ON A NEW CHASMATOSAURUS FROM SINKIANG*[1]

By

C. C. YOUNG (楊鍾健)

(National Geological Survey of China)

All the triassic reptiles so far described from Sinkiang were Dicynodontia. It is therefore of special interest to describe from the same formation a completely different, carnivorous type belonging to the Sub-order Pelycosimia of the Thecodontia. The specimen was discovered by Prof. P. L. Yuan in the same Fuyuan area as the Dicynodont forms, but its exact horizon still remains uncertain. The colour of the bone, however, and the degree of fossilization, are the same as in the *Lystrosaurus murrayi* described before[2]. The preparation of the fossil was also made in the Cenozoic Research Laboratory under my care.

Sub-order PELYCOSIMIA v. Huene

GENUS CHASMATOSAURUS Haughton

Chasmatosaurus yuani Young (sp. nov.)

Material: The anterior portion of a skull and its lower jaws with a considerable number of teeth still more or less in natural position were prepared from the same block, but found in very disturbed condition, including a set of vertebræ, a great number of ribs, a whole series of slender rib-like bones, the distal end of a humerus, two ulnæ, one radius, two ilia, two tibiæ, two fibulæ and many isolated hand and foot bones. With exception of the humerus, an ulna and some hand bones (characterized chiefly by a considerably smaller size, see below) all these pieces belong surely to a single individual.

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* Received for publication in March 1936.

1 The author is deeply indebted to Prof. F. Broili in Munich and Dr. C. L. Camp. in California for their kind criticisms.

2 Yuan, P. L. and Young, C. C. On the Occurrence of Lystrosaurus in Sinkiang. Bull. Geol. Soc. China, Vol. XIII, No. 4, 1934.

The bones, almost black in colour and strongly mineralized, were embedded in a red, unusually hard sandy clayish matrix. With exception of the skull on which the two maxillæ are somewhat compressed laterally, they are not disformed. The good preservation of these pieces, contrasting with the fact that a large part of the cranium and several parts of the skeleton are missing, seem to indicate that either a portion of the fossil has been left unexcavated in the field, or is still kept unpacked in the boxes brought from Sinkiang by Prof. Yuan.

As it was in the case of the Dicynodontia, the preparation of this material proved to be a difficult task, although the matrix was not so hard as in the previous case. The bones were scattered in a most irregular manner and it required a long time to connect all those pieces. There still are a number of fragments, mostly broken pieces of vertebræ and ribs, left unconnected.

Description. Essentially the form is characterized by a remarkable downward bending of the tip of the muzzle, and also by the laterally compressed and finely serrated teeth of both upper and lower jaws which show the utmost similarity to *Chasmastosaurus van hœpeni* Haughton, a Pelycosimian recently described by Broili and Schröder[1].

Skull

Anterior (pre-frontal) part only preserved. Premaxillæ, maxillæ nasalia complete. Prefrontalia, frontalia, palatine and pterygoid represented only by their anterior portion. The specimen is somewhat disformed, and the maxillæ laterally compressed. The outlines of the bones generally are difficult to locate either due to obliteration of the sutures, or due to breakage of the specimen.

The most characteristic feature observable on the specimen is a downward bending of the premaxillæ in exactly the same way as in

1 Broili, F. and Schröder, J. 1934. Über *Chasmatosaurus van hœpeni* Haughton. Sitzungsberichte der Bayerischen Akademie der Wissenschaften. Math. u. Natur. Abt.

Chasmatosaurus van hœpeni. This incurved part of the muzzle is even a little longer than in the S. African species. Posterior boundary of the premaxillary with the maxillary marked by a faint suture just above the ninth tooth, counting backwards. Nasal opening large and set more posteriorly. The upper part of the nasal opening is broken; this fact indicating a curvature of the nasalia.

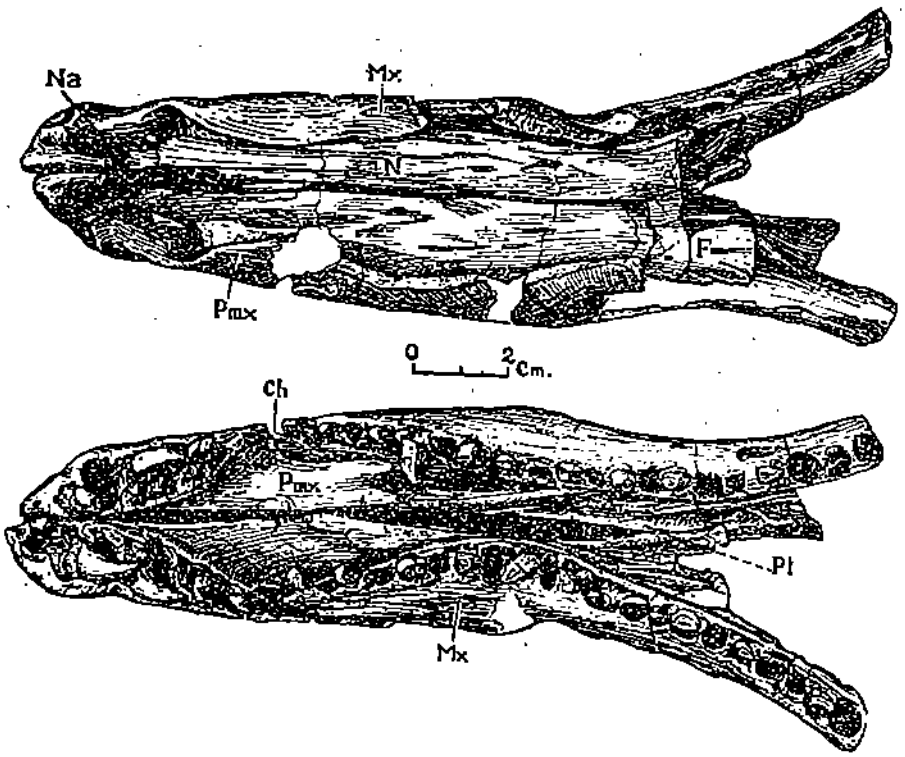


Fig. 1. *Chasmatosaurus yuani* Young (sp. nov.). Skull fragment in top and palatinal aspect. Ch. Choana, F. Frontal, Mx. Maxilla, N. Nasal, Na. Nasal opening, Pmx. Premaxilla, Pt. Pterygoid.

On account of the lateral compression of the fossil, and of the broken condition of the posterior part of the muzzle, the exact shape of the maxillæ can not be ascertained. But judging by the reconstruction

of *Chasmatosaurus van hœpeni* illustrated by Broili and Schröder (1934, p. 227, fig. 1), the broken part visible on our specimen above the upper jaw represents the anterior boundary of the preorbital foramen. The nasal bones are complete, but their posterior boundary with the frontalia is missing.

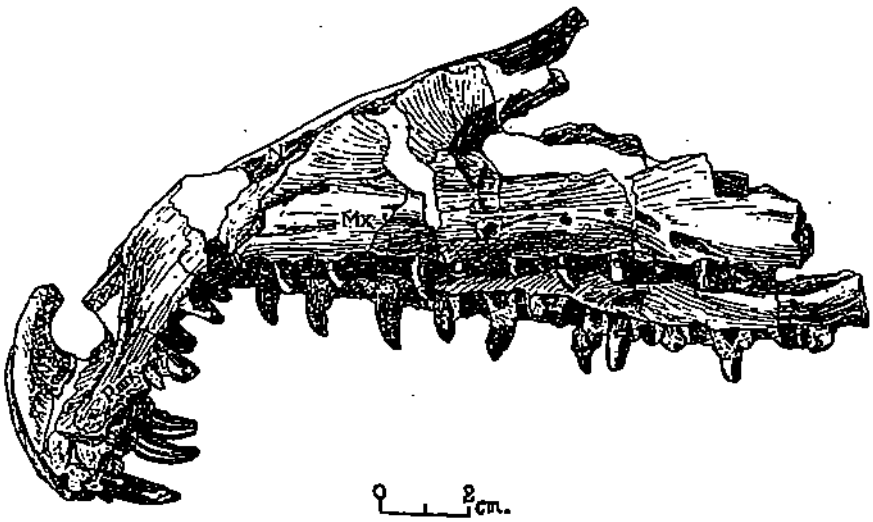


Fig. 2. *Chasmatosaurus yuani* Young (sp. nov.). Skull fragment in left side view.

On the whole, it seems that the muzzle was slender and did not expand so strongly in its posterior part as in the African form. This character is mostly noticeable in the premaxillary region which is free from lateral crushing.

Observed in palatal view, the skull is characterized by the posterior location of the choana, which begins only *behind* the bent part of the muzzle, (in *Chasmatosaurus van hœpeni* the anterior part of the choana extends on the bent portion of the premaxilla). Due to the crushing of the specimen, the exact shape of the choana and of the vomer is not recognisable. Pterygoid bones preserved but incomplete. Palatal bones either concealed, or destructed by the compression of the maxillary area.

In size, the Sinkiang form is much smaller (by about two fifth) than the Karroo species, at least as far as the breadth of the muzzle is concerned. It was also apparently a long and slender muzzled type.

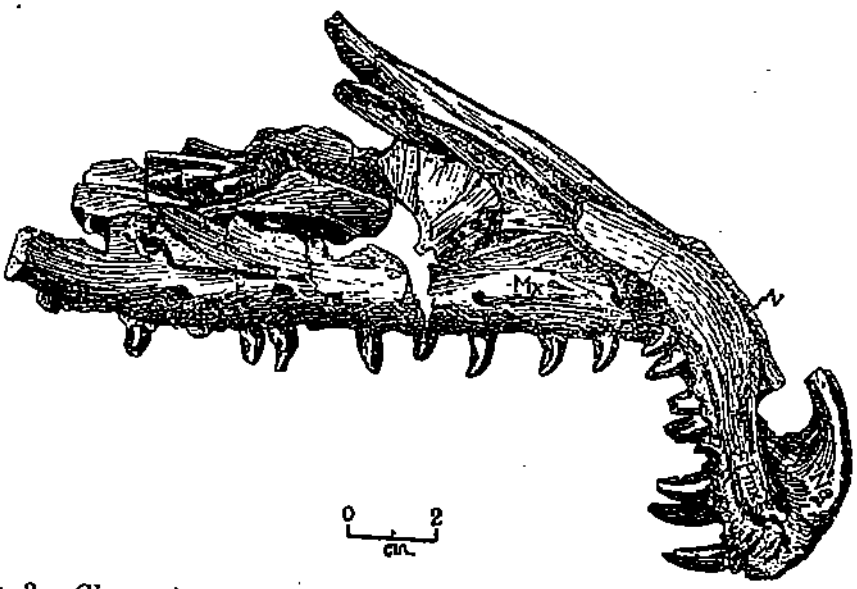


Fig. 3. *Chasmatosaurus yuani* Young (sp. nov.). Skull in right side view.

Lower Jaw

Both lower jaws are preserved but mostly broken behind the dentale.

In proportion to the skull, the mandibula looks rather massive, slightly convex externally and flat internally. 8-9 foramina for the nerves are clearly expressed on the external side. Along the anterior inner side, a shallow groove extends backward and disappears below the toothrow. Suture between the dentale and the spleniale obliterated. Symphysial area roughly granulated labially and lingually. On the whole, the lower jaw of our form seems to be more massive than that of *Chasmatosaurus van hœpeni*. Its depth increases also much more rapildy backward (cf. measurements, below). With much smaller upper

jaw and muzzle, the Sinkiang *Chasmatosaurus* nearly reaches the same size as the Karroo species with its lower jaw.

Dentition

a) *Upper teeth.* In our specimen the teeth are preserved or indicated on both upper and lower jaws. But since the maxillæ are broken on both sides posteriorly, the total number of the upper teeth is uncertain. There are 32 teeth alveoli visible on the right side and 30 on the left side. Half of the teeth only are still embedded in the bone. I agree fully with the idea of Broili and Schröder, that the loss

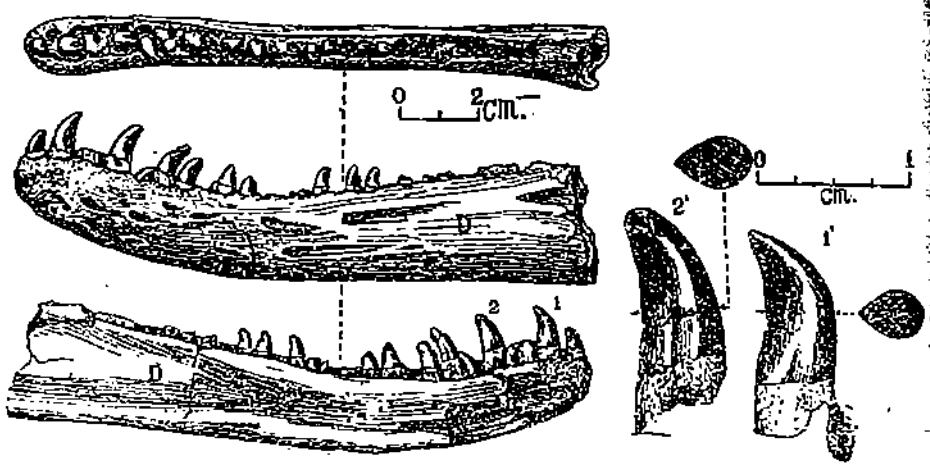


Fig. 4. *Chasmatosaurus yuani* Young (sp. nov.). Left lower jaw in upper outer and inner views. D. Dentary. 1 and 2. Two teeth enlarged on the right side of the figure.

of the others occurred largely postmortem. All these teeth are sub-equal in size, but a differentiation is already weakly indicated on them: the 3 premaxillary teeth are stronger than those set on the maxillæ. Most probably, the total number of the teeth was approximately 35 on each side, similar to the Karroo species.

b) *Lower teeth.* On the lower jaw, the complete toothrow is preserved on both sides, only a few of the teeth are missing and indicated by a hole in the dental bone, 24 teeth on each side, that is the same

number approximately as in *Chasmatosaurus van hœpeni*[1]. With the exception of the first tooth which is small, the two or three teeth following the first one are considerably larger. Then the size reduces

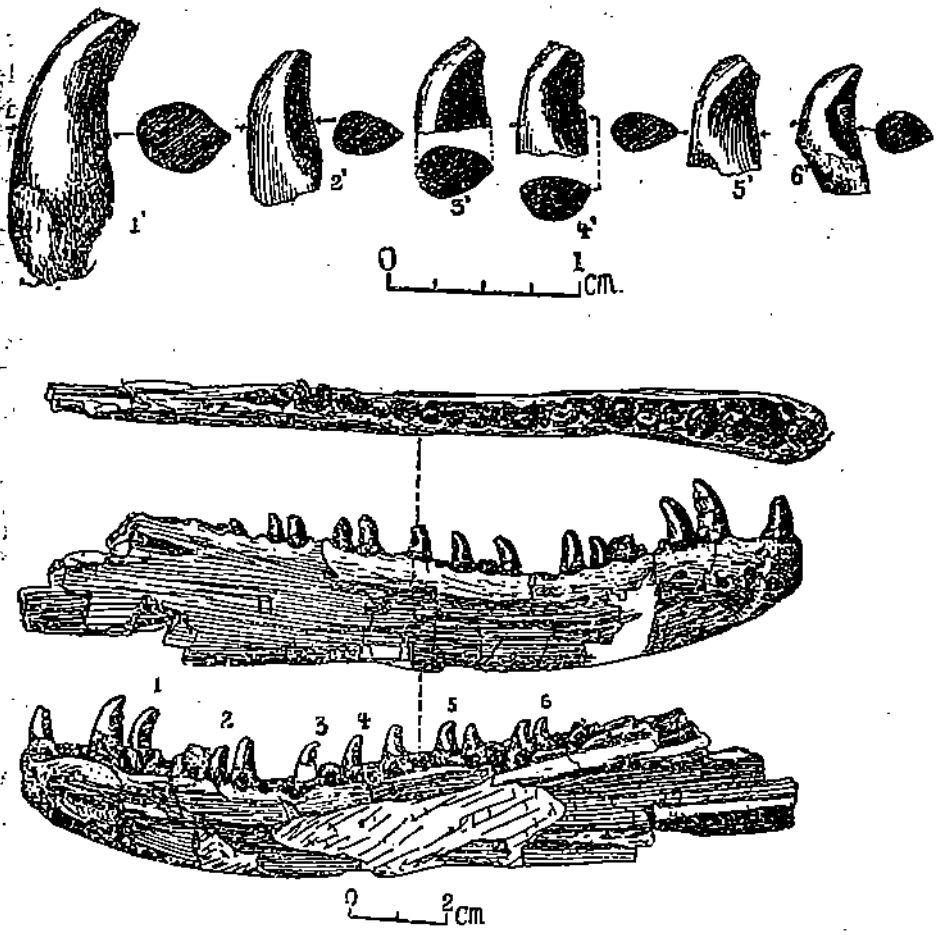


Fig. 5. *Chasmatosaurus yuani* Young (sp. nov.). Right lower jaw in upper, outer and inner views. 1,2,3,4,...6. Some teeth shown on a larger scale on the upper part of the figure.

1 In figure 1 of *Chasmatosaurus van hœpeni* given by Prof. Broili, there are 22 teeth for a left lower jaw. In figure 8, 24 teeth for a right lower jaw.

gradually posteriorly, the last few teeth being the smallest. This character is not clearly expressed on the figures given of *Chasmatosaurus van hœpeni.*

c) *Structure of the teeth.* By their detailed structure the teeth of our specimen agree with the description given by Broili and Schröeder for *Chasmatosaurus van hœpeni.* Anterior serration mostly well indicated, but replaced gradually in other cases by a smooth edge, and finally by a smooth surface. A fusion between the root of tooth and the bone of the jaws was also observed in some cases, this fact indicating that the teeth of our form were acrodont as in the African form.

Size of both upper and lower teeth about the same as in *Chasmatosaurus van hœpeni.*

d) *Pterygoid teeth.* Beside the teeth set on the præmaxilla, maxilla and dentale a large number of smaller teeth is observable on the pterygoid, mostly indicated by small cusps only. These pterygoid teeth seem to be more anterior in their position than in *Chasmatosaurus van hœpeni.*

Dimensions:	Dimensions of *Ch. yuani*	Same dimensions of *Ch. van hœpeni* using fig. 1 and 8 of Broili and Schröder.
Length of the skull from the tip to the posterior margin of 32nd. tooth....	.....185 mm	.....231 mm
Length of the premaxillæ along the teeth 1-8 (the bent part of the muzzle)..	.....53 mm	.....69 mm
Breadth of the muzzle (across the 3rd. tooth)	.....30 mm	.....49.5 mm
Breadth of the skull between the premaxillæ and maxillæ	.....40 mm	.....61.5 mm
Length of the lower jaw from the tip to the posterior margin of the last tooth	Left Right 126 mm; 119 mm	Left Right ...153 mm; 168 mm
Depth of the jaw between 3rd. and 4th. tooth	Left Right 21.4 mm; 20 mm	Left Right ...21 mm; 21 mm
Depth of the jaw behind the last tooth	Left Right 27.5 mm; 28 mm	Left Right ...27 mm; 31 mm

Postcranial Skeletons

The postcranial bones are only incompletely represented. With the exception of four vertebræ, a humerus, a doubtful ulna, and a few associated fragments of carpal and digital bones most of which are considerably smaller in size, they fit well together in size and shape and evidently belong to the same individual.

Vertebræ. 31 vertebræ are preserved. With exception of the four vertebæ (see below), these certainly belong to *Chasmatosaurus*. But nearly all of them were found isolated, so that their real connection is not sure. According to the size and to the general structure, we have sorted them as shown in text-figure 6 numbered from 1-27. Nos. 1-10 may best be regard as pre-, and nos. 11-27 as post-sacral vertebræ. All of them are typically amphicelous in structure, but not deeply excavated. In most cases, the dorsal spina and the diaphysis were broken. In many of them the various facets can be recognized.

Ribs and rib-like bones. Besides the vertebræ, our material ncludes a large number of complete and fragmentary slender bones. Many of them are clearly ribs usually well indicated, and some times less differentiated "head". In the best preserved pieces, the curvature of the rib is still well preserved. The cross-section of the rib is flattened in the upper portion of the bone as result of the presence of an anterior and a posterior grooves. Further on it becomes oval or round. In some specimens, the distal part is flattened again.

More of a puzzle is another large series of "rib-likes" elongated bones, thin, round in cross-section, curiously undulated or contorted, showing no trace of head, but only a weak excavation on both ends. Average thickness, 6 mm. Average length, 140 mm. On a piece of rock, three or four of these peculiar bones were found associated in close parallel position, 3-4 mm. apart from each other. They might well be interpreted as representing some ossified elements of the animal.

Slightly similar but probably quite different from these "ventral ribs?" are two elongated bones (one of them complete, see fig. 8), slightly contorted also, but at a lesser degree and characterized by a definite shape: One end thicker than the other. By their general

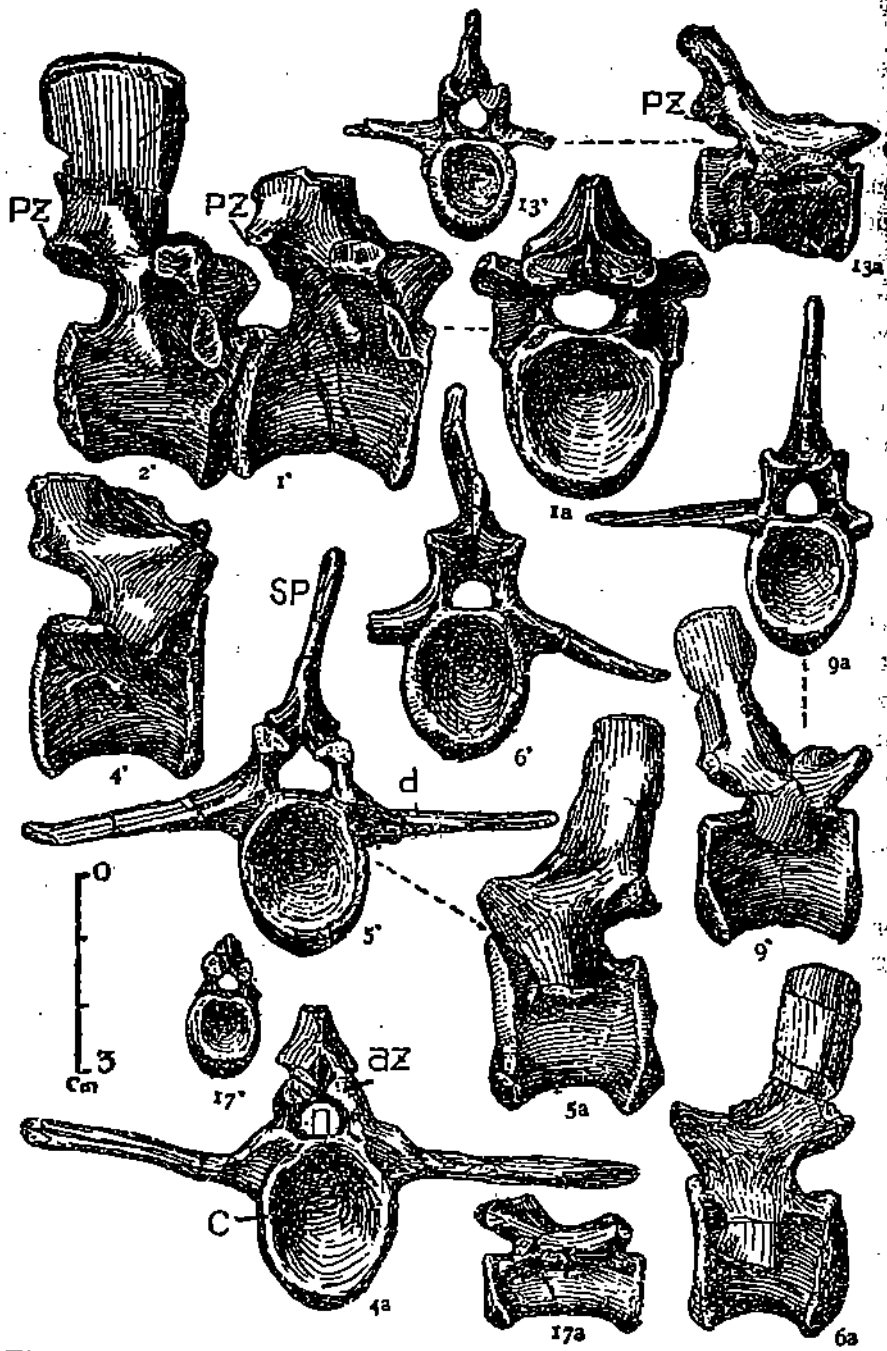


Fig. 7. *Chasmatosaurus yuani* Young (sp. nov.). Some vertebræ shown in lateral and anterior views. C. Centrum, n. Nerve canal. Other abbreviations see fig. 6. The numbers followed by an apostrophe"'" correspond to those of Figure 6.

outline, these bones resemble the "cornua branchialia" as figured and described by Broili and Schröder for *Chasmatosaurus van hœpeni*. Since however our specimens were not found in association with the skull (the posterior part of the skull is unknown) this interpretation is not certain.

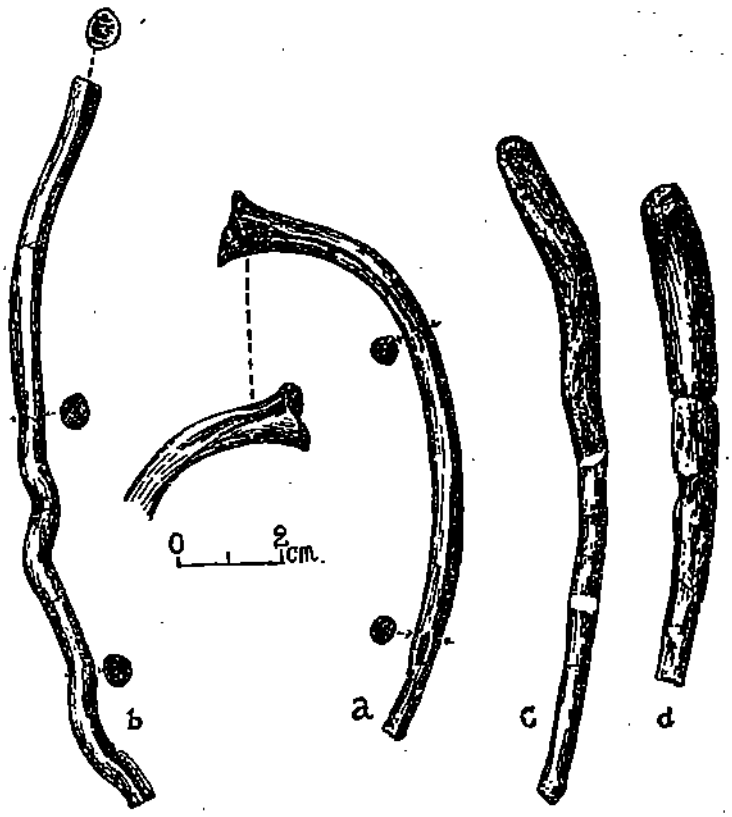


Fig. 8. *Chasmatosaurus yuani* Young (sp. nov.). a. Rib, b. Problematical ventral rib, c. and d. ?Cornua branchialia.

Radius and ulna. No trace of the presence of Pectoral girdle and humerus. The radius and ulna are represented for the right side only. But are complete, and sub-equal in length. General appearance rather stout. The *radius* has a very well rounded

proximal end. From there the bone thins out gradually up to a point corresponding to two thirds of the total length of the bone; and then it expands considerably up to the distal end. Distal portion of the bone weakly excavated ventrally, and distal end of epiphysis is rounded triangular in distal view. In the middle part of the diaphysis a distinct postero-lateral ridge is observed. Proximal end of *ulna* massive, but with weakly developed olecranon area. The proximal end of the bone is semi-circular. Distally the ventral face

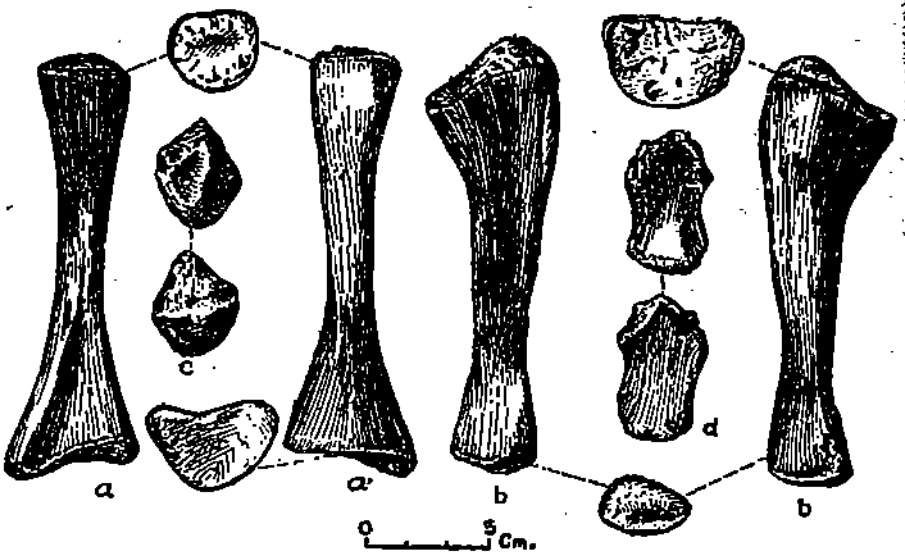


Fig. 9. *Chasmatosaurus yuani* Young (sp. nov.). a. and a'. Right radius in outside and inside views, b. and b'. Right ulna in outside and inside views. Their proximal and distal ends are shown, c. Left radial, d. Left ulnare.

becomes nearly flat, but is not strongly excavated. The middle part of the bone is compressed. The shaft reaches its minimum thickness very close to the distal end. The expansion of the distal end is very weak, with ovally elongated distal end.

Radial and ulnare. Both completely preserved. They are illustrated, from the left side in text-figure 9 c and d. The *radial* is a rounded

rectangular bone of irregular thickness. The articular facet with radius, central and distal carpalia are recognizable but without sharp boundaries. The *ulnare* is an elongated flat bone, with a proximal end considerably thickened. Articular facet with the intermedium very distinct.

Many of the round or square bones in our possession represent probably the intermedium, the central or other carpalia. But, in the absence of clear connections observed *in situ*, and on account of lack of material for comparison, we shall refrain from giving them a definite name.

Ilium. From the pelvic girdle, only the two ilia are preserved. They show a marked opposition between the base and the wing. The bone is extremely massive in its lower part and thins out gradually and develops posteriorly a peculiarly shaped expansion. External depression for articulation with the femur rather strong. Connection with pubis and ischium indicated by rough sutures. Above the cotyloid depression, the antero-superior border of the bone is marked by a prominent ridge developing a distinct protuberance above the middle of the depression. Further on this ridge forms the antero-superior border of the acetabulum. Then, behind the acetabulum, it vanishes into the fan-like thin elongated expansion mentioned above. On the whole the bone shows an internal convexity. Its surface on both sides is marked by a somewhat radiated structure. No trace of attachment with the sacrum can be observed.

Tibia and fibula. These bones are completely represented for both sides on our specimens. Both of them are rather elongated. On the *tibia* which is a strongly built bone, the proximal end is massive and triangular in cross-section with a small embayment on the external side. Distal end is well rounded. The *fibula* on the contrary is slender, weakly and symmetrically expanded on both ends. Shaft gently curved in a peculiarly S-shaped way.

Astragalus. Fig. 11, c. Among the tarsalia the most recognisable bone is a right astragalus, of a rather elongated shape. The

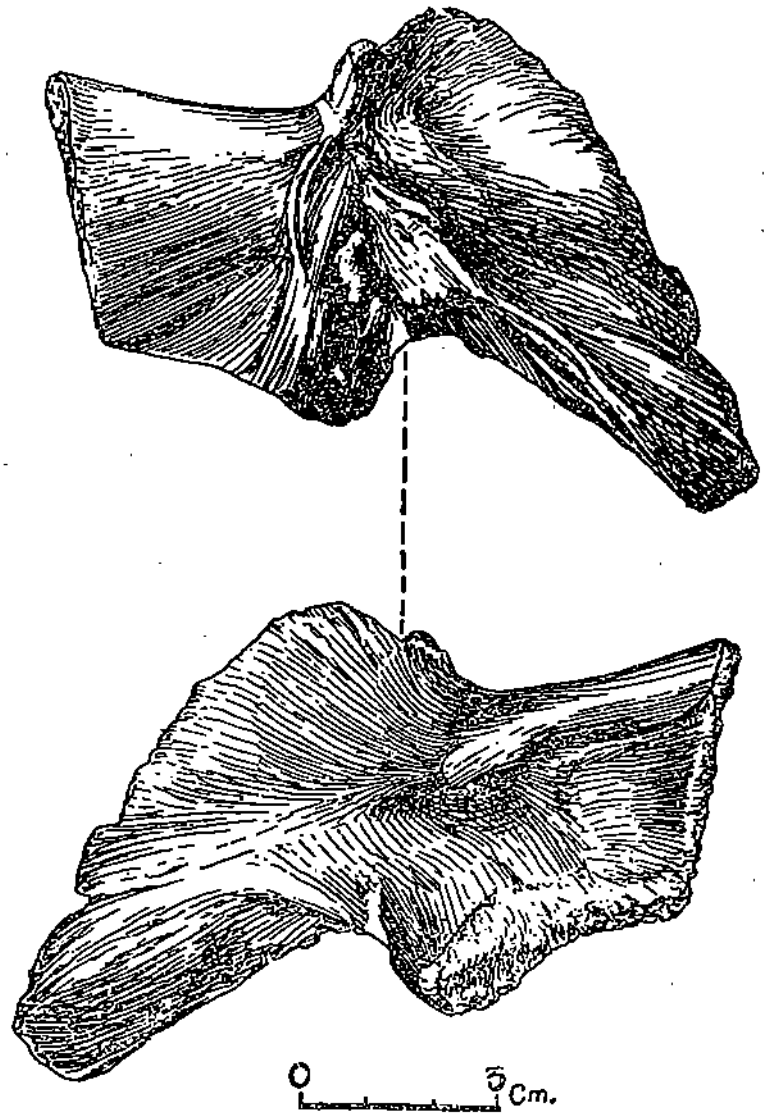


Fig. 10. *Chasmatosaurus yuani* Young (sp. nov.). Right ilium, inner and outer views.

proximal end narrow and elongated; distal portion expanded. The dorsal side is flat while in the ventral side the bone thins out and slopes down remarkably to the anterior border.

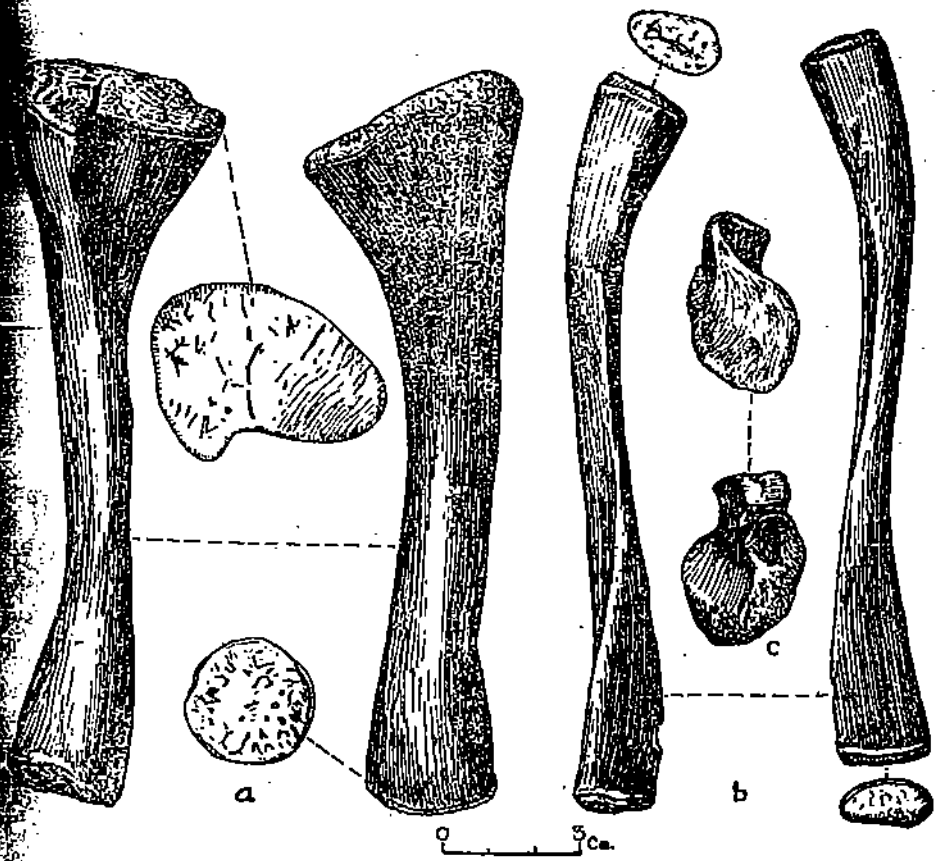


Fig. 11. *Chasmatosaurus yuani* Young (sp. nov.). a. Left tibia in two views, b. Left fibula, and c. Right astragalus.

Other tarsalia possibly represented in our collection; but not determinable immediately.

Hand and foot bones. In text-figure 12 we have tentatively arranged a series of metapodial bones, found isolated in the matrix.

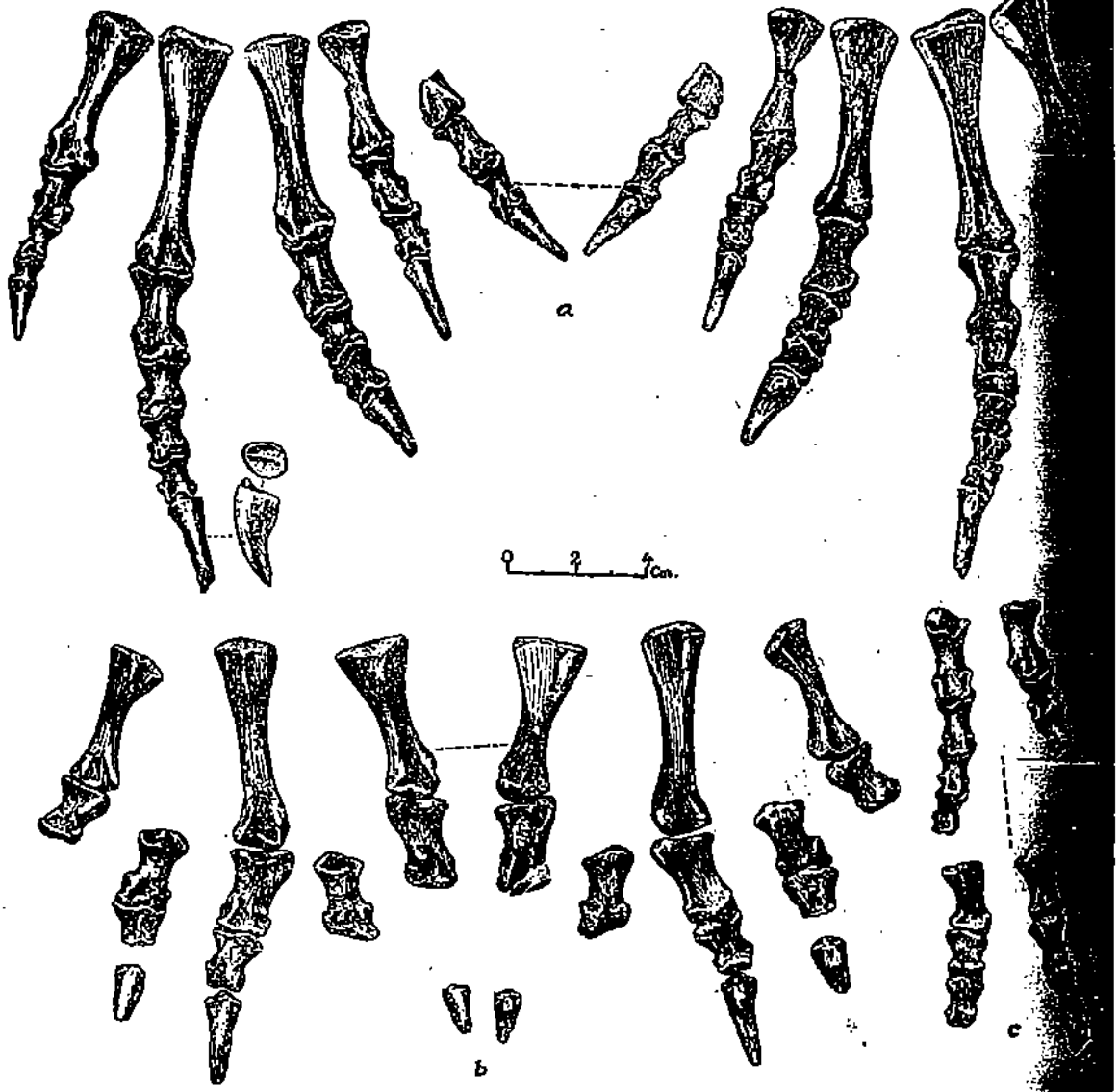


Fig. 12. *Chasmatosaurus yuani* Young (sp. nov.). Hand and foot bones. Explanation see text.

Groups *a* and *b* have about the same size and are larger than group *c*, so that *a* and *b* represent possibly the feet and *c* the hand. The ungual phalanx is characteristic, being compressed laterally with a general curved tip, a clear indication of a carnivorous reptile.

Os Incertæ Sedis

Beside the above described bones there are some pieces which on account of their poor preservation and disconcerting shape we cannot determine with certainty. These specimens are illustrated in text-figure 13.

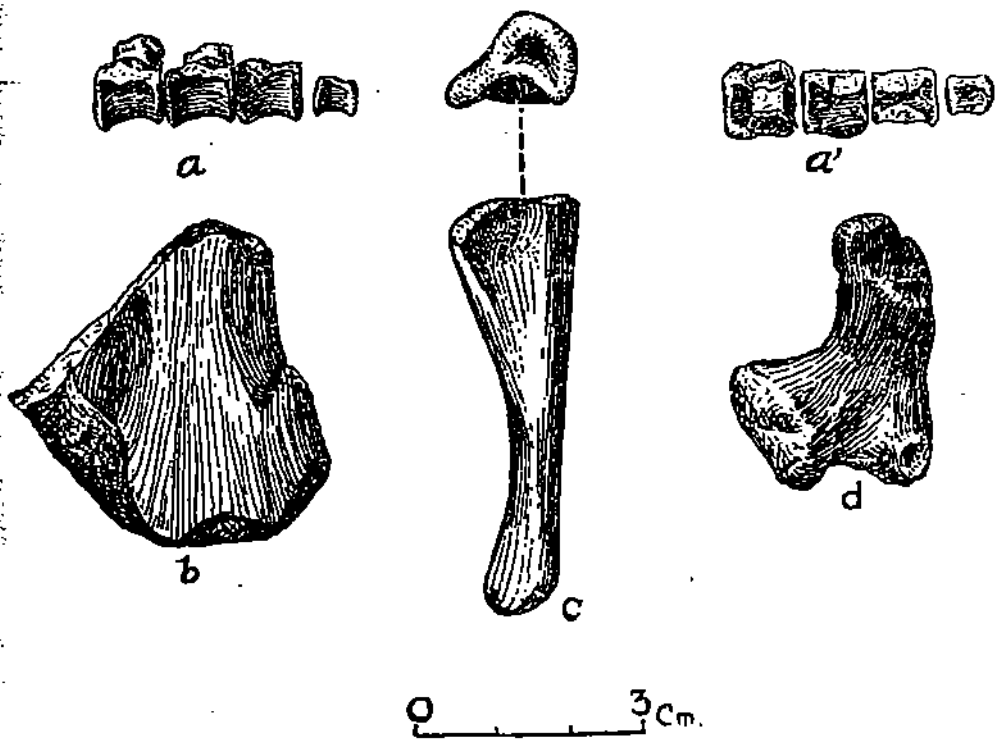


Fig. 13. Os incertæ sedis. a Vertebræ in lateral view and a' in top view. b. Distal end of a humerus, c. ?Ulna, d. ?Calcaneum.

Spec. A There are 4 vertebræ which do not fit with the others described above. They are too small for being presacral- and too short for postsacral vertebræ. The centrum is moderately amphicelous, two of them have the prezygapophysis (eventually postgyapoprysis) preserved. Length of the largest one, 9 mm. Anterior breadth, 9.5 mm.

Spec. B. A broken distal end of a humerus. It belongs probably to *Lystrosaurus*.

Spec. C. An ulna, which belongs either to a young individual, or which indicates the presence of a second form. Proximal end characterized by a thinly compressed protuberance. (Distal end a little damaged.) Size is much smaller than in the ulna described above.

Spec. D. It is a L-shaped flat bone with weakly convex middle portion. According to Dr. C. L. Camp, it may represent the first metacarpal of a crocodilian-like animal, probably *Chasmatosaurus*, but the slenderly constructed ulna and radius would seem to exclude its attribution to this latter form. A definite determination of this bone requires further evidences.

DIMENSIONS:

Vertebræ

Length of the first and second vertebræ	58	mm
Breadth of the anterior centrum of the first vertebra	25.5	mm

Radius

Length	93	mm
Proximal breadth	21	mm
Distal breadth	31	mm
Medial breadth (minimum)	10.5	mm

Ulna

Length	102	mm
Proximal breadth	32	mm
Distal breadth	22	mm
Minimum breadth near the lower end	13	mm

Radial

Length	22	mm
Breadth	19	mm

Ulnare

Length	32	mm
Breadth	22	mm

Ilium

Maximum length of the left ilium from the anterior tip to the posterior tip of the wing-like expansion	121	mm
Length of the lower part (across the acetabulum)	66	mm
Minimum breadth above the acetabulum	41	mm

Tibia

Length	152	mm
Maximum proximal breadth	47	mm
Maximum distal breadth	38	mm
Minimum medial breadth	14	mm

Fibula

Length of the right one	155	mm
Proximal breadth	21	mm
Distal breadth	20.5	mm
Minimum medial breadth (lateral)	9	mm

Astragalus

Length	34	mm
Proximal breadth	13.2	mm
Distal breadth	22	mm

Foot bones

Length of the fourth digit from the proximal end of metatarsus to the tip of the distal phalanges	158	mm

Summary and Determination

As already made clear in the description, the present form is characterized by a downward bending of the muzzle, by laterally compressed and serrated teeth, and by phalanges of a carnivorous type. The first two characters (including the number of the teeth) are exactly those of *Chasmatosaurus van hœpeni* as recently fully described by Broili and Schröder. A further comparison between these two forms is made difficult by the fact that the posterior part of the skull is missing in our specimen, and the limb bones mostly unknown in the African fossil. Yet the reference of both to the some genus is practically certain.

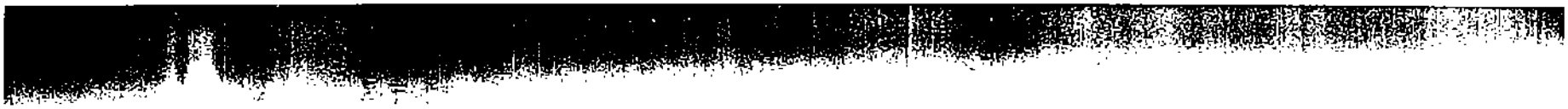
Specifically, several differences are clear. The Chinese form shows at least the following differential characters: 1. Size much smaller (about one fourth), 2. Muzzle more slender, 3. Choana set more posteriorly, 4. Lower jaw comparatively more massive with heavier symphysis, 5. Differentiation of the teeth more advanced. The Sinkiang form represents therefore, a new species which I name *Chasmatosaurus yuani* Young (sp. nov.), in honor of P. L. Yuan, the discoverer of a Theromorpha fauna in Sinkiang.

Chasmatosaurus van hœpeni has been found in the *Lystrosaurus* zone (Lower Trias) from the Karroo formation. Together with *Proterosuchus fergusi* Broom (perhaps a synonym, according to Broom, of *Chasmatosaurus*) it represents the carnivorous type of the zone. Parallelizing exactly these conditions, *Chasmatosaurus yuani* has been collected (judging by its field number and its mineralization) in the same horizon as *Lystrosaurus* (*Lystrosaurus hedini* Young). Both therefore swam together and had the same biological struggle for existence as supposed by Broom[1]. The presence of a *Chasmatosaurus* in the *Lystrosaurus* beds of Sinkiang reinforces strongly and strangely the stratigraphical and palæobiological affinities already noted by others and the present writer between Central Asia and South Africa in the Triassic times.

1 Broom, R. 1932. The Mammal-like Reptiles of South Africa. London. Witherby. p. 253.

We may add that the limb bones of *Chasmatosaurus yuani* show a decided analogy with those of *Varanosaurus*, a Pelycosauria.

Concerning the systematic position of *Chasmatosaurus* discussed by Broili and Schröder (loc. cit., p. 257) they agree with Haughton, Broom and Huene, in regarding the *Chasmatosaurus* as a form closely related with *Erythrosuchus*. According to Haughton and those other authors, both belong to the sub-order Pelycosimia.



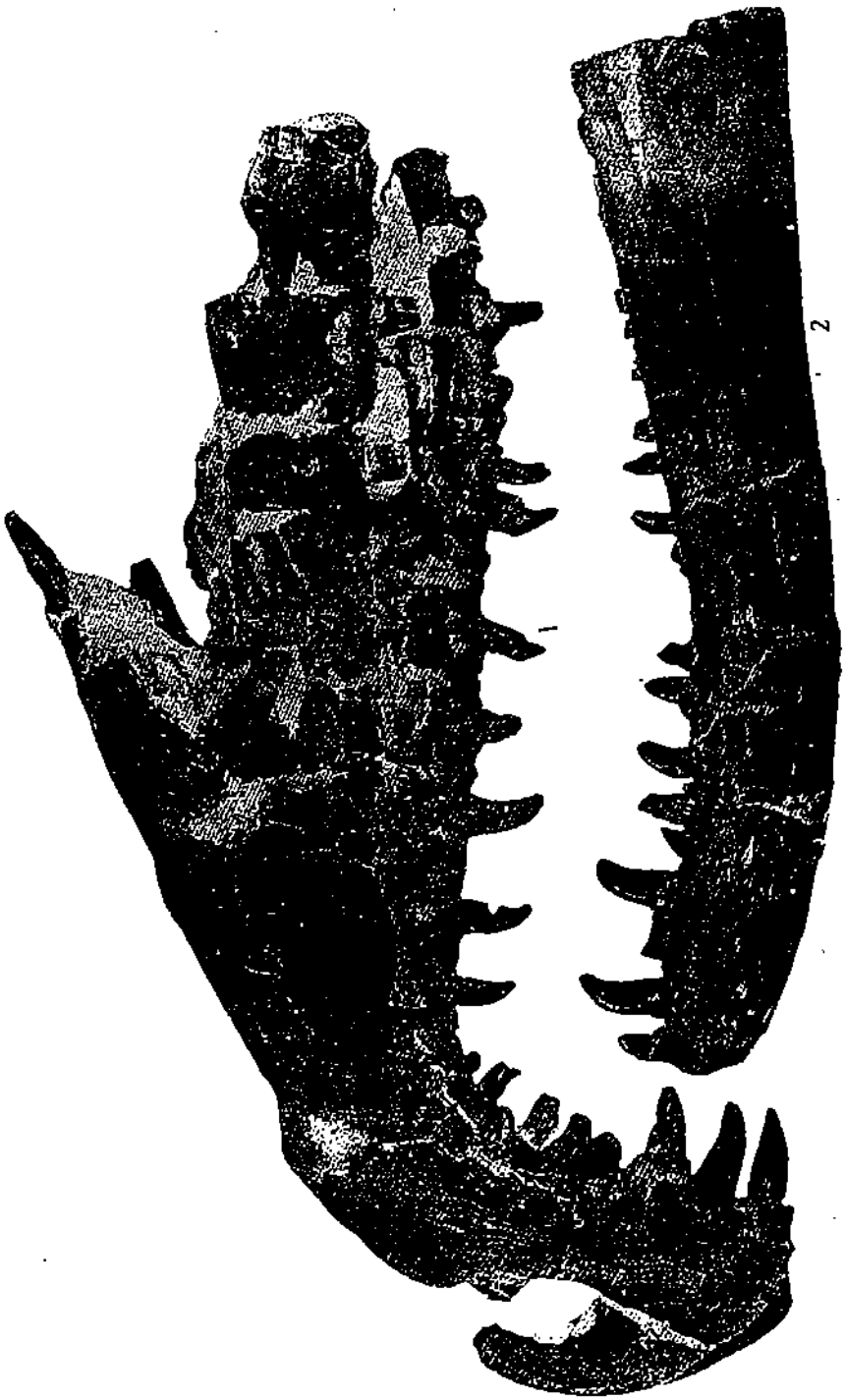
Explanation of

Plate I

PLATE I.

Fig. 1. *Chasmatosaurus yuani* Young (sp. nov). Skull in left side aspect. ibid. Pl. II and Pl. III, Fig. 1. Nat. size.

Fig. 2. *Chasmatosaurus yuani* Young. Left lower jaw in external view. ibid. Plate IV, Figs. 1 and 1a. Nat. size.



Explanation of

Plate II

PLATE II.

Figs. 1 and 2. *Chasmatosaurus yuani* Young (sp. nov.). Skull in top and palatinal views. ibid. Plate I, Fig. 1 and Plate III, Fig. 1. Nat. size.

1

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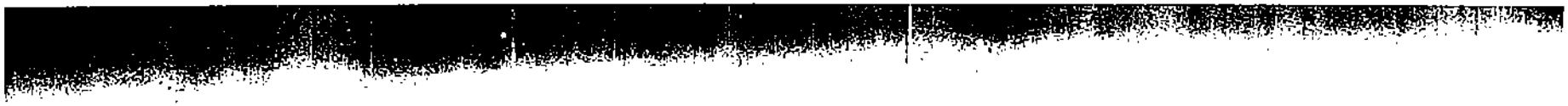
Explanation of

Plate III

PLATE III.

Fig. 1. *Chasmatosaurus yuani* Young (sp. nov.). Skull in right side view. ibid. Plate I, Fig. 1 and Plate III. Nat. size.

Fig. 2. *Chasmatosaurus yuani* Young. Right lower jaw in external view. ibid. Plate IV, Figs. 2 and 2a.



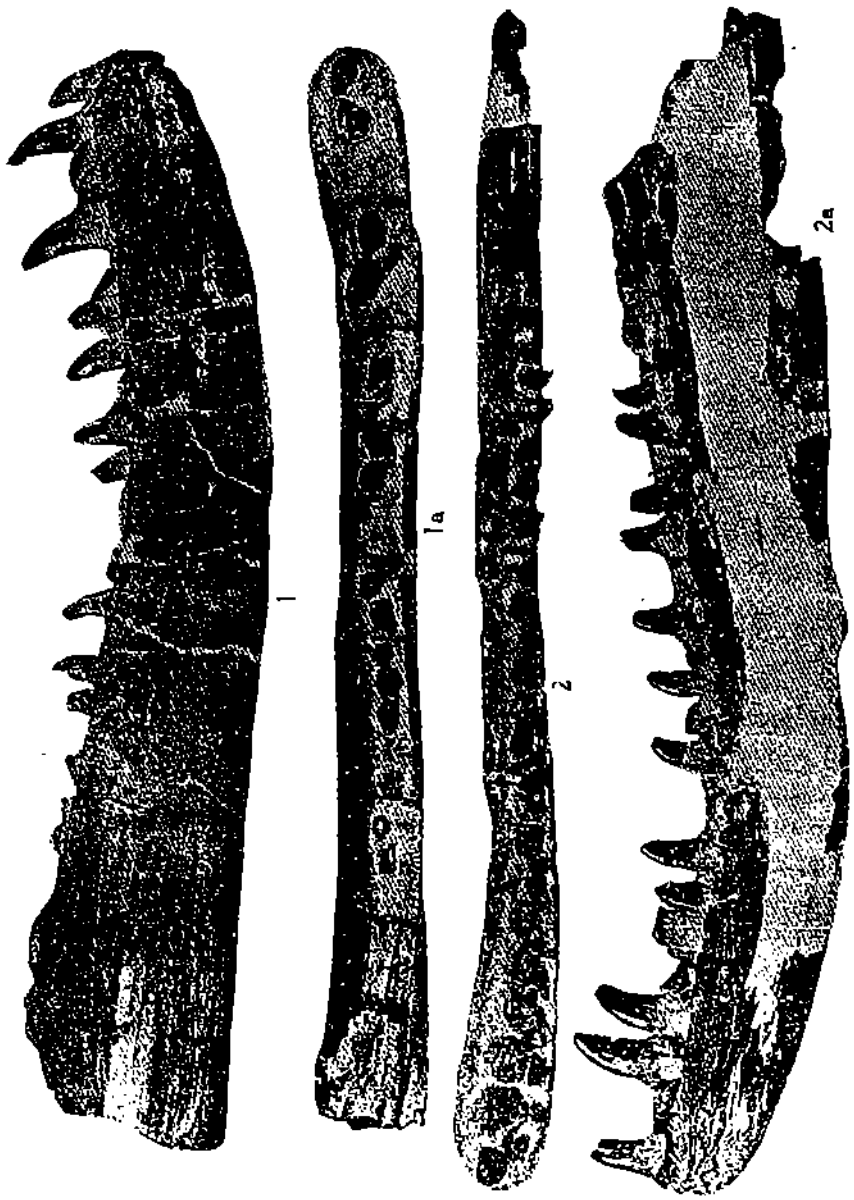
Explanation of

Plate IV

PLATE IV.

Fig. 1 and 1a. *Chasmatosaurus yuani* Young (sp. nov.). Left lower jaw, in inner and top views. ibid. Plate I, Fig. 2. Nat. size.

Fig. 2 and 2a. *Chasmatosaurus yuani* Young. Right lower jaw, in top and inner views. ibid. Plate III, Fig. 2. Nat. size.


1
1a
2
2a