Overview of the vertebrate fauna of the Tendaguru Beds, with a brief characterization of the newly established types of sauropods.

by W. Janensch.

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The following attempted overview of the vertebrate fauna of the Tendaguru Beds only intends to deliver a preliminary compilation of the forms known up to the present. Currently, only a small portion of the very voluminous bone material that the excavations of the Tendaguru Expedition have yielded could be prepared. The preparation of the dorsal and cervical vertebrae, especially those of the enormous sauropods, particularly important for comparative purposes, is unusually difficult and time consuming, so that only relatively little of this material could be completed to date. Therefore the examination and comparison of many important finds must as yet be left undone, and thus the true count of types cannot at present be confirmed. It is highly likely that the list of vertebrates presented here will later undergo an increase in types once the processing of the entire yield of four years of excavation is complete.

Within the vertebrate fauna, dinosaurs stand utterly dominant in the foreground. Next to them, what has been found of other reptiles, mammals, birds, and fishes diminishes completely in significance.

Among the dinosaurs it is the sauropods that greatly dominate the other groups of dinosaurs through their overall distribution, the abundance and size of their remains, and, moreover, also in number of types.

In order to make the overview of the vertebrate fauna relatively complete, it is above all necessary to give an impression of the wealth of forms of sauropods. To this end, it appeared highly desirable to briefly characterize and simultaneously name a number of new sauropod types here. The more detailed description of the skeletal elements, upon which the preliminary characterization of the new forms is based, follows below.

List of the vertebrates.

Mammalia.

A small, only about 2-cm-long mandible likely originates from a representative of those primitive Mesozoic mammals that are mostly classed as polyprotodont marsupials.

Aves.

A metacarpal certainly belongs to a bird that might be related to *Archaeopteryx*, according to a friendly communication from Prof. Stremme.

Reptilia.

Order *Pterosauria*.

Bones of pterosaurs could likely be referred to two types on the basis of size differences, according to Prof. Stremme.

Order *Dinosauria*.

Suborder *Theropoda*.

Compressed teeth with serrated margins, typical of these predatory forms, were not rare, at times of significant size (up to 15 cm), also skeletal elements of animals of highly variable size, which likely are to be referred to two different species.

Suborder *Sauropoda*.

Of sauropods, E. Fraas (Palaeontographica v. 55) described two species as *Gigantosaurus*.

Genus *Gigantosaurus* E. Fraas (=*Tornieria* Sternfeld[1]).

Gigantosaurus africanus E. Fraas.

As far as can be perceived at present, a subsequent more detailed examination may thoroughly confirm the view of E. Fraas, that in its morphology *G. africanus* exhibits clear concordances to the North American genus *Diplodocus*.

Gigantosaurus robustus E. Fraas.

Genus *Brachiosaurus* Riggs.

This North American genus is characterized by the length of the front extremities, which at least match those of the hind extremities, through the shortness of the dorsal

[1] Without waiting for the analysis of the collections of the Tendaguru Expedition, Sternfeld (Sitzungsber. d. Ges. Naturforsch. Fr. z. Berlin 1911, p. 398) introduced the designation *Tornieria* for the generic name erected by E. Fraas, *Gigantosaurus*, because *Gigantosaurus* was preoccupied. Fraas himself alluded that the name had initially been used by Seeley for the ungual phalange of a dinosaur, but regarded the name as eliminated and thereby again available, after Lydekker referred the ungual phalange to *Ornithopsis*. I reserve my judgement on the renaming by Sternfeld to a later date, once progress in the preparation of the yield of the Tendaguru Expedition has delivered sufficient new material to finally allow a decision on the question of the affiliation of the two Fraas species to one genus, and their possible relationships to existing genera, and until the expected settlement of the nomenclature question will ensue in palaeontology.

vertebrae with unbifurcated neural spines, and the enormous dimensions, which mark it as one of the largest known genera of land animals.

Brachiosaurus Brancai n. sp.: Neck extremely long. Length of the humerus 2.10 and 2.13 m, length of the ulna 1.30 m, length of the longest metacarpal 62 cm, tail moderately long. Upper and lower jaw toothed over the greatest part of their length.

Brachiosaurus Fraasi n. sp.: Closely related to the previous species, smaller, length of the femur and humerus identical, approximately 1.70 m. Humerus less gracile than in the previous species.

Both species are so close to the genus *Brachiosaurus*, so far as the present state of preparation allows a judgement, that there was no recognizable reason to hold them separate from *Brachiosaurus*.

Genus *Dicraeosaurus* nov. gen.

Cervical vertebra moderately long, with two tall, fully independent neural spines, dorsal vertebra with very tall neural spines, which are split in the thoracic region. The posterior dorsal vertebral centra lack lateral excavations.

Dicraeosaurus Hansemanni n. sp.: Rear extremities quite robust. Dorsal and caudal vertebrae strongly constructed. Length of the femur 1.23 m.

Dicraeosaurus Sattleri n. sp.: Dorsal vertebrae lighter, more gracile and constructed even higher. Femur and pubis slimmer.

In addition to the described sauropods, at least another two species are found in the yield of the Tendaguru Expedition, about which detailed statements cannot be made at present.

Suborder *Praedentata*.

Family *Ornithopodidae*.

A small form related to the American *Laosaurus* and the British *Hypsilophodon*. The length of the femur measures approximately 30 cm, the humerus is significantly shorter.

Family *Stegosauridae*.

One form of stegosaur is present, whose dermal armour consists of very strong spines, in comparison to which bone plates appear almost insignificant. Its size is not significant, the length of the femur measures up to 78 cm. I thank Dr. Hennig, who is describing this family, for the communication that the two existing posterior cranial halves differ from one another so strongly, that they undoubtedly belong to two different species

Order *Crocodilia*.

Isolated small teeth.

Pisces.

Order ***Selachii.***

Orthacodus sp.: Isolated teeth of this shark genus were found (Identification of Dr. Hennig).

Brief characterization of the newly established types of sauropods.

Each of the following newly established forms is based on a specific skeleton as a type. As a result of being in arrears in preparation only a few characteristic skeletal elements could be figured graphically for the preliminary description of the four species presented here. Yet based on knowledge of the remaining elements of the type skeletons as well as other finds, the diagnoses of the new species could be considerably expanded.

I am grateful for the kindness of Dr. W. Dietrich for the photographically produced illustrations. Miss L. Margot in Zürich masterfully drafted the remaining figures.

To Privy Councilor Professor Dr. Branca, who entrusted the examination of the entire sauropod material to me, I express my most sincere and respectful gratitude.

Brachiosaurus Riggs.

Brachiosaurus Brancai n. sp.

This species is based on Skeleton S, which was found approximately 2 km south of Tendaguru in the Middle Saurian Bed.

Cervical vertebra (Fig. 1)

The vertebra may have belonged to the second quarter of the neck; it is slightly distorted and compressed, whereby the lateral aspect has nevertheless been little affected.

The centrum exhibits a considerable downwardly concave curvature. The narrow vertical side exhibits a strong lateral excavation, which is bounded by margins that possess sharp edges at the rear and that gradually converge anteriorly to the middle of the vertebra, to then proceed, expanding outwards rapidly, to the somewhat pendant parapophyses.

The condyle is positioned somewhat crookedly and is directed ventrally; correspondingly, the ventral margin of the cotyle extends backward farther than the dorsal margin.

An extensive pleurocoelus cavity is situated approximately at the midpoint of each side of the centrum, and the depression on the right side is deeper than that on the

left side. The dividing wall between the two pleurocoels has a thickness of only ½ to 1 cm, is however, not perforated anywhere.

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The neural arch is relatively low and correspondingly lends the entire vertebra a special character, in that it exposes an 8-cm-length of the posterior centrum while the prezygopophyses extend forward far beyond the condyle. The impression is thereby created, as though the entire neural arch is pushed forwards.

The prezygopophyses present very robust projections approximately 14 cm long, that symmetrically taper anteriorly, and which exhibit four lateral margins with various deep lateral excavations between them. Those on the ventral side of the prezygopophyses are particularly deeply excavated. Located on the dorsal side is a deeply depressed pocket, approximately 11 cm long, which is perforated by a small opening. The articular surfaces are latero-elliptical, strongly convex and directed steeply downwards and simultaneously slightly backwards.

Fig. 1. Cervical vertebra of *Brachiosaurus Brancai* n. sp. *di* = diapophysis, *hr* = cervical rib, *po* = postzygopophysis, *pr* = prezygopophysis (1/4 nat. size).

The postzygopophyses consist of steeply ascending, upwardly diverging lamellae, which display a strongly projecting ridge on the outer side that covers a cavity at their point of origin under the neural spine. The articular surfaces are identical in form and position to those of the prezygopophyses.

The neural spine is very low; it extends only about 12 cm above the connecting line of the upper margins of the articular surfaces of the anterior and posterior zygopophyses. It peaks in a 5-cm-wide flat plate of bone, from which ridges extend to the anterior and posterior articular processes. Small grooves, bulges, and ridges are found below the bone plate.

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The cervical ribs are not co-ossified with the vertebra. The tubercular process of the right rib extends 12 cm from the outer ridge of the rib; the capitular process extends 7 cm. The facet of the capitulum is 9 - 10 cm long; that of the tuberculum 3 ½ cm.

The left cervical rib is preserved to a length of 30 cm, the right to a length of 57 ½ cm, though even the latter is missing its terminus, which is of unknown length.

The following features of the described cervical vertebra can be declared as characteristic: Overall form is stretched and low. Prezygopophyses extended far anteriorly, and correspondingly, the postzygopophyses terminate considerably before the posterior end of the vertebra. Neural spine very low, without indication of bifurcation.

Dimensions:

Length of the vertebra……58.5 cm
Vertical diameter of the condyle (estimated)……..……10.5 “

Vertical diameter of the cotyle (estimated)…….……14.5 “
Maximum length of the vertebra…….……...approx. 69.0 “
Distance of the ends of the post and prezygopophyses from each other.…58.5 “
Height of the vertebra above a ventral line connecting condyle and cotyle
……approx. 35.0 “

A comparison of the cervical vertebra under consideration with those of other known sauropods does not allow the recognition of closer relationships with certainty.

Unfortunately, cervical vertebrae of *Brachiosaurus altithorax* Riggs are not yet known. The genera with bifurcated neural spines, like *Diplodocus*, *Morosaurus*, and *Dicraeosaurus* n. gen., are eliminated at the outset during comparison.

Hulke (Quat. [*sic*] Journal, vol. 35, 1880, p. 31) states that the cervical vertebrae of *Ornithopsis* from the English Wealden do not possess neural spines. The figures (Pl. III Fig. 1-3) depict an eminence that is only slightly elevated above the postzygopophyses, that is designated as a “neural crest”, and that, insofar as is obvious from the figures, exhibits no bifurcation. The prezygopophyses extend far over the condyle, as in our African species. The entire form of the vertebra is very much shorter and consequently, very much higher relative to length. In *Haplacanthosaurus* [*sic*] *Utterbacki* Hatcher (Mem. Carn. Mus., vol. II) the relatively very much shorter cervical vertebrae possess very much taller neural spines. The cervical vertebrae of *Brontosaurus* already indicate a completely divergent type just through the robust construction of the cervical ribs.

The vertebra under consideration here is distinguished, in contrast to all these genera, by the unusually long, low, extended shape.

Humerus (Fig. 2).

The figured right humerus is preserved in its entirety, and does not exhibit noticeable compression of its shape.

The entire form is very gracile. From the top and bottom, the shaft narrows very evenly to the narrowest point, which lies somewhat below the midpoint.

In lateral view, the humerus appears almost straight and simultaneously very flat. The proximal and distal ends lie totally in one plane; no torsion is recognizable. The broad proximal portion of the humerus has the shape of a shallow tub. The upper contour of the proximal end ascends noticeably medial from lateral side. The shaft exhibits a symmetrically oblong cross section in its central, thinnest section. The lower portion of the humerus flattens out with increasing broadness distally and ultimately forms a nearly flat surface on the anterior side. On the posterior side in contrast, a flat depression begins approximately 80 cm from the distal end; this deepens and broadens distally to the degree that it ultimately occupies more than half the width of the humerus. In side view, the humerus appears strikingly flat and thin.

Fig. 2. Right humerus of *Brachiosaurus Brancai* n. sp.

Fig. 3. Right ulna of *Brachiosaurus Brancai* n. sp.
Fig. 4. Right radius of *Brachiosaurus Brancai* n. sp.
(All figures 1/12 natural size.)

The proximal articular surface, which proceeds in a slight curve, divides into a narrow lateral portion that is on average approximately 13 cm wide, a broad central portion, and a narrow, short, medial portion. The broad central portion forms the major part of the articular end; it separates sharply from the narrow lateral portion by a sudden swelling.

Its outline can be best described as egg-shaped; the thickened end presents the sudden swelling, while the gradually narrowing end of the egg-outline is oriented toward the medial side of the humerus, and here rapidly tapers to the thin medial portion, which drops down some distance on the sloping medial margin of the humerus.

The central broad portion, which averages 25 cm in width, essentially forms the articular condyle, which sits somewhat asymmetrically and extends somewhat on the proximal side.

The distal articular surface does not sit quite symmetrically on the shaft relative to fore and aft, but rather faces more to the front to a very slight degree. Upon examination, it presents an elongated surface that proceeds anteriorly in a convex arc, at an average width of 17 cm, and whose short medial demarcation line proceeds obliquely forwards and outwards. Two rounded tubercles emerge at the anterior margin of the articular surface; the one that is approximately 9 cm wide lies nearly exactly in the middle, the second, approximately 7 cm wide, lies toward the lateral side at a distance of 5 cm from the first, and about 15 cm away from the lateral side. The processus lateralis sits approximately 12 cm from the outer margin of the bone, and ascends steeply approximately 14 cm above the anterior surface of the bone's outer margin.

Dimensions:

	Dimensions	Ratio
Length…….	213 ½ cm	100
Width of the proximal end……..	59 “	27.6
Width of the distal end……	51 “	23.9
Minimum width of the shaft……...	24 ½ “	11.5
Thickness of the shaft at this point…….	13 ½ “	6.3

Comparison of our humerus with the illustration of that of *Brachiosaurus altithorax* Riggs shows that the entire form of the former is somewhat more gracile than the latter, that the proximal end is narrower. The distal end of the American example is unfortunately too poorly preserved to allow comparison. Judging by Riggs's figure, the processus lateralis appears to sit a bit more laterally.

Riggs gives the length of the humerus of the American *Brachiosaurus* as 2.04 m, but considers it likely that the complete length may have totalled several inches more, since the absence of the rugosities at the distal end due to erosion shows that some of the

length has been lost. Therefore the length of the humerus of this species can only have been very little less than that of the African species. The width of the proximal end of the humerus measures 65 in *B. altithorax*, that is, 6 cm more than in *B. Brancai*, whereby however, one could consider that, according to the statement of Riggs, the humerus of his species is compressed and thereby perhaps somewhat broadened. At 24 cm, the narrowest width of the shaft in the American species is nearly the same as that in the African species.

In any case, the similarity in form of the humerus of both species is quite considerable. Another quite similar humerus is that of *Pelorosaurus Conybeari* Mantell (Philosp. [*sic*] Trans. 1850 Pl. XXI) from the Wealden of Sussex. The entire shape is not quite as gracile as that of the African species.

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The upper arm of the second largest of this type from Tendaguru, *Brachiosaurus Fraasii* [*sic*] n. sp., likewise differs as less gracile in form and additionally, through the nearly horizontal outline of the upper contour of the proximal end on the lateral side.

All these described characters belong to a type that possesses an elongated humerus, a type that is very different from that of *Diplodocus*, *Morosaurus*, and *Apatosaurus*. The humerus of *Cetiosaurus* exhibits a somewhat elongated form, which Phillips illustrates from the Great Oolite of Oxfordshire (Geol.of Oxford, p. 272), though it is by far not as elongated and gracile as in *Brachiosaurus* and *Pelorosaurus*.

Ulna (Fig. 3).

The ulna is obviously almost completely uncompressed, only on the medial side does a lateral groove appear to be somewhat deepened through compression.

The entire bone is rectilinear, only the lowest distal portion is slightly curved to the rear. The shaft of the ulna tapers uniformly from the very flattened proximal end until it reaches its minimum width of 14 ½ cm approximately 35 cm from the distal end, and then expands slightly again.

At its narrowest point the cross section of the shaft is markedly triangular, only slightly disturbed by a crista that proceeds almost exactly in the middle of the anterior surface but disappears approximately 20 cm before the distal end.

The proximal portion exhibits to a very pronounced degree, the division into a medial and a lateral wing, which together form an approximate right angle and enclose a deep cavity between them. The profile of the proximal articular end clearly descends downwards from rear to front.

The profile of the articular surface of the medial wing is slightly concave lengthwise, transverse to this it is shallow, almost flat; that of the lateral wing shallowly convex lengthwise, transverse to this it is strongly convex.

The broad hollow cavity enclosed by the wings can be traced to a distance of 50 cm from the distal end, ultimately becoming shallow, and then still continues onwards beyond this in the form of a flat surface close to the distal end.

Flat, broad, longitudinal grooves are found on the outer side of the wings, grooves that descend to somewhat over half the length of the bone. The groove on the lateral

wing is insignificant, and the groove on the medial wing is more strongly defined - as mentioned above, apparently deepened beyond the original amount through mechanical compression - and approaches the posterior margin.

The distal articular surface is positioned squarely on the shaft, which broadens slightly downward, and is very slightly vaulted. Its circumference is highly rounded-triangular, whereby the maximum diameter appears somewhat rotated against the maximum width of the proximal end.

Dimensions:

Total length	130 cm
Maximum width at the proximal end	45 "
Width of the medial wing of the proximal end	44 ½ "
Width of the lateral wing of the proximal end	37 ½ "
Maximum width of the distal articular surface	22 ½ "
Diameter of the distal articular surface perpendicular to its maximum width	17 "
Minimum width of the shaft	14 ½ "
Thickness of the shaft at this location	11 ½ "

Radius (Fig. 4).

The entire bone is very mildly curved in a plane perpendicular to the longitudinal diameter of the cross section of the shaft. It is gracile and of overall consistent robustness, it attains a minimum width of 13 ½ cm at a distance of about 43 cm from the proximal end and broadens downwards only to a small degree. It enlarges rapidly to the broadened articular end.

The cross section is slightly oval at the top, somewhat sharpened on one side, and at the bottom, where the shaft becomes slightly thicker, the point turns somewhat against its position in the proximal portion.

The proximal articular surface is oval, extended to one side at an acute angle. The distal articular surface is elliptical, with an indication of a kidney shaped outline. In the context of the curvature of the entire bone, two ridges appear on the concave broad side; of these, one is situated marginally, the other fairly in the centre. Both exhibit a slight rotation from top to bottom toward the side of the distal articular surface that is characterized by the sharpened point.

Dimensions:

Total length	124 cm
Maximum diameter of the proximal articular surface	30 ½ “
Width of the proximal articular surface at its midpoint	21 ½ “
Longitudinal diameter of the distal articular surface	26 ½ “
Width of the distal articular surface	16 ½ “
Maximum width of the shaft of the radius	13 ½ “
Thickness of the shaft at this location	10 ½ “

Details on additional elements of Skeleton S.

To complete the description several additional particulars on the elements of Skeleton S not figured or described here should follow.

The skull is present, though disarticulated into its individual elements. The latter have been prepared for the most part, and will certainly provide a complete picture of the skull with the exception of a few details.

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It must be emphasized that the maxillae are completely toothed, in contrast to *Diplodocus*, in which the dentition is limited to the anteriormost region. The teeth themselves are quite similar to those referred to *Ornithopsis* of the lowest Cretaceous of the Isle of Wight.

The entire length of the neck is present in Skeleton S. Although an exact measurement of it cannot yet be provided since the cervicals were found only partly in articulation, it was still recognized with certainty that the total length is extraordinarily great, in any case very much more significant than in *Diplodocus*. The posterior cervical vertebrae could be a metre and more in length.

One of the preserved dorsal vertebrae, the exact position of which cannot be determined for the present, is currently mostly prepared. It is characterized by horizontally positioned diapophyses that extend far outward, and the broadly rounded distal ends of the unbifurcated neural spine. The unfortunately strongly crushed centrum exhibits a greatly developed pleurocentral groove. The total height of the vertebra in relation to its width is not very great for a sauropod.

The described characteristics imply a significant resemblance to the dorsal vertebrae of *Brachiosaurus altithorax* Riggs. A more detailed comparison must be postponed until more vertebral material of the African species is prepared.

The ribs are present for the most part, the largest prepared to date has a length of 2.60 m. It is flat for its entire extent, its width in the middle measures approximately 16 cm, 11 cm close to the lower end that broadens to 16 cm. In addition, there are much smaller ribs, which may originate from the posterior dorsal region. Thus, a nearly 2-m-long rib has a width of only 3 ½ - 4 cm in its lower half. The cross section, which is rounded in the upper portion, becomes oval toward the bottom and flat near its end.

Of the front limb, of which humerus, ulna, and radius have been described above, the hand is also present, of which all elements but a few phalanges are present. The largest metatarsal measures 62 cm.

The scapulae and coracoids are not yet prepared.

Two large, oval, completely separated plates could be considered sternal plates.

The pubes are characterized by a very strong broadening of the distal end.

The upper half and portions of the lower end of the femurs are present. The upper end is 62 cm wide, the thickness of the articular condyle is 30 cm.

Tibiae and fibula also exist.

Supplementary details on the skeletal reconstruction of *Brachiosaurus Brancai* based on other discoveries.

Other skeletal discoveries provide additional information. The site Gl unfortunately supplies only incomplete bones from a deep lying erosional surface, which, however, were unequivocally determined to belong to *Br. Brancai*. A large number of caudal vertebrae were found here, though always only with more or less incomplete processes. The

vertebrae are weakly amphicoelous, the sides are flat without any grooves or cavities. The anterior, short, plate shaped centra possess almost circular end surfaces, are extended to the rear, and carry low-elliptical end surfaces.

The enormous shoulderblades[1] from excavation site Sa which, based on their dimensions, belong here, are characterized by the strongly pronounced distal broadening. The femur is very nearly the same length as the humerus, as the specimen from Quarry XV shows. This site, in contrast to the previously discussed sites that originate in the Middle Saurian Marl, originates in the Upper Saurian Horizon. Additional discoveries were made in this level which, according to characteristics and dimensions, obviously belong to the same species; for example, the find no, which, in addition to two femora, produces a complete caudal vertebral column. Posterior dorsal vertebrae, sacrum, ilium, and ischium from other sites might also belong to the species before us. Of our species probably only the hind foot will remain unknown with the exception of individual elements, which, like the numerous examples of the astragulus [*sic*], could still be present in the mass of collected material.

Systematics.

I allow myself to dedicate with grateful respect, the largest and most completely known sauropod type under consideration to Privy Councilor Professor Dr. Branca, whom we have to thank for the management and organization of the entire expedition.

The species under consideration is undoubtedly so closely related to the following one, *Br. Fraasi*, which above all the cervical vertebrae demonstrate, that a generic separation does not seem justified. The referral here of both species to the American genus *Brachiosaurus* Riggs will be based on the description of *B. Fraasii* [*sic*] below.

Brachiosaurus Fraasi n. sp.

This species is based on Skeleton Y, which was found northwest of Tendaguru near the village of Kindope in the Middle Saurian Horizon.

Scapula (Fig. 5).

The figured right scapula is almost completely preserved: the upper half of the ascending wing is missing the outermost margin of the front side; in addition, the

[1] See Sitz..-Ber. d. Ges. Naturforsch. Freunde 1912 p. 135 Fig. 9 and Janensch, Bericht über den Verlauf der Tendaguru-Expedition. (This volume Plate V Fig. 2.)

proximal portion of the margin against the coracoid is eroded, presumably already prior to final burial.

The proximal portion is relatively very wide compared to the length of the entire bone.

The massive thickening, which proceeds upward in a shallow curve and borders the entire proximal plate, drops steeply to the large basal depression in the middle, and falls shallowly to the sides. The forward directed processus deltoideus has a triangular transverse section

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approximately 10 cm thick; its end is truncated diagonally in such a manner that the diagonal surface points outwards.

The articular surface for the humerus has an irregular rhombic outline and presents a shallow depression; it is separated from the coracoid articular fusion surface by a very low ridge. The thickest portion of the proximal articular area is situated in the region of this ridge, and has a thickness of approximately 23 cm.

Fig. 5. Right scapula of *Brachiosaurus Fraasi* n. sp.
Fig. 6. Right humerus of *Brachiosaurus Fraasi* n. sp.
(Both figures 1/12 natural size.)

At the distal wing, the rear margin proceeds extraordinarily straight; the front margin would likely extend considerably farther in its upper half if it were completely preserved, than in the bone at present. The distal contour descends shallowly from the posterior margin in a straight line and at the midpoint, turns downward toward the anterior margin at an acute angle.

A significant curvature can be recognized in the lateral view of the scapula, which reaches its maximum where the distal wing departs from the proximal portion. The curvature is far less in the upper portion of the distal wing.

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Dimensions:

Total length…….	153 ½ cm
Width of the proximal portion……	93 “
Minimum width of the distal wing…….	21 ½ “
Maximum (but incomplete) upper width of the distal wing…...	39 ½ “

The scapula of *Apatosaurus* (=*Brontosaurus*) differs from that of our species in the relatively greater length and narrowness of the distal wing (see Riggs, Structure and relationships of the opisthocoelian dinosaurs I. *Apatosaurus* Marsh, Field Columbian Mus. Geolog. Ser., vol. II, p. 169, Fig. 1, 2).

Morosaurus grandis and *robustus* possess a scapula in which the distal wing is relatively wider at its narrowest point. *Camarosaurus* [*sic*] *supremus* has, according to the incomplete fragment figured by Cope, much more robust distal wings (see Riggs, The

fore leg and pectoral girdle of *Morosaurus*, Field Columb. Mus. Geol. Ser., vol. I, no. 10, Fig. 1-4).

In the scapula of *Diplodocus* the posterior margin of the distal end curves outward noticeably; in addition, the distal wing is relatively shorter. Moreover, the crista on the proximal portion has an unusually sharp shape. The enormous scapula from Tendaguru (Sitz.-Ber. naturforsch. Freunde 1912, p. 135, Fig. 9), which certainly belongs to *Brachiosaurus Brancai*, has relatively longer, distally very strongly broadened distal wings, but the identical extraordinarily rectilinear posterior margin.

Humerus (Fig. 6).

The entire outline of the right humerus under consideration is moderately slim. The proximal and distal ends appear strongly expanded in contrast to the narrowness of the middle of the shaft. The contour of the proximal end proceeds straight medially from the lateral side and thus perpendicular to the long axis of the bone. The cavity of the proximal portion is shallow. The lateral view depicts a slight backward curve of the proximal end and an equally straight, forward curve of the distal end. The minimum width of the shaft lies 80 cm from the distal end, therefore almost in the middle length of the bone.

The processus lateralis is very high and strongly displaced from the lateral margin toward the middle. The shaft possesses a triangular cross section below the processus; the section becomes elliptical distally and completely flat on the anterior side; on the posterior side the groove is very broadly and shallowly developed.

The articular head, characterized by a not sharply defined enlargement, lies within the proximal end surface, roughly in the middle of its length, thereby simultaneously extending somewhat to the rear.

The distal end surface overall has the outline of a parallelogram, since the short sides are positioned diagonally to the long sides. Corresponding to the broad groove on the posterior side, the rear side of the parallelogram is concavely curved.

The centres of the two projecting condyles on the anterior margin of the distal articular surface are situated 14 and 16 cm respectively, from the lateral margin, and have a 4 ½-cm-wide furrow between them.

Dimensions:	Dimensions	Ratio
Length…….	169 cm	100
Width of the proximal end..……	50 ½ “	29.9
Width of the distal end..……..	44 “	26.0
Maximum thickness at proximal end……..	23 “	13.6
Thickness at the distal end, medial……..	24 “	14.2
Minimum width of the shaft……	19 ½ “	11.5

The humerus under consideration differs from *Brachiosaurus Brancai*, beyond its lesser size, by the relatively greater width of the proximal and distal ends. In addition, the contour of the proximal end does not ascend from the lateral side, rather

perpendicular to the bone axis. Further, the processus lateralis sits relatively deeper. The entire shape is squatter but still similar.

The humerus of *Pelorosaurus Conybeari* Mantell (Phil. Trans. 1850 Pl. XXI 1a, b and in Owen Fossil. Rept. Weald. and Purb. Form. Suppl. II Pl. XII) from the Wealden of Tilgate Forest is quite similar. Even if the proximal portion is not complete in its width, it can still be recognized from the figure that outline and proportions were very similar, only the shaft does not narrow in the middle quite as strongly. The humerus of *Pel. Conybeari*, however, is only 4 ½ feet long.

All the relationships of the humerus of *Brachiosaurus altithorax* Riggs (Field Columb. Mus. Geol. Ser., v. II, no. 6) are very similar to our species. The width at the proximal end of our species is indeed relatively still somewhat larger than in the American sauropods. Above all the contour of the proximal end is different insofar as it ascends sharply medially from the lateral side.

Details about the skeletal elements of *Brachiosaurus Fraasi* and its systematic position.

A nearly completely prepared cervical vertebra, the centrum of which is 68 cm long and the condyle of which is 13 ½ cm high and 17 cm wide, in all points exhibits extraordinary similarity to the described and figured smaller, more anteriorly positioned cervical vertebra of *Brachiosaurus Brancai*. A recognizable difference exists in that the prezygopophyses of the latter extend somewhat farther over the condyle. However, it is possible that this difference is due to the different position of the vertebra within the cervical vertebral column.

Skeletal elements that obviously belong to our species have often been found at Tendaguru and may complete the picture of the skeletal construction. I would just like to mention here that a left ilium was found with Skeleton J from the Upper Saurian Marl, which resembles to quite an extraordinary degree that of *Brachiosaurus altithorax* Riggs (Field. Col. Mus. Geol. II Pl. LXXV Fig. 3). A caudal vertebra of the same skeleton [J] exhibits exactly the same form as that of the second caudal vertebra of the American species (l. c. Pl. LXXV Fig, 1, 2). Of the differences - less diagonal shape to the centrum, straighter positioning of the neural spine – at least the first is with certainty a result

of its position farther back in the caudal vertebral column. Skeleton D (see text figure 16, p. 43 in Bericht über den Verlauf der Tendaguru-Expedition. This volume) also obviously belongs to the species under consideration.

This similarity of the ilium and the caudal vertebra further render it quite likely that the species under consideration cannot be generically separated from *Brachiosaurus*. The same is also valid for the large species of *Br. Brancai* due to the similarity of the cervical vertebra.

I name this species for Prof. Dr. E. Fraas, who is to be thanked for the first scientific investigation of the presence of dinosaurs at Tendaguru, successfully carried out under the most difficult conditions.

The generic position of *Brachiosaurus Brancai* and *Fraasi*.

The narrow relationship of the two largest sauropods from Tendaguru, *Brachiosaurus Brancai* and *Br. Fraasi* originates in the similarity of all skeletal elements that currently were available for comparison. In particular, the great similarity of the cervical vertebrae is alluded to. Both species are so close to one another that they may not be separated generically.

The assignment of both species to the North American genus *Brachiosaurus* Riggs appears strange in view of the great geographic distance between the discovery sites. However, a comparison of the East African forms with that of *Brachiosaurus altithorax* Riggs allows very major similarities to be recognized, as cited above, particularly in the description of the individual skeletal elements.

This is valid above all for the dorsal vertebrae of the American sauropods and those of *Br. Brancai*. The degree of similarity here must be held in reserve pending details of a future investigation.

The similarity in relation to the humerus is particularly great between *Br. altithorax* and *Br. Fraasi*; the ilium in these two species has a nearly entirely identical form. Furthermore, the caudal vertebrae of all three species are very similar. Finally, the agreement in the enormous dimensions, which exists especially between *Br. altithorax* and *Br. Brancai* can also be cited.

For all these reasons, it did not appear to me to be justified to hold the two described East African species under consideration generically separate from the cited North American [genus].