end, the body appears very short and thin, but the length is shortened by and the thickness has been affected by weathering. The head is completely preserved, even if the marginal parts are a bit weathered. The articulating surface drops laterally in a position perpendicular to the longitudinal axis of the body; it is 172 mm long and 110 mm wide, but the width is probably diminished by marginal weathering of the lateral condyle. The latter appears less extensive than it originally was; posteriorly it is bordered by a narrow notch. The tuberosity forms a large projection, which rises rapidly proximally over the surface of the proximal end, and exhibits a shallow depression accentuated by pressure on its medial surface; on its lateral side an elongated depression runs distally, and is bordered proximally by a faintly defined, rounded ridge that curves weakly to the crista that forms the proximal extension of the lateral crista. This part appears very different from tibia *T L* 42. The lateral crista is preserved only by way of suggestion because of weathering. The body exhibits a weak lateral convex curvature on the distal half of the plane of the distal expansion, and in its present condition the cross-section is compressed in the anteroposterior direction and laterally narrowed. The present shape of the cross-section complies with the concentric lamellar build and could be quite similar to the original shape. The incomplete distal end does not show anything else. The length of the body is 54 cm. The body is permeated with transverse fractures filled with very crystalline chalkspar. As mentioned, it has been shortened somewhat by compression. From the relation of proximal width to length of the apparently conspecific smaller tibia 37, the length of this tibia can be estimated at about 61 cm.

The comparison with other tibiae, which points to similarities with *Ceratosaurus*, will be found under the section on tibia 37.

Right and Left Femur.

Pl. VI, Fig. 3a, b, c.

These two femora (*Tl* 30 and *Tl* 16) apparently stem from one animal. The left one is missing the projecting parts of the distal condyle, the right one has lost a flat section from the proximal section and the opposite end is enlarged. The shafts of both have been weathered in the middle so that they are narrower than they originally were. This type of exfoliation shows – especially on the left femur – that a new surface can be created that is very smooth and quite extensive and can even be mistaken for the original surface. The general shape of the femur is very thin, even with the presumed thickening of the top surface, it is distally moderately widened, and weakly arched in the lateral view. The proximal end is rather strongly compressed on the sides and has very flatly convex surfaces on both sides, in the neck region it is about 56 mm thick. The medial profile line of the proximal section curves in a very flat arch, almost straight, medially relatively little. On the left femur the plane of the main enlargement of the proximal section makes an angle of about 25° with the anterior surface of the distal section, while on the right one they almost converge; which is the undisturbed position is difficult to say. The proximal end surface is thickest, (103 mm on the right femur) on the medial side, on the actual head, it narrows uniformly on the opposite side and is very weakly curved toward the front. The head projects 2 cm past the narrow neck on the medial side; the fossa that borders the proximally directed, well- rounded medial head of the head* on the posterior side, is quite sharp when compared to this and is somewhat covered by it. The trough between the proximal part and the greater trochanter is wide and deep. The latter is a well-developed ridge; its free part, which is not preserved on either of the two femora, begins about 7 cm beneath the lateral end of the proximal surface. There is only a trace of the lesser trochanter on both of the femora, perhaps it has been obliterated by weathering. The proximal section of the fourth trochanter is well preserved on the left femur; it is a narrow ridge that runs about 3-1/2 cm from the medial margin of the posterior surface of the shaft; the middle of the fourth trochanter is about 29 cm from the proximal end. The shaft of the femur has a rounded-triangular cross-section in its midsection, that has a rounded corner running toward the greater trochanter on the anterior side, whereas on the posterior side, laterally from the fourth trochanter, the surface is depressed as a shallow trough. The distal end is complete on the right femur. The medial condyle is broader on the posterior side than on the lateral side, but does not project as far as the latter. The lateral condyle projects rearward, is 9 cm long and about 5 cm wide, runs in the long direction of the shaft, and is set off from the very strongly bulged condylar section on the distal surface by a robust, transverse depression (or saddle), and laterally by a distinct, 2-1/2 cm wide step. The intercondylar fossa is rather broad, about 3-1/2 cm.

	Right	Left
Total length	822	825
Width of the “head”	?	182
Width of the distal end	180	173
Thickness measured across the medial condyle	150	—
Thickness measured across the lateral condyle	149	—

The comparison with OWEN’s (1857, pl. 7) illustrated femur of *Megalosaurus* from Stonesfield shows that it is more robust than our African femur, especially with respect to the distal end, where the medial condyle is much larger than the lateral. However, the 50 cm long femur of *Megalosaurus superbus* SAUVAGE from the “Gault” of the eastern Paris Basin (1882, Pl. 1, Fig. 1) is very similar. The latter differs by the high placement of the saddle near the distal end and between the head and greater trochanter, the placement of the fourth trochanter on the medial margin, and the wider epicondylar fossa. The differences from the much bulkier femur 68 from Tendaguru are discussed in that section. The similarity is unmistakable with the femur credited to *Antrodemus* (*Allosaurus*) *valens* LEIDY, as illustrated by GILMORE (1920, pl. 14) from the Yale Museum. These figures differ in the medial profile of the neck curves in a much sharper arc and the marginal medial position of the fourth trochanter. The cast of the femur from the hind limb no. 290 of *Allosaurus* from the New York Museum shows the same differences in the position of

* I don’t know whether he means the “head” or the head of the “head” (orig. “Caput”). – JDO.

the fourth trochanter and is much bulkier than the East African femur, as is that of the Y a l e Museum, but agrees with the first in the neck profile.

Tibia.

Pl. VI, Fig. 6.

The right tibia (*Tl* 42) obviously belongs to the right femur of the two femora (*Tl* 30) from the same location. The distal end is well preserved, whereas the body (shaft, etc.) is strongly weathered, so that the top layers of bone are more or less deeply peeled off. All projections of the head are lacking. The entire length is 80.7 cm, but if the head was perfectly preserved it would measure about 83 cm. The overall form is straightly stretched and thin. The head is particularly weak; the width of the proximal surface, measured across the "lateral condyle", could not be more than 12 cm. On the lateral side of the head, inside the long trough-shaped depression between the tuberosities and the lateral "crista", is a deeper, particularly thin groove (only a few centimeters long), whose middle is about 6 cm under the edge of the proximal articulating surface. A lateral condyle, also imperfectly preserved, was bordered all around by flat depressions. The remaining basal part of the lateral "crista" shows that made a high, sharp ridge (edge). A "crista" can also be seen from about 25 cm under the lateral condyle running to the top for a distance of about 9 cm. In the area of the "crista" the cross-section of the body is a rounded triangle, laterally drawn out through the "crista". Approximately 2/3 of the entire distance from the proximal end, the cross-section is anteroposteriorly compressed, whereas the lateral side is sharpened. On the distal end, whose profile is strongly broadened toward both sides, the structure is strongly impressed in a lateral and a medial wing. The thin lateral wing juts considerably further out toward the side and the bottom of the medial wing. The medial wing is about 80 mm thick and has strongly arched articulating surfaces. A furrow runs across the middle of the distal end surface. The surface that meets the ascending process of the astragalus is readily visible; it is most strongly depressed on its medial edge (or margin) and stretches about 11 cm toward the top from the highest point of the distal profile. The outermost medial corner of the medial wing is missing, but even so, the end of the lateral wing is somewhat rubbed off, so that 1 cm could easily be added to the preserved width of 19 cm.

This tibia differs from that of the American *Allosaurus* (*Antrodemus*) in the significant thinness of the body and the proximal parts, but also in the deviation in the topography of the proximal parts – both are valid when compared to *Allosaurus* (?) *tendagurensis* – in the weaker broadening of the distal end, and particularly through the less jutting-out outer medial contour of the lateral wing. The outline of the distal end is very similar to that of *Megalosaurus* of S t o n e s f i e l d (OWEN 1857, pl. 9, fig. 2). The entire form of the bone is significantly slimmer than *Megalosaurus*. It differs from the short tibiae of *Ceratosaurus* (?) *roechlingi* from T e n d a g u r u in the deviation in the development of the proximal parts, in the stretched, thinner form, in the weaker head, and in the entirely differently shaped topography of its lateral side. I can find no tibia pictured in the literature to which I can assign this tibia.

Pedal Phalanges.

Only a proximal half of a phalanx of a large megalosaurid is available, presumably from Quarry *T L*. The cross-section is a rounded triangle. The proximal saddle-joint* is 40 mm high and about 50 mm across. The phalanx has a rather elongated shape, and could therefore be from the first or second digit.

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* Original German is "Sattelgelenk" ("Sattel" = saddle, bridge of the nose, ridge, pass; "Gelenk" = joint or articulation)

Individual Finds.

Tibia 67.
***Allosaurus* (?) *tendagurensis*, n. sp.**
Pl. VI, Fig. 7a, b.

The proximal part (40 cm long) and the distal part (26 cm long) of a very large left tibia (67) were found in the Middle Saurian Bed from Tendaguru; the middle section was missing. The pieces show bad weathering of the top layers. The posterior medial corner is missing on the proximal end; the proximal part must have had a rather narrow triangular outline had it been well preserved. The well-developed tuberosities jut out moderately strongly; its anterior contour climbs almost straight and rather steeply up from the bottom and then bends in a very flat curve almost perpendicular to the proximal surface. The rather narrow ridge (or edge), like that from which the tuberosities grow out of, widens to about 7 cm near the proximal end and continues over onto the flatly undulating proximal surface a little bit. The medial side of the proximal end, measured across the tuberosities and lateral condyle, is 272 mm. The efflorescent (weathered?) lateral condyle is quite even proximally and projects strongly posteriorly and is bordered medially by a strongly cutting furrow. The “lateral crista" is broken off, but was apparently strongly developed, as is shown by its swollen base; it ran about 16 cm proximally from a point about 31 cm from the proximal surface of the lateral condyle. The cross-section of the distal breakage surface of the proximal part is broadly elliptical[*], flattened anteriorly and rounded-angular medially. The greatest length of the cross breakage is 120 mm, and the width transverse to it is 95 mm. Further proximally, the cross-section (transverse section) gets larger and becomes more triangular through the development of the “lateral crista”. If it had been better preserved, the distal end would have been as wide and thick at the point of breakage as the distal breakage surface of the proximal part. The distal end lacks the corner of the medial wing; the lateral wing projects strongly back with a straight contour; its point is rounded and has a width of about 4 cm. The groove for the ascending process of the astragalus is quite deep, particularly so proximally, where it reaches to about 14 cm away from the distal end. The lateral border of the groove is a rounded ridge, the medial border is not preserved. The posterior side of the distal end is almost even; distally the facet for the astragalus reaches quite a ways from the bottom upward.

When the weathering and peeling of the projecting parts are taken into account, the tibia is almost exactly the same in pattern and proportion in the proximal part as the cast of the somewhat smaller tibia of the right hind limb (no. 290) from *Allosaurus* (*Antrodemus*) in the New York Museum. The narrow cross-section of the latter’s shaft is a result of compression, as is shown by the cast. Compression could also be responsible for the tuberosities being bent more strongly toward the lateral side. A flat groove on the medial side of the African tibia, approximately in the middle of the proximal part, which is lacking in *Allosaurus*, could be a product of mechanical pressure. The "lateral crista" has a very similar length in both specimens. The distal end also shows a good agreement. The trough that runs proximally on the lateral side of the distal edge on the tibia from T e n d a g u r u is similarly yet more strongly pronounced. The lateral contour of the lateral wing of the African tibia projects a little less sharply laterally, but it appears to be somewhat weathered. The distal contour of the lateral wing and the pattern of the distal end facet

[*] “eiförmig” = egg-shaped – JDO.

correspond, as far as is preserved, with the African[*] cast. Also identical is the position of a foramen just behind the lateral crista. The most medial of three foramina on the proximal articulating surface is also in the same position on the cast. The limb under comparison from the New York Museum was not assigned to a genus in OSBORN's description (1899), but was identified as either *Allosaurus* or *Megalosaurus*. Because an appearance of *Megalosaurus* is no longer believed plausible in the *Atlantosaurus*-beds, it is no longer doubtful that the limb is from *Allosaurus* (*Antrodemus*). In his valuable new monograph on the carnivorous dinosaurs of the American Museum in W a s h i n g t o n , in which LEIDY's older designation *A n t r o d e m u s* is used for *Allosaurus*[1], GILMORE shows illustrations of the tibia of what he calls *Antrodemus valens* LEIDY (skeleton no. 4743). The use of his illustration is to some extent impaired because the tibia is pictured with fibula, astragalus, and calcaneum and the representation of these elements is therefore partly obscured. As far as a comparison is possible, the proximal part, in respect to its contour and the proximal view, compares perfectly with the East African tibia, better even than with the cast in this respect, because of the somewhat bent tuberosities. The distal end also corresponds in shape better than the cast because of the less laterally projecting lateral wing. The tibia from T e n d a g u r u is so close to the American genus *Allosaurus* (*Antrodemus*) that I have no hesitation to use the same name, as my earlier work (1920) mentioned. The deviations of the tibia from Tendaguru as opposed to GILMORE's illustration of *Ceratosaurus nasicornis* MARSH are the same as those GILMORE listed in comparing *C. nasicornis* to *Allosaurus*.

The remaining tibiae described from T e n d a g u r u are so different in form and detailed relations that a detailed comparison is unnecessary.

It is impossible to determine the exact length of the whole tibia from the remaining two parts. The reconstruction of the missing middle piece is a result of relying on the size relations of the two *Allosaurus* tibiae spoken of above and on taking into consideration the position of the distal end of the lateral crista. On this basis, the tibia is 91 cm, as compared to 87 cm for the cast and 69 cm for GILMORE's tibia.

I designate this tibia *Allosaurus* (?) *tendagurensis*, n. sp.

Tibia 37.

Pl. VI, fig. 8.

The complete left tibia comes from the Middle Saurian Bed west of Mtapaia in the north of the Tendaguru. The marginal parts of the head, which is pushed in on the medial wall, are lightly weathered; more strongly weathered are the lateral condyle and lateral crista that runs distally from it. Aside from its smaller measurements, it is just like tibia 69, even in the details of the sculpture of the head. The curvature in the transverse plane of the distal half of the body is more distinct and clearer. Just over the middle this curvature is contrasted by a remarkable angle in the medial contour, but the angle is accentuated by mechanical pressure. The complete distal end is relatively weakly enlarged. The thin lateral wing only projects slightly out, as opposed to the medial wing, which juts out quite a ways. On the latter the facet for the astragalus rises up about 3-1/2 cm on the anterior surface. The surface for the ascending process of the astragalus is an indentation with the outline of an equilateral triangle, whose proximal tip is 8-1/2 cm above the distal end.

Total length	567 mm

[*] He says "African", but I am sure he meant the "American" cast. – JDO.

[1] I do not follow GILMORE when he replaces the generally used term *Allosaurus* with *Antrodemus*, which is based on half of a caudal vertebra.

Greatest expansion of the head	202 mm
Width of the body just below the middle	68 mm
Thickness of the body just below the middle	56 mm
Greatest expansion of the distal end	141 mm

The two tibiae 37 and 69 (p. 70) are unquestionably from the same species and show remarkable similarities with the tibia of *Ceratosaurus nasicornis* MARSH, as illustrated by GILMORE (1920, fig. 65). The particularly strong projection of the proximal tuberosity and the relatively small enlargement of the distal end are also found on *Ceratosaurus*, but the first character is not quite so distinct; as far as one can ascertain from GILMORE's illustration, even the details in the head sculpture appear to be conformable. One difference is that the body of the American former is a bit bulkier. The differences are much less than when the two tibiae are compared to the other tibiae from T e n d a g u r u or to the North American *Allosaurus*. Owen's (1857, p. 9) picture of the tibia from Megalosaurus from S t o n e s f i e l d has less developed tuberosities, as does Lambe's illustration of *Gorgosaurus*, which also has a much bulkier body and a more strongly projecting process on the astragalus, than on both tibiae from the same quarry in the Tendaguru.

It is possible that tibiae 37 and 69 belong to *Ceratosaurus* (?) *roechlingi* (see below on this page!).

Manual Phalanx (H).

First phalanx of the second digit of the manus from Quarry *H* (Upper Saurian Bed). The body is dorsally rounded distally, flat on the palmar side, 33 mm wide, 25 mm thick, toward the proximal end the cross-section becomes very high. The incomplete proximal articulating surface is flatly saddle-shaped, with a low, rounded central ridge. The incomplete distal pivot is strongly arched palmar and deeply forked. Total length of the phalanx is 114 mm. As far as can be determined from the pictures it differs from the corresponding phalanx of *Allosaurus* (*Antrodemus*) MARSH by GILMORE, aside from the size (114 mm versus 94 mm), by stronger bulging of the distal pivot and the strongly palmar drawn-forward, saddle-shaped proximal articulating surface.

Relationships of the Theropod Remains.

The attempt at the thorough, scientific evaluation of the described material raises the attempt to prove whether and which of the remains of the scattered finds can probably or possibly be assigned to a particular species. The new species *Ceratosaurus* (?) *roechlingi* is based on the remains of one animal, but the middle and the fused posterior caudal vertebrae from the Stegosaur-quarry certainly belong to the same species; however the possibility does exist, although it is not probable, that the latter, because it is out of the deeper Middle Saurian Bed, could belong to a very closely related species. Another important point is the evidence of three different tibiae that indicate three new species or genera. I think the large tibia[*] (Fig. 67) belongs to the North American genus *Allosaurus*. The smaller tibiae (69 and 27) are very reminiscent of those of *Ceratosaurus* and therefore could belong to *Ceratosaurus* (?) *roechlingi*, but would have to come from smaller individuals than the type animal. I could not recognize any affinities of any described tibiae with the third tibia (*Tl* 42). Of the vertebrae from Quarry *T L* the short series of posterior caudal vertebrae, based on size, could belong to the same species and individual as the large

[*] He must mean tibia 67. – JDO.

anterior caudal vertebrae. The first ones are similar to the corresponding vertebrae of *Allosaurus*. The anterior caudal vertebra seems to have a taller spinous process than this American form. Whether the other characters are enough to show that it belongs to the genus anyway, I lack the basis for comparison in order to make a decision. Skeletal parts that would be large enough to match the tremendous teeth of *Megalosaurus* (?) *ingens* have not yet been found. With respect to the already mentioned series of posterior caudal vertebrae, there is a possibility that they belong to a very large animal, even though they appear to belong to an animal the size of *Allosaurus*. The anteriormost caudal vertebra that was mentioned as possibly belonging to the posterior series, would certainly be too small for a full-grown *Megalosaurus ingens*. Because it shows no sign of being a juvenile, I deem it more likely that it belongs to *Allosaurus* (?) *tendagurensis* than to the giant *Megalosaurus ingens*. It is not possible to determine the full-grown size of the three juvenile dorsal vertebrae from the same quarry (*T L*). Their general shape does not indicate a particularly heavy animal; that would probably show even in a juvenile specimen. The detached neural arch of a cervical vertebra from the Stegosaur-quarry comes from a youthful animal; perhaps there is a possibility that it is a part of *Megalosaurus* (?) *ingens*. All the available posterior leg bones would need to be much heftier and stronger in order to be considered for the correct size relations of *M. ingens*, even for a half to 3/4 full-grown animal. I cannot give any affinities for the posterior dorsal vertebra and anterior caudal centrum from the Stegosaur-quarry with any known forms; the same goes for the slender femora and the likewise slender, long tibia, which is probably the same species as the femora, from the Quarry *T L*. Because the two former vertebrae similarly indicate a slender and relatively lightly built animal like that of the latter leg bones, it is not impossible that they all belong to the same previously unknown species, or considering the stratigraphic difference of the two bone groups, two closely related species of a new genus. The ilium from the same location as the vertebrae could belong to the same animal, based on its dimensions. I also believe it possible that these skeletal elements could come from *Labrosaurus* (?) *stechowi*, which is based on teeth, but that will be discussed later under the specific assignments of the individual teeth. I can find no basis for definitely assigning the individual phalanges any of the different species.

Teeth.

Preface.

The treatment and scientific evaluation of individual teeth from carnivorous dinosaurs create many difficulties. The literature is very scanty on exact, individual illustrations backed up with descriptions of complete sets of teeth or rows of teeth. Particularly disturbing is the fact that on illustrations the margins (or borders) of the enamel covering are indistinct and therefore the height of the tooth crown is unrecognizable, or that statements about these points are lacking.

The premaxillary teeth are easily recognizable by their cross-section that is compressed in the direction of the course of the jaw margin, and their narrow lingual surfaces enclosed by cutting edges. It is said of the maxillary teeth that they are generally distinguished in the rear half of a line in that the crown is more or less compressed transversely to the course of the edge of the jaw, that the plane of the serrated cutting edges approximately divides the crown into a lingual and a buccal half, and that a curvature perpendicular to that is only slightly or not at all indicated to the lingual side. Toward the front in the row of teeth the cutting edges change position so that they are closer to the lingual side close to the roots, whereby the lingual side becomes smaller and the buccal side larger. A curvature toward the lingual side becomes more distinct toward the front. The teeth of the lower jaw differ from those of the maxilla in that the bottom teeth are smaller, at least according to SMITH WOODWARD (1910) for *Megalosaurus bradleyi* and LAMBE (1917, p. 17) for *Gorgosaurus libratus*. LAMBE also notes that the teeth are worn away by grinding against each other – on the lingual side for the upper teeth and on the buccal side for the bottom teeth. The anterior mandibular teeth are not quite as different from the side teeth as the premaxillary teeth are from the maxillary. They are smaller when the premaxillary teeth are small, as on *Megalosaurus bradleyi* and *Gorgosaurus libratus*. OSBORN (1912, p. 27) says that the first two mandibular teeth resemble the premaxillary type because of a lateral compression, and LAMBE states that only on the anteriormost mandibular tooth of *Gorgosaurus* is there a flatly convex lingual surface. Hence it appears that the characters of the first teeth of the lower jaw are different on various genera. The last teeth in a row differ from the lateral teeth by being markedly smaller. To what extent and how the rearmost teeth of the upper and lower rows differ from the above-mentioned examples is very seldom clearly stated in the literature. In a side view of a jaw, it is generally impossible to tell if a short tooth is actually short or if it is a replacement tooth not yet completely grown in; it is also generally difficult to discern the lower margin of the enamel, which shows the extent of the tooth crown. On *Megalosaurus bradleyi*, A. SMITH WOODWARD (1910) reports that the posteriormost maxillary teeth are shorter and wider than the anterior ones. The well-known skull mold of *Tyrannosaurus rex*[1] shows a short, compressed form of the crown on the rearmost teeth, especially in the lower jaw. Whether or not a different change may occur in the posterior teeth and whether those in the maxilla differ from those in the lower jaw, are questions that would require a lot of illustrations in the literature.

There are 230 teeth that come from all three Saurian Beds, but the fewest come from the lowest layer because it has been worked less. They are separated into 3 groups: I assigned them to the small coelurosaurs, the giant species *Megalosaurus* (?) *ingens*, and the sculptured form *Labrosaurus* (?) *stechowi* (see JANENSCH 1920). The remaining teeth could be divided into two further species, but such a division is not final. From each species, as well as from the remaining material, there are several types that are described separately.

Teeth of Coelurosaurs.

Description.

There are about 150 teeth from the Middle and Upper Saurian Beds. As with the teeth of the larger t h e r o p o d s , there are several types. The size is small; the length of the vast majority is between 20 and 30 mm, the exceptions are 35 mm where the pulp wall is completely preserved. Apparently the teeth come from individuals of different sizes and ages. Aside from the smaller size, the numerous s i d e t e e t h differ from the teeth of the t h e r o p o d s , even from the juvenile forms, in that the crown is shorter and at the same time strongly curved to the rear and the strongly curved rear margin and in relation to size, the relatively coarser serration. My earlier statement (1920) that all these T e n d a g u r u teeth are probably from *Elaphrosaurus bambergi* must be retracted in view of the recent finding of the three tibiae that probably represent three smaller, new c o e l u r o s a u r s , and these probably contributed to the teeth. Due to lack of any other reference point, only the difference in size can be used to separate those of *Elaphrosaurus*

[1] Dr. STEUER and Dr. HAUPT from the Darmstadt Museum made the mold available to me, for which I thank them very much.

bambergi from the teeth of the other c o e l u r o s a u r s . Based on the length of the tibiae, they would have been from 1/4 to 1/2 as large as the skeleton of *Elaphrosaurus bambergi*. Such size differences would certainly be apparent in the teeth, even if the size of the teeth is not proportional to body length or tibia length. The larger of the coelurosaur teeth, which would be much too large for an animal of the size indicated by the smaller tibiae, I believe should be placed with *Elaphrosaurus bambergi*. Whether the smallest of the available side teeth are juvenile forms of *E. bambergi* or are from the smaller coelurosaurs represented by the tibiae, must remain open to debate.

In the following description I have designated three types a–c of large teeth, which I place with *Elaphrosaurus bambergi*; followed by three smaller teeth d–f, which could belong to either this or the smaller species. Even though I place the three larger types with *Elaphrosaurus bambergi*, I cannot firmly prove my conclusion. The greater probability appears to speak for the association. The size of the teeth of the three types is certainly appropriate for a long-necked c o e l u r o s a u r of the dimensions of *E. bambergi*. Because the number of teeth and locations of teeth of the carnivorous dinosaurs in the T e n d a g u r u strata far outweigh the number of bones, which fact is discussed in greater detail in the section on the " R e l a t i o n s h i p s o f t h e T e e t h ", it seems most probable that *Elaphrosaurus bambergi*, being represented by two partial skeletons, should also be represented by teeth.

T y p e **a** . Moderately wide, laterally very compressed, slightly curved toward lingual side; anterior margin on the lower half is rounded, but is angular (or sharp) on the upper half; posterior margin is sharp for the entire length, and arched strongly toward the rear. On the bottom, in the middle of the buccal side is an indentation, which, as is shown on broken teeth, is caused by squeezing of the pulp cavity. The lingual side is considerably more convex (or bulging) than the flatter buccal side, An example of this type is the tooth from Quarry MD (Upper Saurian Bed) illustrated on plate IX, figure 1, which is only slightly worn. On bottom end of the completely retained buccal side the pulp is already quite wide. The largest measurable length is 30 mm, the width is 17 mm on the bottom, the thickness is 7 mm where it is 13 mm wide. The enamel extends for 3 mm onto the bottom end. On the anterior side a serrated* cutting edge runs down for 17 mm and bends slightly to the lingual side at the bottom. As a continuation and in the same direction, a shallow furrow runs diagonally down; this was not noted on other teeth. The posterior margin is finely serrated for its entire length. The number of serrations is 12 on top in the front, 14 on the bottom, 12 on top in the rear, and 15 under the middle. The anterior edge on a few teeth is indistinct toward the bottom. The abrasion is generally so severe that the upper end has become blunt, or in extreme cases, the entire crown appears to be transversely truncated. This type is by far the most prevalent; there are teeth of this form which are not distinguishable, except that the abrasion by opposing teeth show whether they originated in the upper or lower jaw. It is just as difficult to distinguish this type from the Upper Saurian Bed from those of the Middle Bed. As already stated, I place the larger teeth of T y p e a with *Elaphrosaurus bambergi*. If the animals from the Upper Saurian Bed were a different species than those of the Middle Bed, then they were so closely related that the difference is not recognizable in the teeth. I must leave the question open whether the smaller teeth of this type, especially the slender ones, possibly belong to one of the smaller c o e l u r o s a u r s , which are indicated by the three tibiae.

T y p e **b** is very much like the preceding type, but is much thicker on the anterior side and more or less leveled off, and the bottom of the anterior cutting edge curves much more strongly toward the lingual side. The illustrated tooth of this type (Pl. IX, fig. 2) is from the Upper Saurian

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* Original translation reads "crenated". – MTC.

Bed just under the T e n d a g u r u Hill (or summit) (Quarry Z) and is very worn on the anterior and lingual sides of the tip, and the enamel is largely destroyed by weathering. The greatest measurable length is 39 mm, the width somewhat over the bottom end is 14-1/2 mm, the thickness is 9 mm. The enamel covering leaves only a narrow strip on the bottom end free and reaches about 31-1/2 mm from the tip. The tip of the pulp cavity is only a few millimeters from the broken end; the general form is rather narrow and tall. The sharply preserved posterior margin is only slightly curved, the anterior margin in the lower two-thirds is likewise weakly curved, but the upper third is more strongly arched; but this curvature is at least partially a result of the abrasion. The lateral curvature of the entire tooth, like that of the posterior cutting edge, is insignificant. The leveling-off in the lower half of the anterior margin is distinct. On the lingual side in the middle of the bottom end is a shallow depression. The 26 mm long posterior cutting edge is finely serrated; there are about 13 serrations (or denticles) in about 5 mm. The anterior cutting edge on the bottom half is only an unserrated, fine line that extends to about 22 mm from the tip; it lies entirely on the rounded lingual edge (or corner) of the anterior face. This type is much less common and is from the Upper and Middle Saurian Beds; there are often transitions to Type a with less rounded anterior margins.

Considering the characters of Type b and its similarity to the thicker, more conical Type c with cutting edges closer to each other, and in light of the narrower lingual surface, these teeth are probably from the anterior section of the upper teeth.

T y p e **c** has a rather straightly elongated, pillar-like shape and is characterized in that the anterior cutting surface, for most of its length, is not on the broadly rounded anterior side of the tooth, but is very closely positioned to the rear cutting edge and is almost parallel to it. The lingual side that lies between them is therefore very narrow. The best preserved tooth of this type from the Tendaguru area, with no given horizon or locality (Pl. IX, fig. 3) is obliquely truncated because of strong abrasion, and has a greatest length of 26 mm across the bottom end, a width of 11 mm, and a 9 mm thickness that is probably too large because of an open crack on the lingual side. On the underside the pulp opening is 8u long. The posterior cutting edge is finely serrated, extends to the bottom end, and is weakly curved; it has 11 serrations (or denticles) in 5 mm. The anterior edge is a lower, but sharper ridge that can be traced for 20 mm, but extends in a more flattened state to the bottom; the serrations, with 14 per 5 mm, disappear 14 mm from the tip. Immediately behind the anterior cutting edge is a furrow that is probably at least partly emphasized by pressure. The lingual surface enclosed by the two cutting edges is very flatly convex transversely and has a width of about 7 mm.

A s e c o n d t o o t h of this type of equal size from the Upper Saurian Bed of T e n d a g u r u is a 15 mm long stump, whose tip is even more strongly worn, agrees completely with the preceding tooth. These two teeth exhibit the typical narrowing of the lingual surface that characterizes the premaxillary teeth. It is also possible, though, that they are the anteriormost maxillary teeth, which are very similar to the premaxillary teeth, as is the case with *Megalosaurus bradleyi* A. S. W. Because they are assigned to *Elaphrosaurus bambergi* due to their size, they demonstrate that the premaxillary teeth are not significantly smaller than the maxillary teeth.

T y p e **d** . A very short, pillar-shaped, 9 mm long tooth (S t e g o s a u r -quarry at K i n d o p e) with a bottom elliptical cross-section 5-1/2 mm long and 4 mm wide fits the preceding type. The tip is very strongly and obliquely truncated, the bottom end shows a wide, flat pulp cavity. The posterior cutting edge has 4 serrations per 1 mm. On the lingual surface is a centrally located, rather sharp ridge, that is strengthened by ground surfaces next to the posterior edge or corner that are longitudinal, ground-in, surfaces with fine scratches. It is noteworthy that there are fine scratches transverse (to the long axis) on both sides of the pillar-like part of the tooth. This smaller tooth differs from Type A by the form, as far as it can be determined because of the high degree of abrasion, of the ridge on the lingual surface.

A very small tooth (Pl. IX, fig. 4) from the Upper Saurian Bed (Quarry *Om*) is very similar to the preceding tooth, but is even more slender. The greatest length is 9 mm. A cross-section on the bottom is oval that is diagonally terminated by the 3-1/2 mm wide lingual surface; the greatest diameter is 5 mm. The rounded and very arched anterior side is shortly worn on the upper end. The upper half of the lingual surface shows an even abrasion surface across the entire width, with vertical scratches (or abrasions, striations); it lies in the same plane as the lower unabraded part of the lingual surface and cuts off the crown of the tooth in a sharp, transverse edge (or corner). Above the bottom end, in the middle of the lingual surface is a protruding ridge, but unlike the preceding tooth, this ridge is very short. The edge of the lingual surface is near to the anterior surface and, as far as it is not abraded, for a distance of 3 mm from the bottom end, it is not serrated. The other ridge is serrated – 3 serrations per 1 mm – and curved toward the inside and rear. The under-surface of the tooth is shallowly depressed near the center. The character of a premaxillary tooth is perhaps more distinct than on the preceding tooth. Because the serrations are so large with respect to the size of the tooth on the one cutting edge, it is more probable that the tooth comes from one of the other, smaller coelurosaurs, rather than from a juvenile *Elaphrosaurus bambergi*.

T y p e **e** . Two small, very similar tooth (Quarries *Om* and *l*), both from the Upper Saurian Bed, are distinguished by short, broad, laterally compressed crowns that are moderately strongly curved to the rear and only slightly to the lingual side, which have a short, basal, pillar-shaped cross-section that shows on the broken larger one (*l*) as an ellipse. The smaller one (*Om*) (Pl. IX, fig. 5) has a total length of 10 mm, is 5 mm wide, 3 mm thick, the larger is 12 mm long and almost 4 mm thick - the bottom width is unobtainable due to the missing lower part of the posterior margin. On both teeth the basal breakage intersects the thick walled pulp cavity. On the smaller tooth the enamel margin is recognizable 1-1/2 mm above the basal end. On the lingual side of the upper part of both teeth a large, rather narrow swelling is curved strongly toward the rear along the midline. The finely serrated posterior margin is quite straight on the smaller tooth, on the larger tooth the short stretch that is preserved shows a weak concavity on the upper part of the posterior margin. The anterior margin of the smaller tooth shows a weak and finely serrated cutting edge for about 4 mm from the tip, which then curves around on the lingual side, and then is unserrated and is traceable to just below the middle. The posterior margin of the smaller tooth has 4 oblique serrations per 1 mm, the anterior margin has 5 less distinct serrations. On the larger tooth there are 3-1/2 serrations per 1 mm on the posterior margin; its anterior margin is rounded and worn. An abrasion surface that runs from the tip to the lower front on the buccal side of both teeth shows that they are both lower teeth. The asymmetric curvature of the anterior cutting edge on the lingual side speaks against placing then in the rear, and for placement in the anterior section of the tooth row of the lower jaw. A very worn, 6 mm long tooth stump with a broad pulp cavity and a bottom cross-section 5 mm long and 4 mm wide, from the Pterosaur-quarry in the Upper Saurian Bed (MD) east of T e n d a g u r u , has a posterior finely serrated margin that is preserved for a short distance in the middle plane and apparently belongs to Type d. It shows scratches (or striations, etc.) on the lower part (or bottom) that are almost perpendicular to the long axis but are not quite parallel to each other. Whether these small teeth belong to *Elaphrosaurus bambergi*, specifically to juveniles, or to another smaller c o e l u r o s a u r , I cannot say.

T y p e **f** . A small tooth (Pl. IX, fig. 6) from the Middle Saurian Bed (Stegosaur-quarry *St*) differs greatly from all other teeth so far found. It is narrow, laterally very compressed, posteriorly rectangular, very pointed, strongly arched to the rear, and has an expanded rear contour on the bottom. The anterior margin is rounded along its entire length, the narrow posterior surface cuts off the tooth in a very strong concave curvature and almost perpendicular to the lateral surfaces and with these edges (or corners) that run out on the base, form a rounded posterior side. One lateral surface is flat, the other is slightly convex. The edge that borders the latter is faintly serrated just below the middle – about 4 serrations per 1 mm; the upper half of this edge is not well preserved, therefore it is questionable whether the serration was present. Total length is 12 mm, basal width is 5 mm, 3 mm wide halfway up, the thickness is 2 mm from the base almost to the tip. A transverse break on the bottom shows a very thin wall around the wide pulp cavity. A zone 1-1/2 mm wide above the bottom margin appears to be enamel free. The tip shows moderate abrasion, a zone 2 mm wide on the posterior surface and even more on the edges. The described tooth is without doubt a premaxillary tooth. It differs so much from the other described teeth with the characters of premaxillary teeth that it appears risky to make it conspecific with them. Its very compressed form could indicate a pointed-muzzled species, to which one of the small tibiae could belong. I am lacking any basis to conclude whether it belongs to any of the described maxillary or lower jaw teeth. As a matter of fact, it would be very unusual if the only tooth of the species to be found were a premaxillary, because they are less numerous than other teeth.

Abrasion of the Teeth.

The material available permits some observations on the abrasion of teeth through use. The anterior cutting edge is generally incompletely preserved, the tip is usually strongly worn, rounded to transversely truncated to the extent that a flat surface results that cuts off the crown and therefore is curved toward the front in varying degrees. The abrasion surface often reaches down onto the anterior margin and the lateral surfaces. These surfaces have consistently distinctly convex surfaces. These differ from the planed surfaces on the side that results from the action of opposing teeth, and can be used to divide them into upper and lower teeth, as LAMBE (1917, p. 18) points out, by the abrasion being on the lingual or buccal side. Often on these smooth abrasion surfaces are fine scratches that reflect the orthal jaw movement in the direction of the long axis of the lower part of the tooth, in other words, perpendicular to the margins of the jaw, not in the direction of the posteriorly-arched upper part of the tooth. However, there are often transverse scratches on the lower half of the tooth on the sides, that is, parallel to the jaw margins. They appear on the side teeth and on the more anteriorly placed teeth, and on both sides of the same teeth. Their explanation is not easy. One can imagine that as they grabbed the food lying on the ground, as was certainly the method, or in biting and tearing of the food, where they would have pushed against the ground, that they would have picked up sand grains on the basal walls of the crowns and that they would have scratched the tooth as they were pushed through the holes between the teeth.

Comparison with Teeth of Other Coelurosaurs.

The first in line for comparison are the Jurassic c o e l u r o s a u r s , *Compsognathus*, *Coelurus*, and *Ornitholestes*. The teeth of *Compsognathus*, the anterior ones of the lower jaw, were described by WAGNER (1861) as having a curved, cone-shaped, smooth, pointed form. WAGNER said nothing about the presence or serration of cutting edges. A study on them would be desirable. The tooth illustrated by MARSH (1896, Pl. 7, fig. 1a–c) of *Coelurus fragilis* MARSH, whose assignment to that species is by no means proven (see GILMORE, 1920, p. 127), is very narrow in the upper half and differs greatly from the teeth of *Elaphrosaurus* in that the posterior margin projects out toward the base and that the anterior serrated cutting edge reaches far forward. A good illustration of the teeth of *Ornitholestes* is lacking. They are described as "not so serrate or prehensile as in typical carnivorous dinosaurs" (OSBORN, 1903). OSBORN's newer reconstruction (1917) of the skull of *Ornitholestes* shows teeth that are in part of similar shape to MARSH's illustration. I would rather not risk a more exact comparison on the basis of OSBORN's illustration alone. GILMORE (1920, p. 128) and MATTHEW (1922, p. 371) deem the synonymy of *Ornitholestes* and *Coelurus* as probable. With respect to the great differences between the teeth of *Coelurus fragilis* (MARSH) and *Ornitholestes hermanni*, GILMORE points out that according to LULL's work, the assignment of MARSH's teeth to *Coelurus* is uncertain. Under the designation of *Coelurus fragilis*, LULL (1911, pl. 15, fig. 1) pictures a tooth from the Arundel Formation from Muirkirk, Maryland, that is similar and more slender than most of the teeth of *Elaphrosaurus* but otherwise is very similar in general shape. LULL also notes the presence of an anterior, serrated cutting edge, which is similar to *Elaphrosaurus*; it is preserved on one tooth from the tip down for a little ways, whereas it is absent on others, which is the case on many of the African teeth because of wear. A generic relation of *Elaphrosaurus* with these teeth would not be impossible. But because a claw is the only find besides the tooth from the same place, GILMORE (1920, p. 127) points out that it is extremely questionable whether it belongs to the older genus *Coelurus*; the differences of the teeth would more likely speak against it. Very noteworthy is a peculiar tooth that LAMBE (1902, pl. 14, fig. 12, 13) illustrated and, with reservations, designated as *Ornithomimus altus*. The tooth shows a rounded, curved anterior side, and a narrow, straight truncated posterior surface that is bordered by two edges (or corners), of which one has serrations on its middle part, according to the text. Other teeth were found with this peculiar tooth that are intermediate between it and the megalosaurid type. The common occurrence of such teeth with remains of *Ornithomimus altus* caused LAMBE to assign them to that species. After OSBORN (1917) discovered that the skull of *Struthiomimus* (*Ornithomimus*) *altus* has toothless jaws, the assignment of these teeth to that species was dropped. A very similar cross-section, according to LAMBE's illustration (1917, fig. 10), shows that very many larger premaxillary teeth of *Gorgosaurus* come from the same geologic horizon. On the Type f premaxillary tooth from Tendaguru, the cross-section is notably narrower than on the American form from LAMBE, the general shape is more delicate and slender; the length is also only half that of the latter. A closer connection between the two is not evident.

Theropod Teeth.

Labrosaurus* (?) *stechowi JANENSCH.

There are 9 teeth under consideration, 8 from the Middle and 1 from the Upper Saurian Bed that, by the presence of longitudinal grooves and ribs, can be recognized as belonging together.

Type **a**. The teeth from the Upper Saurian Bed, Quarry *Om* (Plate X, Fig. 1a, b), shows the groove sculpturing is on two sides. Bluntly conical, weakly bent (curved) in the back, the back margin (edge) almost straight, insignificantly bent (curved) in the side; point strongly worn down. On the bottom and the wide pulp cavity is enclosed by only a very thin wall of dentine. Length of the entire teeth is 46 mm, that of the enamel covering is 41 mm. The cross-section at a point 26 mm from the point is approximately 16 mm long and 13 mm wide at the greatest width, which is very close to the front margin (edge). The front cutting edge, finely serrated, runs to the end of the enamel covering, likewise probably the back cutting edge (the back of the bottom edge is not preserved). The number of denticles per 5 mm at a point midway to the top is 10 in the front and 9-

1/2 in the rear. The surface sculpture on the lingual side (Plate X, Fig. 1a) is strongly pronounced; it consists of fine, sharp ribs and grooves, that run a little less strongly bent (curved) than the front margin (edge). One cm from the point, the spacing of the ribs is approximately 1-1/2 mm; farther toward the bottom at varying places, new ribs m inserted, whereby the rib spacing is lessened. The point, a zone about 3 mm wide along the front margin (edge), and a zone about 9 mm that broadens downward along the back margin (edge) are all smooth. On the buccal side (Plate X, Fig. 1b) the sculpture consists of only a few short ribs and grooves, slightly over 1 cm in length, that lie halfway to the crown and in front of the middle of the crown.

T y p e **b** . The teeth that I already designated as type-teeth of the species (1920, p. 233, Fig. 7-8) comes from the Middle Saurian Bed in M a h i m b w i V a l l e y at T e n d a g u r u . The conical shape is similar to that described above, but much more strongly bent (curved), the tip strongly worn off and therefore it is rounded off. With a total length of 45 mm the only partially preserved enamel cap extends only to the bottom end, whose obliquely directed cross-section shows the pulp cavity only slightly extended. A cross-section taken 30 mm from the tip is 17 mm long and 14 mm wide. The front cutting edge is serrated for about 30 mm. The back edge is still strongly serrated at the point of breakage, 33 mm from the tip. The number of denticles at the top of the front edge (margin) is 9-1/2 per 5 mm, while on top in the rear it is 8-1/2 and in the middle of the back it is 9. Surface sculpture is evident only on the lingual side, where it consists of a narrow zone of 3 ribs in the middle of the face. On a fragment 25 mm long of another thick tooth of this type there is a striking bulging on the base of the lingual side behind the middle that is only weakly demonstrated on the type teeth. On a third tooth of this type from the Middle Saurian Bed, M a h i m b w i V a l l e y at T e n d a g u r u (Plate X, Fig. 3) with weaker surface sculpture – probably in part due to the loss of most of the enamel – the less strongly worn down tip is rather thinly conical, the bend (curvature) of the sides is strong, and the curvature of the back is moderately strong. The broken end on the bottom still has enamel covering 45 mm from the tip; the pulp cavity is opened widely. The cross-section in the area of the broken end is 18 mm long and 15 mm wide. The short front cutting edge proceeds at the bottom strongly toward the lingual side and disappears just past midway to the top. There is also a fourth tooth of this type that is a 20 mm long fragment with strongly longitudinal grooving on the lingual side.

T y p e **c** . Another conical shaped tooth out of the Middle Saurian Bed of the B o l a c h i k o m b e Valleys at T e n d a g u r u (Plate X, Fig. 4) that is strongly bent (curved) toward the lingual side but not toward the back, differs from type b in that the front cutting edge is indicated immediately under the very strongly worn down tip and is therefore very short, and also in that fine secondary ribs lie over the numerous longitudinal ribs. The number of denticles on the back margin (edge) is 9 per 5 mm at the top and 10-1/2 in the middle.

T y p e **d** . Another tooth that is 36 mm long and altogether covered with enamel, from the m Middle Saurian Bed south of T e n d a g u r u (Plate X, Fig. 5) differs in having a broader form. It also shows the beginning of the pulp cavity; the cross-section taken at 25 mm below the well-worn tip is 19 mm long and 13 mm wide. The backward curvature is moderately strong, and the side curvature (bend) is scarcely noticeable. The front cutting edge is distinct clear to the broken end, which shifts strongly toward the lingual side. The number of denticles in front at the top is 12-1/2 per 5 mm, 14 in the front middle, and 11 in the rear middle. The surface sculpture consists of 3 short rows of ribs, spaced 1-1/2 mm from each other, in the middle of the lower half of the lingual side.

T y p e **e** . In addition to those already described, a lower, rather stocky tooth with still wider shape was found in the S t e g o s a u r -quarry in the second Saurian Bed at K i n d o p e , north of T e n d a g u r u (Plate X, Fig. 6). The sideward curvature is weak. The longest preserved length is 43 mm, and the broken end shows a pulp diameter of about 15 mm; the enamel extends to a maximum of 38 mm from the tip, which has been worn down through use. A cross-section taken 18 mm from the tip is 18 mm long and 11.4 mm wide, while one taken about 35 mm from the tip is 22 mm long and 13 mm wide. The tooth crown, therefore, has a narrower cross-section than those of the previous type. The rear margin (edge) runs almost in a straight line while the front margin (edge) runs in a pronounced bow due to the broadness of the teeth. The front cutting edge disappears about 28 mm from the tip. The number of denticles per 5 mm in the top front is 14, in the middle front 14-1/2, and in the rear top and middle 12. The longitudinal sculpture consists of only 2 very short, about 1 cm long, not very pronounced ribs in about the middle height of the crown, in the middle of the lingual side. Even if the sculpture is very weak, I believe that this tooth must be related to those with heavy sculpture, because the stocky shape does not seem to match the shape of the others with weak sculpture.

The teeth described above show themselves to be at least generically related because of the remarkable sculpture. I do not wish to separate the teeth with sculpture on two sides (Type a) from the others with sculpture on one side because it appears to be in no way impossible that they belong to one species, although the two-sided sculptured teeth comes from the Upper Saurian Bed, while the rest stem from the Middle Saurian Bed. It could be that the first is a younger, more specialized form. Apparently certain sauropod species are continuous though both Saurian Beds. One must, therefore, allow the same possibility for the theropods. The larger number of cone-shaped teeth as compared with the broad ones poses the question whether it is just accidental that fewer broad teeth were found, or if the ratio of the two shapes reflects the original situation in the set of teeth, that is if a set of teeth consisted mainly of conical teeth, and finally if there were smooth teeth besides the sculptured ones that just have not been found yet in the mass of material. In this last case, one would have to assume that very similar, entirely smooth teeth would be connected with the broad type e, which has very weak grooves. But such smooth teeth apparently are not to be found, because the finely serrated teeth otherwise present (Type b) never has a similarly stocky shape. Whether it is a coincidence of collecting that there are more conical than broad teeth cannot be directly decided. It appears to me to be not impossible that the set of teeth of this theropod could be characterized by not only the striking sculpture, but also by a majority of conical teeth, which are normally present in the foremost part of other genera's sets of teeth. The broad teeth also show an unusual stockiness, so that one is led to the conclusion that this is a characteristic of the entire set of teeth. The teeth leave the impression that they were more for crushing (pulverizing, crunching) type of feeding, as on bones, rather than for a cutting type. This would agree with the well-worn appearance of the points of the teeth. It therefore appears entirely possible that the conical type, which is normally restricted to the front of the set in the other large theropods, was found in the rear of the set of teeth of this one.

MARSH found a tooth with similar sculpturing in the M o r r i s o n Formation which he called *Labrosaurus sulcatus* (1896, Plate 13, Fig. 1). A second stocky, cone-shaped, weakly curved tooth with only one finely curved cutting edge and few pronounced longitudinal grooves on the middle of one side from the *Virgula* Zone from M ü n s t e r in the B e r n e r J u r a was called *Megalosaurus meriani* by GREPPIN (1870, Plate 1, Fig. 1a–c). The sculpture – ridges running from the top down with new ones being inserted in – of these agrees so closely with the teeth from Tendaguru that a generic relationship is most highly probable. Even though MARSH and HAY (1908) assume that the sculpture on the American teeth is on the outward side, I conclude because of the curvature that the illustrated tooth closely shows that it is the lingual side that is sculptured, as in the African tooth. According to HAY the tooth has a cross-section of 12.5 mm length and 12 mm width when taken 3 cm from the tip. Whether a second serrated cutting edge is present or not cannot be determined from either MARSH's illustration or HAY's description; apparently it is not. Even if the different degrees of development in the African teeth makes it scarcely possible to determine whether the teeth from all three locations belong to the same species, certainly a new species name for the African teeth is justified when the geographic separation is considered. I named (1920) this highly unique form after the benefactor of the Tendaguru Expedition, His Excellency Lord Head General Practitioner Doctor STECHOW in B e r l i n .

It is a difficult question, which generic designation should be used. MARSH first used the genus name *Labrosaurus* and designated *L. lucaris* (1879), described from neck and thoracic vertebrae end forelimb bones; but no illustration was given. Later a very unique dentary was described by MARSH as *L. ferox* (1884), and finally the above-mentioned tooth was designated *L. sulcatus* (1896). In order to more closely determine the relation of *L. sulcatus* and *L. ferox* to each other, HAY (1908) studied the dentary with respect to tooth remains in the bone and replacement teeth. He found that the cross-section of the preserved crown base of the forwardmost tooth and its replacement teeth, and also of the replacement teeth of the sixth tooth is laterally compressed. In no event did he find traces of grooves and ridges, and so he drew the conclusion that *L. ferox* and *L. sulcatus* could not belong to the same genus. On the other hand the Tendaguru material shows that next to conical teeth with prominent grooving there are wide, strongly laterally compressed teeth which have only a small amount of groove sculpturing. Because HAY could only expose small surface parts of teeth in *L. ferox*, it is still possible that unexposed parts could be sculptured. That *L. sulcatus* does not belong to the same genus as *L. ferox* is, therefore, not yet proven. HAY could also not clear up the relation to *L. lucaris*, the first named species of the genus. GILMORE (1920, p. 12) recently came to the same opinion, while starting from the idea that the tooth of *L. sulcatus* could be a premaxillary tooth. Given these conditions, it is probably best to retain these grooved teeth under the name *Labrosaurus*, but with some reservations.

Megalosaurus* (?) *ingens JANENSCH.

The material at hand comprises 25 teeth and a few tooth fragments. The distinguishing characters of this species are the striking size of a part of the teeth and the relatively coarse serration of the cutting edges, which even serves to separate smaller teeth of this species from other types in the T e n d a g u r u Formation. The differences in form are a result of the different positions in the mouth.

T y p e **a** . The largest available tooth (Pl. IX, fig. 7) already designated by me as the type of the species (1920, fig. 6) from the Upper Saurian Bed of the T e n d a g u r u (Quarry *B*) is about 15 cm from the worn and rounded tip to the most distant remains of the root, the enamel covering is about 12 cm long; the width at about 1 cm above the margin of the latter is 48 mm, the greatest thickness in the area of the margin of the enamel covering, about 1/3 of the width of the anterior margin from the margin of the enamel, is 23 mm. The shape is tall and quite narrow, narrowing consistently to the top, and moderately strongly curved to the rear but scarcely curved at all toward the side. The cross-section is especially rather strongly compressed at the bottom. The serrated cutting edges reach quite a ways toward the bottom, the anterior is still present 1 cm from the end of the enamel and the posterior is at least as long. The coarse serration shows 9-10 per centimeter in the upper part and 11-12 per centimeter midway along the length. The anterior cutting edge curves toward the lingual side at the bottom. Superficial, weakly raised waves, that run in short, concave arcs in distances of 4-10 mm apart, are recognizable on most of the posterior margin. This type is represented by 4 large pieces.

T y p e **b** . Relatively narrower teeth are found individually, whose cross-section is shorter and wider. A strong lateral curvature is recognizable on these. The serration of the cutting edge is identical or very similar to the previous. One tooth (Quarry Aa) is 86 mm long and at a length of 75 mm the enamel covering has a width of 30 mm and a thickness of 19 mm at the lower end (Pl. IX, fig. 8). The tooth could come from the anterior part of the mouth. Another, much larger tooth from the S t e g o s a u r -quarry at K i n d o p e in the T e n d a g u r u , in the Middle Saurian Bed assumes an intermediate position between the two types. It lacks the tip and has a preserved length of 121 mm and a greatest width of 40 mm, a greatest length of the enamel covering of 107 mm and a width of the pulp cavity of about 25 mm on the lower end.

T y p e **c** . Another type of tooth differs from the two already described by its low, wide crown that is strongly curved to the rear; it is very compressed laterally. A particularly typical tooth of this type from the Upper Saurian Bed, Quarry *Z* (Pl. IX, fig. 10) has a total length of 60 mm (preserved length) and an enamel covering length of 54 mm, width of 30 mm, and 16 mm thickness on the lower end of the enamel. The serrated cutting edge extends the entire length of the enamel covering. The number of serrations per centimeter is 11-13 and becomes greater toward the bottom. This tooth type is at any rate from further back in the tooth row.

Teeth with coarse serration from the Upper J u r a s s i c of France are known. The large tooth of *Megalosaurus insignis* DESL. and LENNIER from the lower Kimmeridge of La Hève that LENNIER (1867, pl. 1, fig. 1-3) figured 3 teeth under the same species with equally coarse serration, of which the largest comes from the Portland of B o u l o g n e . It is a rather broad tooth with a very weakly arched posterior margin. The even coarser character of the serration, which does not occur on a long stretch of the lower anterior margin, distinguishes this tooth from the East African species. Figure 3 by SAUVAGE is a short, wide tooth with very short serration of the anterior margin, whereas fig. 2 is the upper end of a narrow tooth. It remains open to discussion whether the teeth of L a H è v e and B o u l o g n e actually belong to the same species. The large East African tooth type is distinguished from the French type on the basis of the coarse character of serration and deserves the new species name.

Other Tooth Material from Theropods.

After the removal of the definitely distinguishable teeth of *Elaphrosaurus bambergi* and other c o e l u r o s a u r s , of *Megalosaurus* (?) *ingens* and *Labrosaurus* (?) *stechowi*, there are 45 remaining teeth. These teeth are separable on the basis of size, width, thickness, curvature, and general shape. Even when considering that certain differences arise because of ontogenetic age differences – teeth of juvenile individuals must have been smaller and more finely serrated than those of adults – and also because of various positions in the jaw, it still does not seem possible to combine into the jaws of one species. On the other hand, though, I cannot definitely divide them into satisfactory species. They are divisible into six types.

T y p e A . Large tooth from the Middle Saurian Bed, S t e g o s a u r -quarry *St* (Plate X, fig. 7). Evidences of wear are visible only on the tip and upper third of the anterior cutting edge. Greatest length 86 mm, width on lower end 37 mm, thickness 17 mm, greatest length of the enamel covering 83 mm, length of the pulp opening 76 mm from the tip is 27 mm. Form large, wide; anterior contour strong and equally concave, posterior contour very slightly arched; entire crown bent toward the lingual side, rather thick, even to the end of the tip. The concavely arched lingual side is along the midline, the convexly curved buccal side most strongly swollen of the broadly rounded anterior edge otherwise almost even (or planar); the anterior serrated cutting edge bends increasingly more toward the bottom on the buccal side, extends 66 mm from the tip, and ends where the crown is 35 mm wide; the posterior cutting edge extends the entire 73 mm of the posterior margin and ends on the bottom. The serrations are fine, near the tip in front are 17, in the rear 19, in the middle front 19, middle rear 20, lower 26-27 serrations per 1 cm. On both sides is a series of superficial transverse swellings, generally about 2-4 mm apart that describe an arch open to the bottom and that curves upward on the lingual side in front of the posterior cutting edge. A second, similarly constructed, incomplete tooth of smaller size comes from the base of the Upper Saurian Bed at K i n d o p e , north of the T e n d a g u r u .

T y p e B . Tooth from the Upper Saurian Bed of the T e n d a g u r u , Quarry *T* (Pl. X, fig. 8). The abrasion is minimal on the tip and the uppermost part of the anterior cutting edge. Greatest length 37 mm; on the lower end 19-1/2 mm wide, 9 mm thick; greatest length of enamel covering 35-1/2 mm. Length of the very thin-walled pulp cavity, 34 mm from the tip, is 18 mm. Form low, broad, rather thin; anterior contour symmetrically convex, posterior contour very weakly convex. The anterior cutting edge rises vertically, the posterior, like the rest of the tooth, curves slightly to the lingual side. The swellings on both sides are both equal in size, on the lingual side it is strongest along the midline and flattens in the rear half, on the buccal side it is rather ?[*] in the upper middle and strongest in the lower part near the anterior margin; the lower anterior margin is rounded and tapers off. The serration extends along the entire preserved length of the posterior margin, but only extends 35 mm from the tip anteriorly, with 2 mm lacking serration. Posterior and anterior edges of the tooth lie approximately in the median plane. The upper and middle anterior margin has 23 serrations per 1 cm, the posterior has 24, toward the bottom the serration becomes finer on both margins. A superficial transverse swelling is only faintly indicated on both sides. Because of the low form and the very slight amount of lateral curvature, I presume that the tooth is from the posterior part of the jaw. Teeth of this type are common, but primarily in the Middle Saurian Bed.

T y p e C . Tooth from the Middle Saurian Bed, M a h i m b w i V a l l e y , T e n d a g u r u (Pl. X, fig. 9). The abrasion is insignificant on the tip and upper part of the anterior cutting surface. Greatest length 67 mm, width 53 mm from the tip is 25-1/2 mm, 13 mm thick; greatest length of the enamel covering 59 mm, length of pulp cavity 58 mm from the tip is 15-1/2 mm. Form elongated, narrow, symmetrically running to the tip, moderately thick. Anterior contour almost symmetrically and rather strongly convex, posterior contour weakly concavely arched. The entire tooth is notably curved toward the lingual side, the posterior edge shows this curvature especially distinctly. The lingual side is strongly bulged along the midline, the buccal side is weakly curved in the upper half, but toward the bottom and in front of the midline is quite strongly swollen. The anterior and posterior edges lie almost in the median plane and have not ended at 56 and 52 mm, respectively, from the tip. The anterior side is distinctly sharpened on the bottom end. The serration is very fine; in 1 cm there are 19 serrations on the upper posterior margin, 20 in the middle, 21 on the middle of the anterior margin, toward the bottom the number increases anteriorly and posteriorly to 21. The enamel layer is mostly exfoliated due to weathering. Even on the well-preserved, smooth places there is very little evidence of superficial transverse swellings. This type is represented by some pieces from the Middle Saurian Bed. The more conical shape makes it probable that these teeth come from the anterior part of the mouth.

T y p e D . Tooth from the Middle Saurian Bed of the M a h i m b w i Valley, south of the T e n d a g u r u (Pl. X, fig. 10). The tip of the crown is missing. Greatest preserved length 48 mm,

[*] He left out the word. – JDO.

width about 10 mm from the lower broken edge is 25 mm, 15 mm thick. The enamel covering reaches to a few millimeters from the lower end, length of the pulp opening on the lower end is about 17 mm; form narrow, conical. Anterior contour weakly convex on the bottom, moderately so on the top, posterior contour weakly concave. The tooth is quite strongly curved to the lingual side. The lingual side is strongly arched, the buccal is rather flat. The anterior serrated cutting edge runs about 13 mm from the upper breakage downward, it ends at a point where the crown is 19 mm wide; about 35 mm from anterior margin to the lower and is free. This entire section of the anterior margin is broadly rounded. The posterior margin is serrated along its entire length. The serration is fine; in front in the middle there are 22 serrations per cm and in the rear in the middle are 20. The superficial transverse rolls (or humps, bulges, etc.) are apparent only near the posterior margin on both sides as short, upward-curved hooks. The conical shape and the pronounced lateral curvature of the entire tooth show that it was more toward the front of the jaw than the previous 3 types. A tooth from N i o n g a l a is quite similar to this one; the serrated cutting edge extends t0 about 39 mm from the moderately worn tip, where it ends at a point that is 19-1/2 mm wide. The entire form is thinner, and less laterally curved, the serration a little finer. A second tooth from N i o n g a l a is even flatter, its anterior cutting edge extends 44 mm from the tip (where the width at the lower end is 22 mm). Both of these teeth probably belong to type D.

T y p e E . Tooth from the Middle Saurian Bed, B o l a c h i k o m b e Stream, T e n d a g u r u (Pl. X, fig. 11). The upper half of the anterior cutting edge and the top of the tip are somewhat abraded. Greatest length 61-1/2 mm, 56 mm from the tip the width is 25 mm, 12 mm thick; greatest length of the enamel covering is 58 mm; length of the pulp opening 56 mm from the tip is 20 mm. Form high, slender thin. In completely unabraded condition the tip must have been very pointed. Anterior contour in the upper half is very convex, in the lower half is only slightly convex; the convex posterior contour is not symmetrically curved, and midway up is bluntly projecting. The tooth is notably curved toward the lingual side, even angular 1/3 of the way; the posterior cutting edge runs correspondingly. The anterior cutting edge runs a little toward the lingual side on the bottom. Both sides are flatly arched, on the lingual side most noticeably on the upper half in the riddle, and also quite a bit on the lower third of the anterior margin, so that a rounded cross-section is the result. The fine serrations run the entire preserved 52 mm of the posterior margin, on the anterior margin it extends for 56 mm from the tip. The number of serrations per 1 cm is 25 on the upper anterior margin, 27, in the middle, on the upper rear margin 24, and 24-1/2 in the middle; they increase greatly toward the bottom anteriorly and posteriorly (34 and 32). On both sides swollen elevations run in very flat, open to the bottom arches, 1-2 mm apart, that bend sharply up immediately in front of the posterior cutting edge. A somewhat smaller, but otherwise very similar tooth from the Upper Saurian Bed (Quarry *B*) was found with a type F tooth.

T y p e F . Tooth from the Upper Saurian Bed, Quarry *B* (Pl. X, fig. 12). Only the tip and the upper part of the serrated anterior cutting edge is very slightly worn. Greatest length 37 mm; on the under edge the width is 14 mm, 29 mm from the tip is 13-1/2 mm, the thickness is 6 mm; greatest length of the enamel covering is about 30 mm; length of the very deep pulp opening 35 mm from the tip is 11 mm. Form very tall, slender, thin and tapers upward to a slender point; the posterior contour in the upper half is scarcely curved, the lower half is weakly curved. The tooth is curved toward the lingual side. The arch on both sides is approximately equal; it is greatest in the upper half of the midline but even then only moderately pronounced, further down in the middle it is flatter. The very fine serration extends the entire length of the posterior margin, in front it ends 27-1/2 mm from the tip; from there on down the anterior margin is rounded. The number of serrations per 1 cm is 28 on top in front, 29 in the middle, 26 on top in the rear, and 30 in the middle. On the buccal side a superficial swelling (or hump, etc.) is visible in a very shallow curve. The tooth was found with one of the type E teeth, as mentioned above, and could well be from the same species, even perhaps from the same individual.

The question is raised whether the six types could be from the jaws of one species or whether they are from two or more species. The two laterally more compressed types C and D apparently come from a position further forward in the mouth than the other four; but I would like to withhold judgement on whether the two types belong together or with the other types. Apart from these two types, the other four differ greatly in general shape. I do not consider too probable that the very large and broad type A fits the same mouth as the slender E and F. If one should assume that the posterior teeth of a narrow-crowned upper or lower set of teeth should have a lower and broader shape than the side teeth, type A is still too large, and the same goes for the slender type E if it were assumed to be a posterior tooth. Therefore I would like to propose that there are the teeth of two theropods among this material, one of which has broader side teeth than the other. The broader type was considerably larger than the other. The low type B may well have been from the rear of a row of teeth. With much reservation, I tentatively assign type B to the same species as type A and assign E to the same species as type E.

The American literature gives no information about the teeth of the important American genera *Allosaurus* and *Ceratosaurus* from the Morrison Formation. Then, are no separate illustrations of the teeth in the skulls of *Allosaurus agilis* Marsh and *Ceratosaurus nasicornis* MARSH, so that an exact study of their form is scarcely possible. GILMORE (1920, p. 92) could see no other difference between the teeth of the genera than that the premaxillary teeth on *Ceratosaurus* are more robust than those of *Allosaurus* that he had access to, as would be expected on a larger animal. A comparison of the illustrations of the teeth of both skulls shows that GILMORE is probably correct. As far as I can determine from the pictures, I assume that type E is very similar to the teeth of *Allosaurus*. The attempt to identify the six types of teeth with anything in the literature failed. I limit myself to a few short indications (or hints). Type F is quite similar to a tooth identified as *Megalosaurus superbus* from the Aube of Bar le duc, which is illustrated by A. GAUDRY (1890, fig. 329). The difference on this one, aside from its larger size, is its somewhat more long-pointed form. LULL (1911, pl. 14, fig. 1, 2) pictures a tooth identified as *Allosaurus medius* MARSH from the Lower Cretaceous of Muirkirk, Maryland, that is similar to our type C from a side view, but differs in the shorter serrated anterior cutting edge and the more strongly curved profile of the posterior margin. A tooth from Niongala, east of Tendaguru, from an uncertain horizon (?Middle Saurian Bed) has a similar general shape and short anterior cutting edge and is closer to the tooth from Muirkirk. When MARSH established the species he gave no illustrations. Just as MARSH lists his assignment of the species to *Allosaurus* as tentative, so also must LULL's tooth be considered questionable because of lack of conclusive evidence. The tooth figured by SIMIONESCU (1913) from the Lower Cretaceous of the Dobrudscha as *Megalosaurus* cf. *superbus* Sauvage is likewise similar to type C, but differs in that the profile of the posterior margin is straighter, and the serration is finer, very long and reaches to the very lowest part of the crown.

Relationship of the Teeth of Coelurosaurs and Theropods.

A treatment of the question about the relation of the single teeth to the skeletal elements, requires some statistical data about the finds of the quarries, *Elaphrosaurus bambergi* is represented by skeletal parts from two quarries, three other c o e l u r o s a u r s from two locations. All the t h e r o p o d bones come from 6 locations. Because the field *T L* is so large and so many species are found there, it is equivalent to 3 or 4 other quarries, and because the Stegosaur-quarry has yielded 2 or 3 different species it can be as 2 or 3 occurrences; so there are at most 16 occurrences of bones of c o e l u r o s a u r s and t h e r o p o d s in the T e n d a g u r u area. Opposed to that, isolated teeth of *Elaphrosaurus bambergi* and other c o e l u r o s a u r s have been found at 9 places in the Middle Saurian Bed, 20 in the Upper; of *Labrosaurus* (?) *stechowi* there are 5 in the Middle and 1 in the Upper Saurian Bed of *Megalosaurus* (?) *ingens* there an, 2 in the Lower Saurian Bed, 2 in the Middle, and 10 in the Upper; of the rest of the material that I assume represents 2 species but is here counted as one, there are 1 in the Lower Saurian Bed, 8 in the Middle, and 9 in the Upper. From this review it is evident there are 67 occurrences of individual teeth, a number that would increase if the last two species were separated. There is also the possibility that the teeth of a species from any given location could come from several individuals, whereby the number of occurrences is increased even more. Because of the greater number of teeth than bones, I conclude that the teeth do not all represent dead animals, but rather fell out while living, most often during biting. The repeated occurrence of single teeth by cervical vertebrae of s a u r o p o d s would support this conclusion. The conclusion is further supported in that unfinished replacement or even those without signs of wear are almost entirely lacking, whereas those that are well worn predominate. Also striking is the small number of single sauropod teeth compared with the large number of single bones and bone groups from sauropods. The numerical predominance of the occurrence of teeth of c o e l u r o s a u r s and t h e r o p o d s over the bones of the same appears to support the observation that the probability is much greater that species represented by bones are also represented by teeth, than it not be true. I will use this conclusion to attempt to match up some of the teeth and bones.

That the larger coelurosaur teeth (types A, B, C) belong to *Elaphrosaurus bambergi* because of their size and form, is already discussed in their description, as was the probability that the diminutive types D and F probably and type E possibly belong to the other smaller c o e l u r o s a u r s that are indicated by the 3 tibiae. In the section on the relationship of the bones it was stated that no bones were found that would be large enough to match the large teeth of *Megalosaurus* (?) *ingens*. For the skeletal parts assigned to *Allosaurus* and *Ceratosaurus*, the teeth must be sought in those labeled and described as "remaining material". If I may venture a guess, I would assign the large broad type A and perhaps also B to the large *Ceratosaurus* (?) *roechlingi* and types E and F to *Allosaurus* (?) *tendagurensis*. What I could gain from the illustrations of the North American species of these genera, while it is admittedly uncertain, seems to support such a separation. So that leaves the peculiar posterior dorsal vertebra and the anterior caudal vertebra from Stegosaur-quarry, perhaps the ilium from the same location, and the slender femora and the long tibia. from Quarry *T L* to match up with the remarkable *Labrosaurus* (?) *stechowi* teeth. I do wish to emphasize, however, that the matching of isolated teeth to isolated bones is no more than an uncertain guess on my part.

Summary of the Coelurosaur and Theropod Fauna from the Tendaguru Formation.

The investigation of the remains of carnivorous dinosaurs leads to the conclusion that in the Tendaguru area, from v. HUENE's group of the coelurosaurs there is a relatively large species, *Elaphrosaurus bambergi*, and three smaller forms, and that the larger theropods are probably represented by 4 species, of which *Megalosaurus* (?) *ingens* is characterized by its large size, and *Labrosaurus* (?) *stechowi* by the peculiarity of its ribbing (or grooving). As with the last mentioned species, it also appears that the other two species of theropods can be assigned to North American genera, namely *Allosaurus* and *Ceratosaurus*. The paleogeographic relations that are known for East Africa and North America are certainly remarkable. The Tendaguru fauna is interesting in that the giant *Megalosaurus* (?) *ingens* is found in all three saurian horizons, while *Labrosaurus* (?) *stechowi* and *Elaphrosaurus* are found only in the top two. For the latter this is true if the teeth actually belong to the species. Of *Ceratosaurus* (?) *roechlingi* from the Upper Saurian Bed there are also vertebrae from the Middle Bed. Because the teeth of this species and of *Allosaurus* (?) *tendagurensis* are so questionable, nothing more can be said about the appearance of these two species in the various horizons; but it is noteworthy that besides *Megalosaurus* (?) *ingens* in the Lower Saurian Bed, there are teeth of types A–F that probably belong to both *Ceratosaurus* and *Allosaurus*.

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Plate I.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate I.

Reconstruction of *Elaphrosaurus bambergi* JAN. at 1/15 nat. size. P. 49.
The available parts of the skeleton are represented by hatched lines.

Plate II.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate II.

Presacral vertebrae of *Elaphrosaurus bambergi* JAN. Right lateral view at 1/2 nat. size

The designation of the position of the individual vertebrae corresponds to the assumed VERF. and to the arrangement represented in the reconstruction in Pl. I.

Plate III.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate III.

Sacrum and pelvis (without pubis) of *Elaphrosaurus bambergi* JAN. at 1/3 nat. size

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Plate IV.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate IV.

Caudal vertebrae of *Elaphrosaurus bambergi* JAN. Right lateral view at 1/2 nat. size

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“ 3.	“ “ e	“ 26
“ 4.	“ “ f	“ 26
“ 5.	“ “ g	“ 27
“ 6.	Middle “ h	“ 27
“ 7.	“ “ i	“ 28
“ 8.	Posterior “ l	“ 28
“ 9.	“ “ m	“ 29
“ 10.	“ “ n	“ 29
“ 11.	“ “ p	“ 29
“ 12.	“ “ q	“ 30
“ 13.	“ “ r	“ 30
“ 14.	“ “ s	“ 30

Plate V.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate V.

Femora of *Elaphrosaurus* and t h e r o p o d s at 1/6 nat. size

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" 2a.	Right femur (68) of a t h e r o p o d . Viewed perpendicular to the level of the main expansion of the proximal part	" 69
" 2b.	The same femur. Viewed perpendicular to the anterior (upper) surface of the distal part, at the same time at the level of the shaft curvature	" 69
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Plate VI.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate VI.

Tibiae of c o e l u r o s a u r s and t h e r o p o d s .

Plate VII.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate VII.

Fig. 1. First (?) metacarpal of *Elaphrosaurus bambergi* JAN. Lateral view at 1/1 nat. size p. 34
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" 3a. Left pes of *Elaphrosaurus bambergi* JAN. Anterior view at 1/3 nat. size. (N.B. Metatarsal II is drawn from an undeformed reconstruction) 41, 42, 43, 44
" 3b. The same. Outlines of the proximal end faces of the metatarsals at 1/3 nat. size. (N.B. The dotted line within the outline for metatarsal II is the assumed outlined as undeformed) 41, 42, 43, 44
" 4. Left metatarsal II of *Elaphrosaurus bambergi* JAN. Medial view at 1/3 nat. size p. 42
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Plate VIII.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate VIII.

Vertebrae of t h e r o p o d s at 1/2 natural size.

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“ 2a.	Middle caudal vertebra (*St* 270) of *Ceratosaurus* (?) *roechlingi* n. sp. Left lateral view	“ 58
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Plate IX.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate IX.

Teeth of coelurosurs and theropods at natural size.

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" 4.	Coelurosaur Type d, premaxillary tooth, lingual side half from the front	" 83
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The cross sections under each of the teeth are taken at the place designated by the fine lines.

Plate X.

W. Janensch: The Coelurosaurs and Theropods of the Tendaguru Formation, German East Africa.

Plate Legend.

Plate X.

Teeth of t h e r o p o d s at natural size.

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“ 3.	*Labrosaurus* (?) *stechowi* JAN., Type b, lingual side half from the front	“ 87
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“ 5.	*Labrosaurus* (?) *stechowi* JAN., Type d, lingual side	“ 87
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“ 7.	Theropod Type A, lingual side	“ 91
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“ 9.	Theropod Type C, lingual side	“ 92
“ 10.	Theropod Type D, lingual side	“ 92
“ 11.	Theropod Type E, lingual side	“ 93
“ 12.	Theropod Type F, lingual side	“ 93

The cross sections under each of the teeth are taken at the place designated by the fine lines.

Figure Legends.

Fig. 1. Fifth presacral vertebra of *Elaphrosaurus bambergi* JAN. Viewed from above at 1/2 nat. size.

Fig. 2a. Seventh presacral vertebra of *Elaphrosaurus bambergi* JAN. Viewed from the front at 1/2 nat. size.

Fig. 2b. The same vertebra. Viewed from below at 1/2 nat. size.

Fig. 3a. Eleventh presacral vertebra of *Elaphrosaurus bambergi* JAN. Anterior view at 1/2 nat. size.

Fig. 3b. The same vertebra as 3a. Posterior view at 1/2 nat. size.

Fig. 4. Thirteenth presacral vertebra of *Elaphrosaurus bambergi* JAN. Viewed from behind at 1/2 nat. size.

Fig. 5. Fourteenth presacral vertebra of *Elaphrosaurus bambergi* JAN. Viewed from the front at 1/2 nat. size.

Fig. 6. Cross-section of the fifteenth presacral vertebra of *Elaphrosaurus bambergi* JAN. at 1/2 nat. size.

Fig. 7a. Twentieth presacral vertebra of *Elaphrosaurus bambergi* JAN. Anterior view at 1/2 nat. size.

Fig. 7b. The same vertebra. Posterior view at 1/2 nat. size.

Fig. 7c. The same vertebra. Viewed from above 1/2 nat. size.

Fig. 8. Sacrum and pelvis of *Elaphrosaurus bambergi* JAN. Lateral view at 1/3 nat. size.

Fig. 9. Anterior caudal vertebra f of *Elaphrosaurus bambergi* JAN. Viewed from behind at 1/2 nat. size.

Fig. 10. Middle caudal vertebra h of *Elaphrosaurus bambergi* JAN. Viewed from the front at 1/2 nat. size. [The medianward-bent right prezygapophysis was put into its correct position in the figure.]

Fig. 11a. Posterior caudal vertebra n of *Elaphrosaurus bambergi* JAN. Viewed from the front at 1/2 nat. size.

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Fig. 13a. Right humerus of *Elaphrosaurus bambergi* JAN. Anterior (ventral) view at 1/3 nat. size.

Fig. 13b. The same humerus as 13a. Medial view at 1/3 nat. size.

Fig. 14. Left pubis of *Elaphrosaurus bambergi* JAN. Viewed from the front at 1/2 nat. size.

Fig. 15. Left fibula of *Elaphrosaurus bambergi* JAN. Lateral view at 1/6 nat. size.

Fig. 16. Posterior dorsal vertebra of *Elaphrosaurus bambergi* JAN. from the *Dysalotosaurus*-quarry. Viewed from below at 1/2 nat. size.

Fig. 17. Cervical vertebra (missing centrum) of a theropod from the Stegosaur-quarry. Anterior view at 1/2 nat. size.

Fig. 18. Right ilium of a theropod from the Stegosaur-quarry at 1/6 nat. size.

Fig. 19. Left quadrate of *Ceratosaurus* (?) *roechlingi* JAN. Viewed from the articular surface at 1/2 nat. size.

Fig. 20a. Left fibula of *Ceratosaurus* (?) *roechlingi* n. sp. Lateral view at 1/6 nat. size.

Fig. 20b. The same fibula as 20a. Viewed from the proximal articular surface at 1/6 nat. size.

Fig. 21. Anterior dorsal vertebra from Quarry *TL*. Left lateral view at 1/2 nat. size.

Fig. 22a. Anterior caudal vertebra of a theropod from Quarry *TL*. Posterior view at 1/4 nat. size.

Fig. 22b. The same caudal vertebra. Right lateral view at 1/4 nat. size.

Fig. 23. Posterior caudal vertebra (c) of a theropod from Quarry *TL*. Left lateral view at 1/2 nat. size.