

ON A NEW GENUS OF KANNEMEYERIDS FROM NINGWU, SHANSI

SUN AI-LIN

(*Institute of Vertebrate Paleontology and Paleoanthropology, Academia Sinica*)

The here described skull with its postcranial bones is one from the rich collection of *Sinokannemeyeria* fauna discovered in the Triassic basin of Shansi in recent years.

Regarding the *Sinokannemeyeria* fauna of Shansi, several papers dealing with the general characters of the fauna and the description of some reptilian groups have recently been published, but so far nothing has been written on kannemeyerids itself.

The specialized large dicynodonts were world wide in distribution. Their systematic relationship and paleogeographic distribution have attracted the interest of many paleontologists. Camp's recent monograph (1956) has given a detailed description of the genus *Placerias* and its comparison with the other Triassic dicynodonts, besides, some correlated problems were also discussed. Due to the scantiness of the known material the role played by the Asiatic form in these respects has no account. However, recent discoveries seem to indicate that Asia is one of the most important centers of the dicynodont evolution.

In China, the first fossil of the kannemeyerids described by Prof. Young (1937) under the name of *Sinokannemeyeria pearsoni* was discovered in South-eastern Shansi at Shihpi of Wuhsiang district. The material merely consists of some vertebrae and limb bones and two pieces of lower jaws. No skull bone was included.

Nothing more come into light until 1955 when a party was sent by the Institute of Vertebrate Paleontology to Wuhsiang with the purpose of searching and excavating the Triassic reptilian fossils. After the work of two field seasons in 1955 and 1956, a large collection of dicynodonts as well as the other tetrapods was assembled. Among these the kannemeyerids constitute the largest bulk, including three skeletons and eight skulls.

Of further interest in 1957 the same kinds of fossils were found at Ningwu, some 250 km. north of Wuhsiang in North Shansi by Mr. T. Y. Wang of the Taiyuan Station of the Institute. In the following year the stratigraphy of this locality was reexamined and more reptilian bones were excavated. It is highly probable that the Triassic basin of Ningwu will turn out to be another richly fossiliferous district.

With the progress of geological exploration work more new localities of *Sinokannemeyeria* fauna are being discovered continuously.

Among the fossils collected by Mr. Wang at Ningwu, there is a beautifully preserved skull which is of considerable interest. It is distinguished from the others in its unusual

length and narrowness and belongs evidently to a new genus of the kannemeyeriid group. A preliminary description of it is given here before the study of the whole collection is finished.

Suborder Anomodontia

Family Kannemeyeriidae

Genus *Parakannemeyeria* Gen. nov.

Diagnosis: As for the genotypic species *Parakannemeyeria dolichocephala*.

***Parakannemeyeria dolichocephala* sp. nov.**

Material: A complete skull with partial postcranial skeletons containing three presacral vertebrae, four sacral vertebrae fused with the anterior expanded blade of the left ilium, right scapular and the middle part of the leftside one, a pair of clavicles, right and left humera with shaft and distal ends, right radius, left fibula and several phalanges. (Cat. No. I.V.P. V. 973).

Diagnosis: Skull narrow and high and bent downward anteriorly. Preorbital region long. Interorbital length $1/3$ or less than $1/3$ of skull length (curved distance). Premaxillary extremely pointed. Surface of premaxillary and nasal region rugose, with dots and striations. Maxillary process large, directs downward with the stout tusk. Temporal region rather short, orbits backward and directs laterally. Preparietal large and round. Prefrontal large, with posterior extension. Parietal region pressed into a low and short crest. Squamosal not so expanded. Quadrate region not pushed forward. Occipital plate high and narrow. Septosphenoid thin and large, posteriorly expanded. Basicranial axis extended, not foreshortened and arched. Interpterygoid vacuity large in comparison with that in the other genera. Lower jaw high and extremely laterally compressed. Angular extended anteriorly to the base of dentaries. Prearticular base not expanded. Limb bones flat and thin.

Geological Age: Late early Triassic to early middle Triassic.

Locality: Ta-Chang, Ning-Wu, Shansi Province.*

DESCRIPTION

Skull

Skull moderate in size, completely preserved, but most of the sutures are not clearly traceable.

* 山西省宁武县大场虎台沟。

Dorsal view

The skull is long and narrow. The fused premaxillaries is rhomboid with the anterior end of which extends anteriorly and much downwardly to constitute the pointed beak only 33 mm. broad. The posterior end of it inserted deeply into the center of nasals with sharp angle.

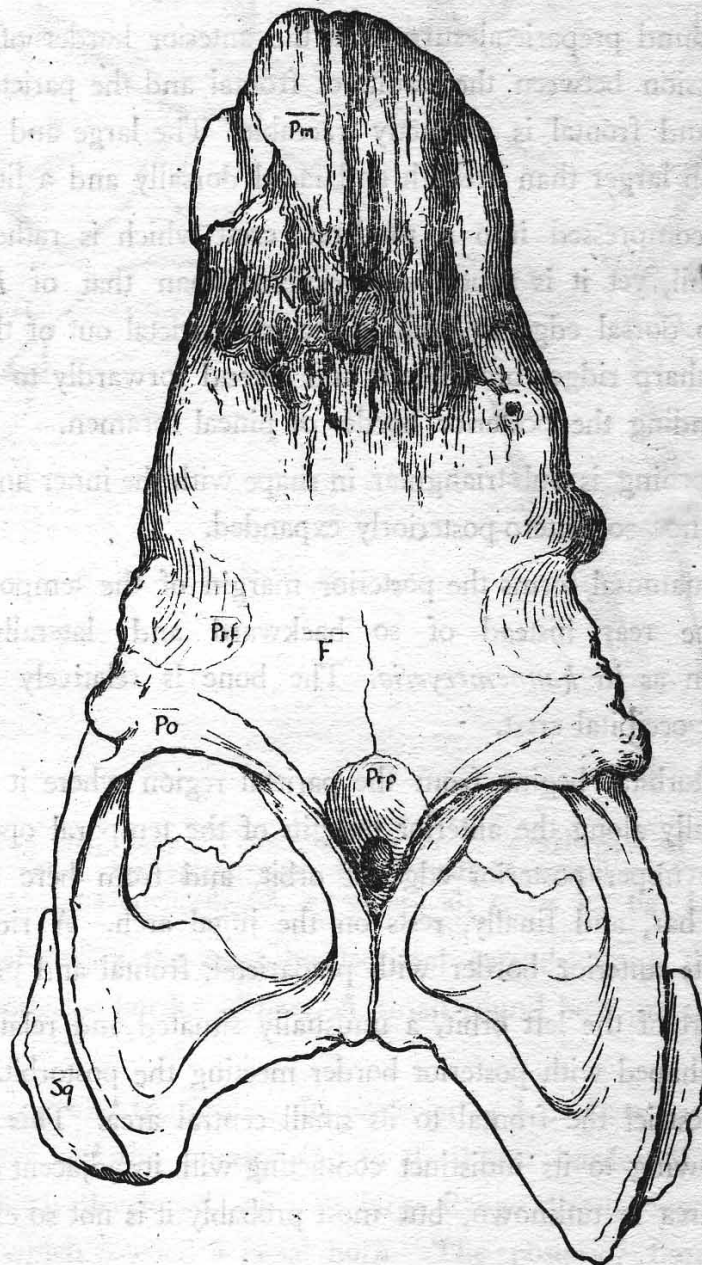


Fig. 1. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Dorsal view of the type skull. 1/4 nat. size. Abbreviations: F, frontal; N, nasal; Pm, premaxillary; Po, postorbital; Prf, prefrontal; Prp, preparietal; Sq, squamosal.

The nasal is heavy and extensive, with a pair of unprominent bosses on its lateral posterior surface. The nasal of each side separated from each other anteriorly and extends along the external margin of premaxillary to form the posterior border of the narial opening. Posteriorly, the contact with frontal is not distinct. The rugosity of the skull surface

starts from the tip of the snout and continues to the end of nasal region. It is decorated with various-sized pits and striated grooves. No midnasal ridge is present.

Frontal region is rather small in size and with the convex center part. It is almost excluded from the orbit rim by the posteriorly extended prefrontal. Its posterior margin is in contact with the postorbital and preparietal. The surface of frontal is much smooth than the anterior bones.

The large and round preparietal surrounds the anterior border of the pineal opening and sink into depression between the vaults of frontal and the parietal crest. The suture between preparietal and frontal is distinctly traceable. The large and deep pineal foramen is ellipsoid with length larger than breadth and faced dorsally and a little anteriorly.

Parietal region compressed into a moderate crest which is rather low and short in proportion to the skull, yet it is much unspecialized than that of *Kannemeyeria*. The crest formed a sharp dorsal edge to exclude the interparietal out of the skull roof. From its anterior end two sharp ridges branch out and extend forwardly to from the dorsal edge of postorbital surrounding the posterior border of pineal foramen.

The temporal opening is sub-triangular in shape with the inner angle pointed medially. It is shortened and not so antero-posteriorly expanded.

The triradiate squamosal forms the posterior margin of the temporal opening and expands slightly to the rear instead of so backward and laterally as in *Placerias* and *Stahleckeria*, even as in *kannemeryeria*. The bone is relatively thin, not thickened and roughened at the occipital crest.

The curved postorbital begins from the parietal region where it overlaps the parietal and runs antero-laterally along the anterior margin of the temporal opening. It is rugosed and expanded at the upper posterior edge of orbit, and from here twists downward to form the postorbital bar, and finally, rests on the jugal arch. A ridge is formed along the contact line of its anterior border with preparietal, frontal and prefrontal respectively.

At the upper part of the left orbit, a unusually situated and relatively depressed bone is seen. It is round shaped with posterior border meeting the postorbital almost directly. It expands inward to restrict the frontal to its small central area. This is a posteriorly expanded prefrontal. Owing to its indistinct contacting with its adjacent anterior elements, the extension of facial area is unknown, but most probably it is not so extensive on preorbital region.

Lateral view

Narial opening is large and broad, and is situated almost at the tip of the snout. A thin and expanded septum extends downwardly from the premaxillaries fully separated the narial openings.

Septomaxillary sub-triangular, obliquely and transversely stands at the posterior end of the narial opening above the maxillary. A descending flange from the dorsal nasal covers

the upper border of the narial opening also the septomaxillary.

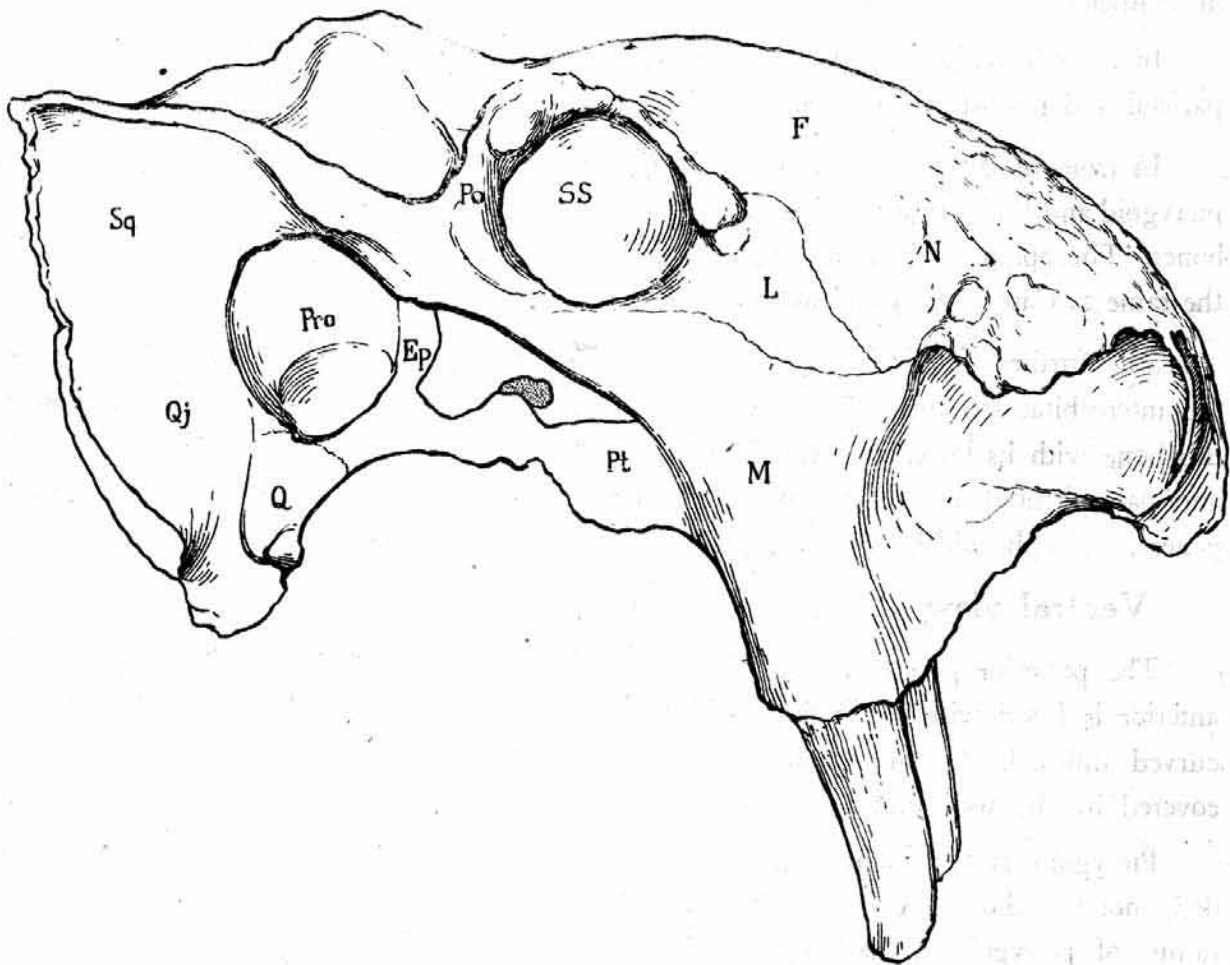


Fig. 2. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Lateral view of the type skull. 1/4 nat. size. Abbreviations: Ep, epipterygoid; L, lacrimal; M, maxillary; Pro, prootic; Pt, pterygoid; Q, quadrate; Qj, quadratojugal; SS, septosphenoid; others see fig. 1.

At the preorbital region the extensive lacrimal extends along the nasal margin and almost reaches the posterior border of nare. A small round boss projects at the anterior rim of orbit.

The maxillary large and triangular. Its posterior end projects backward to the base of the front part of orbit and the anterior end to the lower border of narial opening. The maxillary process much developed with its large flange directs downwardly, but not like that of *Placerias* in which formed a facial horn. The posterior border of the flange is stout owing to the containing of the long tusk root. The anterior part of the maxillary process is relatively thin and sharp in edge. Its border forms a concaved curvature up to the anterior end.

The well developed tusk projects out from the tip of the maxillary process and directs more downward. It is cylindrical and strong, with 40 mm in diameter. No clear worn surface is observed, but probably the wearing comes from outside, for the tip of the tusk curved a little inwardly.

The orbit is round and entirely laterally directed. It is moderate in size (80—90 mm in diameter) and rather posteriorly located.

In the otic region, the proötic is fused with the downward extending and thickening parietal and postorbital, no suture can be traced.

In front of the proötic, epipterygoid rises from the base of the quadrate-ramus of pterygoid and leads upward along the side of brain cavity till to articulate the skull roof bones. The epipterygoid is a long and slender bone, and is broken at about its mid-height, the same as Case (1937) had noticed in *Kannemeyeria*.

Still further anteriorly, a thin and expanded bony plate extends medially to form the interorbital septum. This is septosphenoid. It is difficult to trace the contactation of this bone with its lower adjacent elements. But most probably the underlying presphenoid and parasphenoid are not so upwardly extended. To compare with the other known genera, septosphenoid is larger and more backwardly stretched.

Ventral view

The posterior part of basioccipital forms the lower part of the occipital condyle. Its anterior is fused with the basisphenoid to form a concave base with the two lateral sides curved upward. In our specimen *fenestra ovalis* which situated on these lateral sides are covered by the well preserved stapes.

Pterygoid is the main element constituting the basicranial axis which is rather extended, not foreshortened and arched as in *Placerias* and *Stahleckeria*. The quadrate-ramus of pterygoid is vertically broadened, it runs latero-posteriorly and terminates in contacting with the inner side of quadrate and the distal end of the stapes. The central parts of the pterygoids are also fused with the basisphenoid to form a short broad base. A short distance forward, it again diverged into the pair of palate-rami which are vertically expanded and run antero-laterally to merge into the fusion with maxillary and palatine.

To compare with the other genera the oval interpterygoid foramen lying in front of the pterygoid fusion is relatively large. The anterior part of the pterygoid fusion curved downwardly to slide into this foramen. Below which the vertical parasphenoid runs through.

Beginning from the anterior border of interpterygoid foramen the thin and vertical vomer extends through the middle line of the heart-shaped choanae to the posterior part of the massive palate where it is thickened to form a median ridge in the palate and fused with its adjacent bones.

Owing to the large flange of the maxillary process, a deeply vaulted palate is formed. All the bones of palate firmly fused together. Two longitudinal ridges extend from the tip of the premaxillaries and divide the surface into three parallel grooves which in correlating with the narrow and pointed snout are relatively small and narrow,

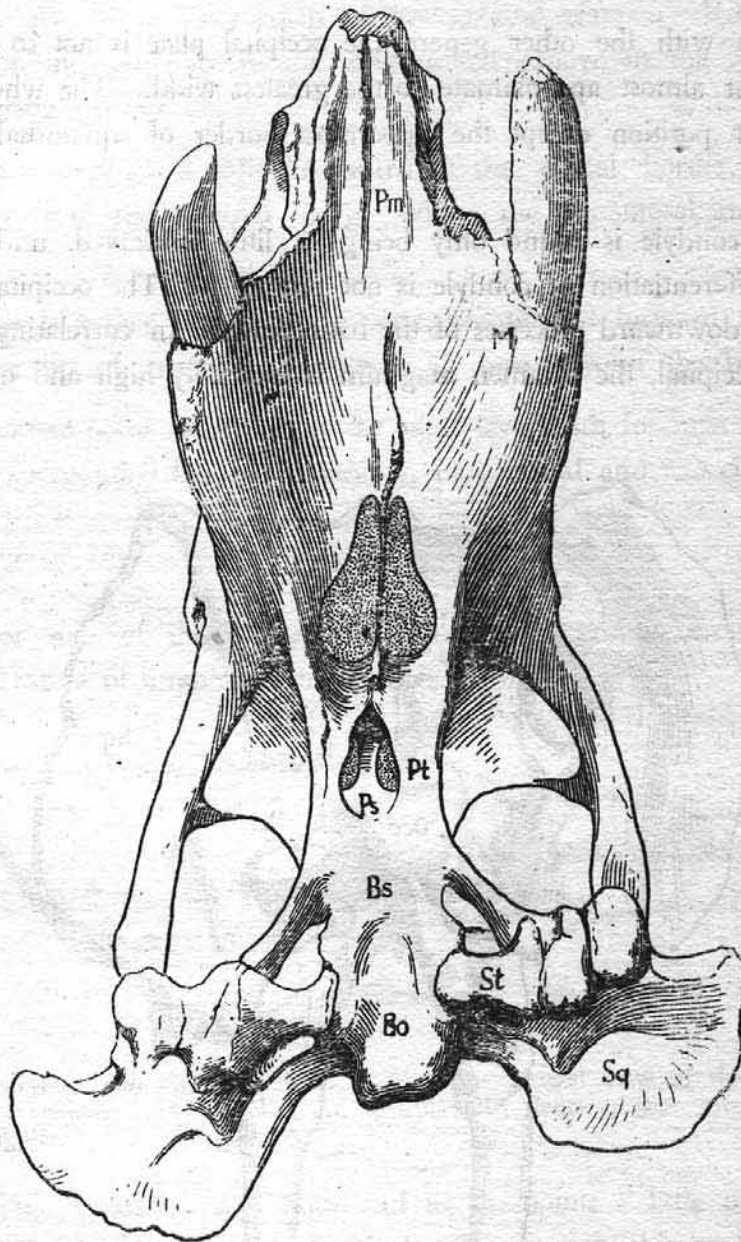


Fig. 3. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Ventral view of the type skull, 1/4 nat. size. Abbreviations: Bo, basioccipital; Bs, basisphenoid; Ps, parasphenoid; St, stapes; others see above figs.

At the rear end, two stapes transversely hanging between the *foramen ovalis* and quadrate are perfectly preserved and rather simple in structure. It is tapering and flat, with the quadrate extremity broader than the footplate. The end of footplate is thickened and forms an ellipsoid area to press over the *fenestra ovalis* but no boss-like structure is developed. The distal end of the stapes is expanded into a sloping surface attached to the inner side of the quadrate.

The pulley-like articular surface constituted by quadrate is well developed. Quadrate expands upward and firmly attaches to the lower anterior face of the squamosal.

Occipital view

In comparison with the other genera, the occipital plate is not so greatly spreaded. The greatest height almost approximate to the greatest width. The whole occipital plate is in perpendicular position except the uppermost border of squamosal projects a little backward.

The occipital condyle is round only being a little concaved under the foramen magnum. The differentiation of condyle is not prominent. The occipital condyle is supported by the two downward processes of the basioccipital. In correlating with the shape of the skull and occipital, the foramen magnum is especially high and narrow.

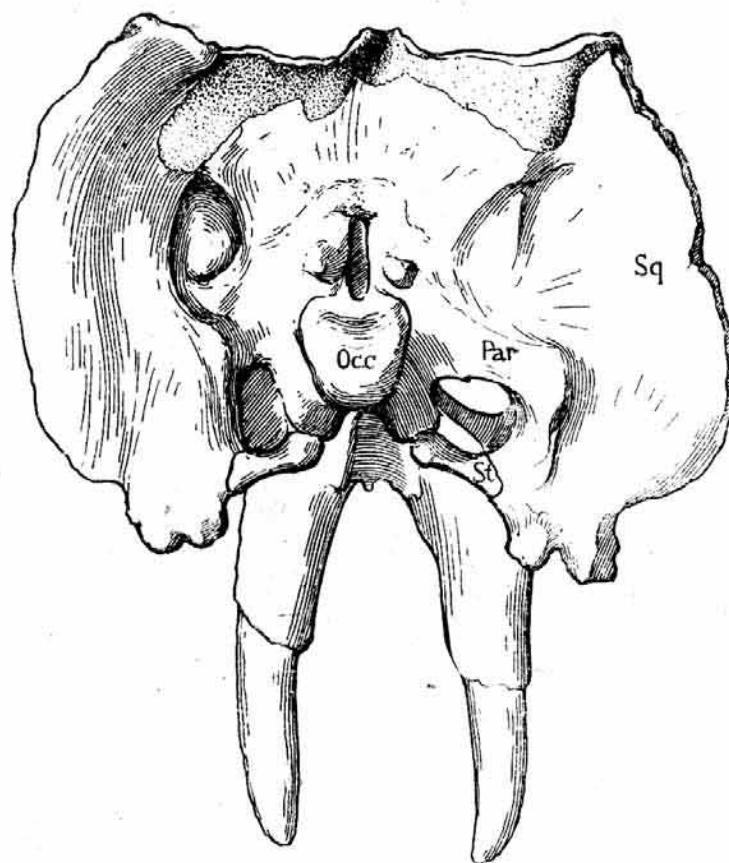


Fig. 4. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Occipital view of the type skull. 1/4 nat. size. Abbreviations: Oc.c. occipital condyle; Par, paroccipital; others see above figs.

The paroccipital process is well developed directing laterally and downward. At the contacting surface, where it is attached to squamosal, an acute process projects out. From here on, it turns downward to form a broad surface where it meets the distal part of the stapes and the end of quadrate ramus of pterygoid.

The wing-like supraoccipital expands dorso-laterally from the dorsal level of foramen magnum. Its lower and external border extends to form the inner upper edge of the

posttemporal fossa. No distinct suture can be traced between exoccipital, supraoccipital and interparietal. At the upper median of the occipital plate a shallow depression is observed corresponding probably to the longitudinal groove in the *Kannemeyeria* skull described by Pearson (1924).

The squamosal expands a little backward at the dorsal border. A curved angle projects anteriorly from the external margin where the squamosal meets the quadratojugal.

The quadrate is rather downward located, not pushed forward as in *Placerias* and *Stahleckeria*. The tip of articulate surface is 60 mm beyond the basioccipital process.

The large posttemporal fossa sets at the same level with foramen magnum. It opens obliquely and is surrounded by the squamosal, paroccipital and exoccipital.

Lower Jaw

The posterior half of the left ramus is lost, right ramus preserved but the part of the reflected lamina of angular is broken off.

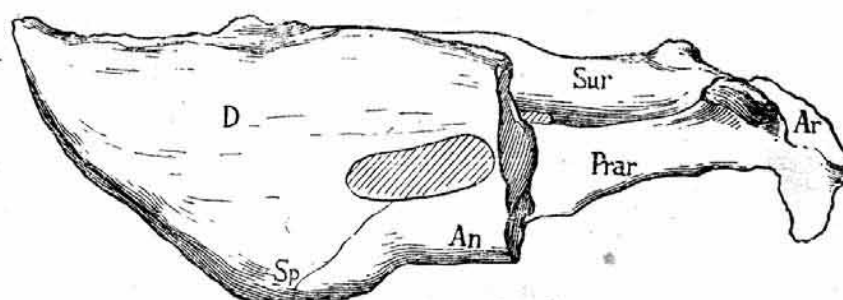


Fig. 5. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Lateral view of the lower jaw. 1/4 nat. size. Abbreviations: An, angular; Ar, articular; D, dentary; Prar, prearticular; Sp, splenial; Sur, surangular.

The lower jaw is narrow and high and its tip points a little upward. The upper margin is straight. The dentaries are firmly fused, extremely thin and high at symphysis. On the symphysis surface the two ridges form a medium groove which though much narrower is broader and deeper than the two side grooves. Besides, two indistinct longitudinal grooves also run through the ventral surface of the symphysis from the tip to the base. The upper arm of dentary runs horizontally backward, the lower arm extends downward. The sutures between splenial and dentaries are not very clear.

The surangular is a small bone constituting a part of the posterior upper border of mandibular in front of the articular. The boundaries between surangular and articular, angular can not be distinctly traced.

The broad posterior outer flange of angular is lost, but the inner branch is still attached to the lower border of surangular. The main shaft lies below the mandibular

foramen. Its anterior end inserts into the base of the dentary symphysis beside the splenial.

The prearticular covers the lingual surface of mandible. It extends from the base of the articular forward to form the inner wall of the mandibular foramen when it runs across it. The base of prearticular is narrow like those in *Kannemeyeria* and *Stahleckeria*.

The triple-ridged condyle of the articular directs more upward than backward. The inner flange is semicircular; the outer one is broken at the edge and curves somewhat externally. The digastric process turns downward, it is not so stout.

Postcranial skeleton

In contrary to the skull the postcranial bones are in rather fragmentary state of preservation.

Presacral vertebrae are represented in the collection by three dorsal vertebrae which are jointed together. In view of backward position of neural spine and upwardness of diapophysis, they belong probably to the posterior dorsal. The centrum is laterally compressed.

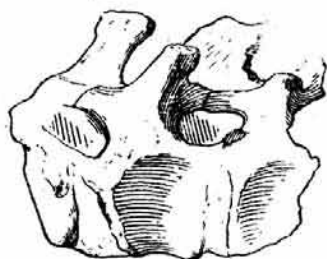


Fig. 6. *Parakannemeyeria dolichocephala* Gen. et sp. nov.
Presacral vertebrae in lateral view, 1/4 nat. size.

The antero-posteriorly broadened neural arch inclines obliquely backward. This is rather similar to that of *Kannemeyeria*. At the antero-lateral side of neural arch, the transverse process projects laterally backward and upward. Prezygapophysis extends forward and laterally from the base of the transverse process. The length from pre- to postzygapophysis is 66 mm, 10 mm greater than the height of the centrum.

The four sacral vertebrae are fused together. All the upper part of neural spines are broken. The sacral rib is not rod-like but expands vertically and twists antero-posteriorly with its broadened fan-like base firmly attached to the inner side of ilium. The first sacral rib is long, more rod-like than the following ones. The last one is the shortest, and in the form of a flattened plate. The ventral side of sacral centra is flattened, no keel is seen.

The scapula is thin, strongly curved, and convex outside. The large and high acromion directs forward and outward. The anterior margin of the scapula is concave. No cleithral groove is observed. The posterior border is more straight and thickened. The glenoid fossa is enlarged.

The clavicle is a flat S-shaped bony band with lower part curved inward and joined probably to the ventral interclavicle or sternum proximally. Its upper part is a little broa-

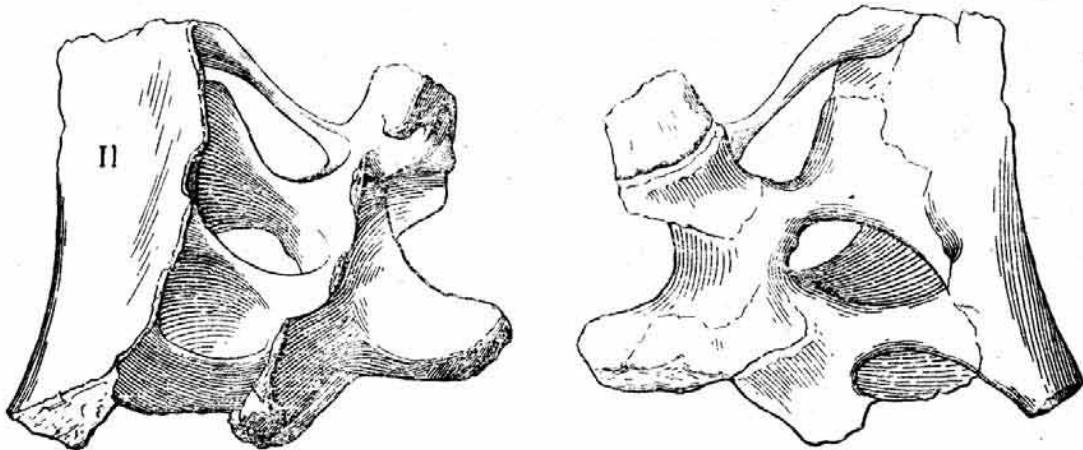


Fig. 7. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Sacral vertebrae with the anterior blade of left ilium (II) in dorsal view (left) and in ventral view (right). 1/4 nat. size.

der than the lower, longitudinally convexed at the front face and concaved behind. At the posterior lower part, a ridge runs from the external end, directs laterally and upwardly and lost at the lower one third height of the bone.

The humerus is relatively flat, with a twist between the pectoral crest and the distal plane. The deltopectoral crest is thin, probably it causes the incomplete preservation

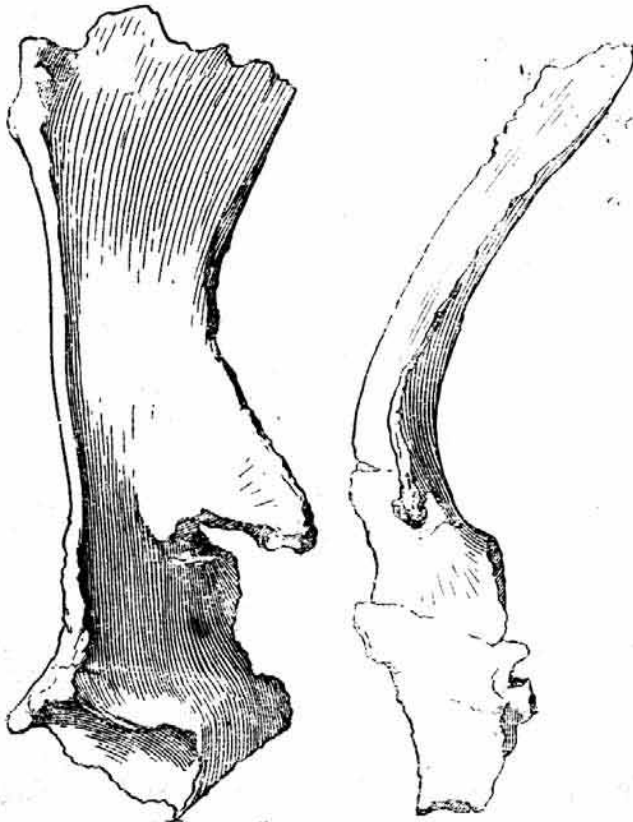


Fig. 8. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Right scapular in external (left) and anterior (right) views. 1/4 nat. size.

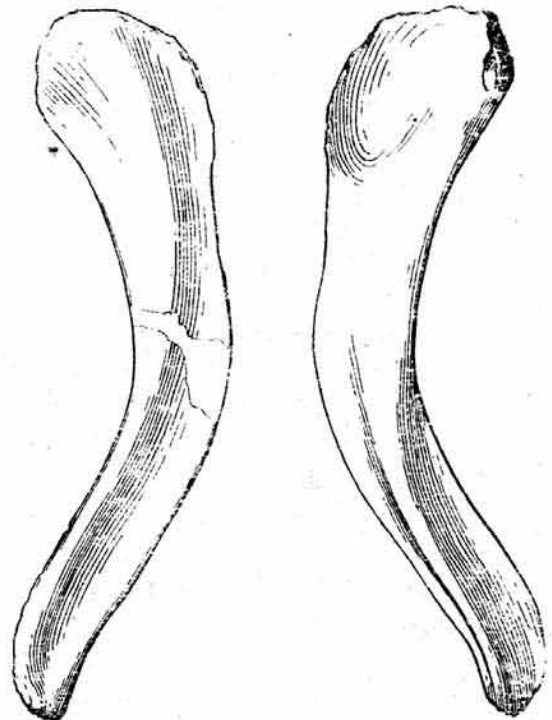


Fig. 9. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Left clavical in anterior (left) and posterior (right) views. 1/4 nat. size.

of this part while in general it is often much stout and heavy. The distal part is flattened at both sides. The plump radial condyle is well developed and with a separating groove. The outer edge of ectepicondyle projects outward to form a crest. The entepicondyle is merely a flat plane without condylar process. The entepicondylar foramen is large, penetrating the strong entepicondylar ridge which runs through the shaft to continue with the deltopectoral crest. There is no distal extending, either ectepicondyle or entepicondyle, the two condyles set almost at the same level.

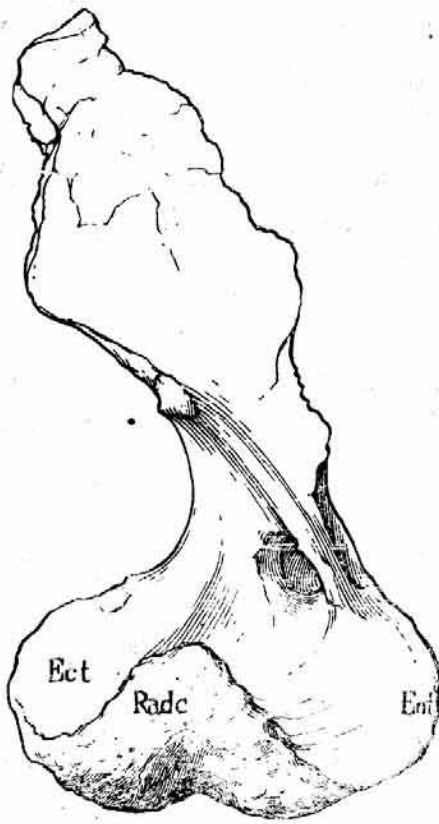


Fig. 10. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Right humerus in ventral view. 1/4 nat. size. Abbreviations: Ect, ectepicondyle; Ent, entepicondyle; Radc, radial condyle.

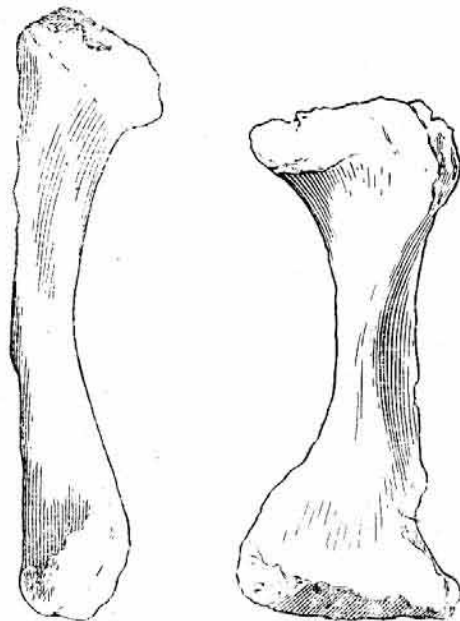


Fig. 11. *Parakannemeyeria dolichocephala* Gen. et sp. nov. Right radius in posterior view (right) and left fibular in internal view (left). 1/4 nat. size.

The radius is relatively straight and with a long shaft, at the posterior side of which a ridge extends.

The fibular is slender relatively straight and with the posterior distal end turning little backward.

Two fragmentary digits were preserved on matrix, but it is so badly preserved that no more description can be given.

COMPARISON AND DISCUSSION

The Kannemeyerids had world-wide distribution in Triassic time. Four main genera were grouped in this family: *Kannemeyeria* from South Africa, *Stahleckeria* from South America, *Placerias* from North America and *Sinokannemeyeria* from Asia. A comparison (based on skull only) of the Ningwu specimen with the other known genera is shown in the accompanying table following mainly the features listed by Camp to distinguish it from the other three genera.

	<i>Parakannemeyeria</i>	<i>Kannemeyeria</i>	<i>Stahleckeria</i>	<i>Placerias</i>
1	Snout narrow and pointed	+*(blunt to moderate pointed)	-(broadened)	+
2	Maxillary process develops more downwardly	+(not so downwardly)	-(process reduced)	+(into facial horn)
3	Tusk stout, downward	+(a little forward)	-(absent)	-(reduced)
4	Septomaxillary fused to maxillary	+	+	-(to Pm)
5	Nasal large, thickened and rugose	+	+(not so rugose)	-(small, thin)
6	Interparietal not extensive on skull roof	-(narrowly extended)	?+(probably not extend far forward)	-(extensive)
7	Prefrontal large, thick	+	-(small, thin)	-(thin, fragile)
8	Postorbital without rugose tubercles	+	+	-
9	Parietal crest moderately developed	+(strongly elevated)	-(not compressed)	-(not compressed)
10	Squamosal not so extended	-(more posteriorly extended)	-(laterally extended)	-(far backward to form saddle like)
11	Stapes tapering broader at Qu. extremity than at footplate	+	-(strongly tapering)	-(not tapering)
12	Paroccipital process directs laterally and downward	+	+	-(horizontal)
13	Basicranial axis not foreshortened and arched	+(slightly)	-(more)	-(greatly)

* "+", the same feature to that of *Parakannemeyeria*; "-", different.

It is generally thought that *Placerias* is a group of most specialized kannemeyerids. It differs greatly from our specimen by a number of characteristic features such as the saddle-like extension of its squamosal resulting in the greatly forward extending of the quadrate region and great shortening of basicranial axis, broad parietal region and most extensive of interparietal on skull roof, its strange "facial horn" and reduced inner projected tusk, etc.

The South American genus *Stahleckeria* is distinguished by its larger size, broad-head, the great lateral extension of squamosal, less projecting maxillary process, absent of tusk, and some other features that it shares with *Placerias*, such as foreshortened and arched basicranial axis, broad parietal region, etc. Obviously, our specimen is in quite another trend diverging from that of *Stahleckeria*.

Parakannemeyeria shows the closest relationship to the South African genus *Kannemeyeria* as can be seen above. Both retained the primitive characters such as the incipient extension of squamosal, slightly foreshortened basicranial axis, well developed stout maxillary process and cylindrical tusk. Besides, the narrow-headed form and probably corresponding pressed parietal crest are, likewise, the common features of these two genera.

Parakannemeyeria has its own diagnostic characters, which serve well to separate it from *Kannemeyeria*. The skull is narrower and more elongate, snout more pointed, temporal region shorter and the orbits relatively more backward. The parietal region though pressed into a crest is not so elevated as in *Kannemeyeria*. The squamosal extended only at the rear uppermost part and the occipital plate is rather perpendicular. The maxillary process and tusk direct more downward. In the basicranial region the interpterygoid vacuity is larger than that of the others.

So far the skull of *Sinokannemeyeria* has not been reported. The here described postcranial skeletons of *Parakannemeyeria* are also distinct from those of *Sinokannemeyeria*.

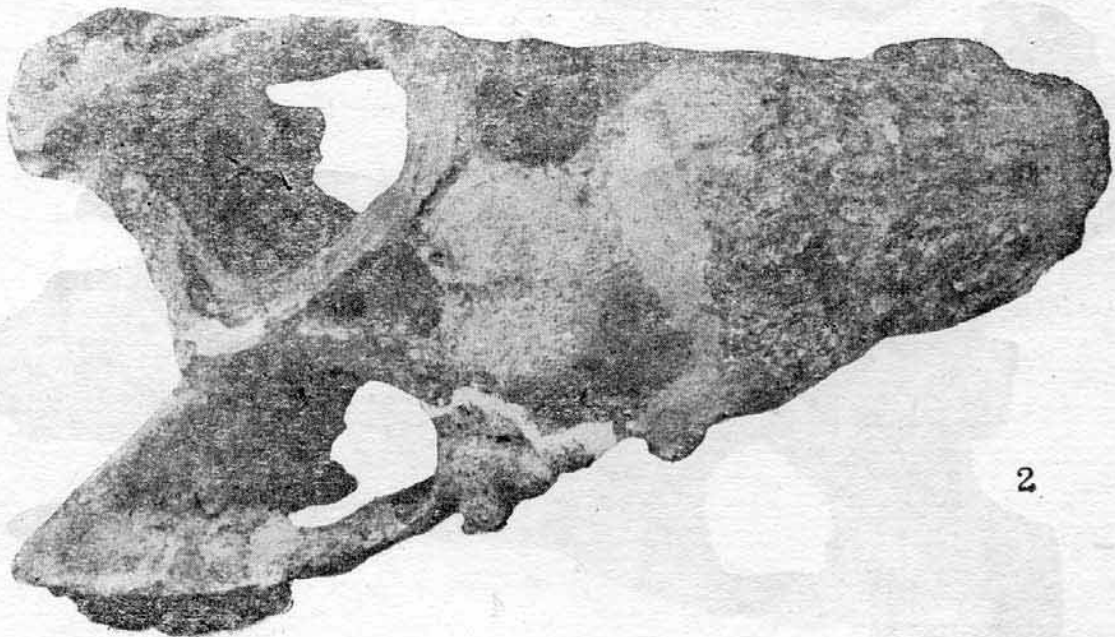
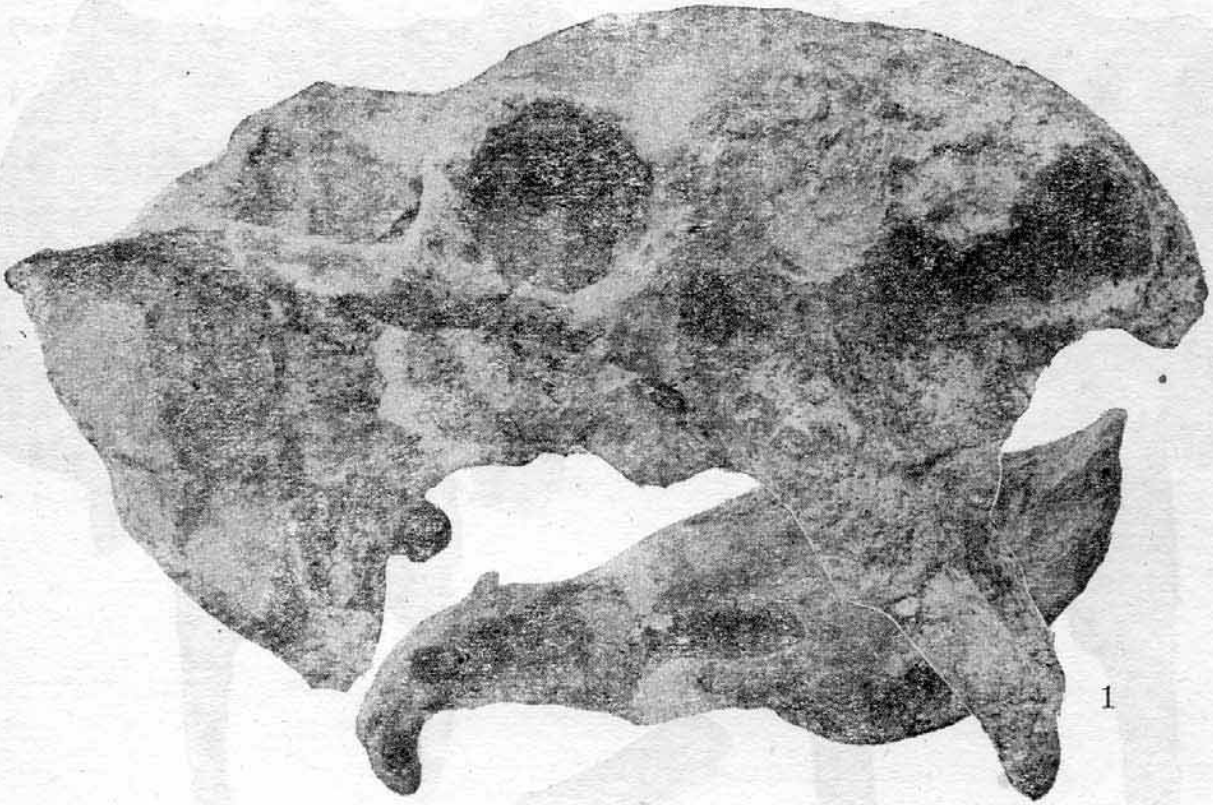
The vertebrae of these two genera are difficult to compare with each other because of the bad preservation of our specimen, yet no noticeable differences between these two genera are shown. The sole comparable element is the humerus. The humerus of *Parakannemeyeria* is different from that of the other not only by its large size but also by its thinness at the proximal part, its stouter shaft with more developed ridges extended from the distal condyles, its flatness of entepicondyle and having a prominent ectepicondylar crest.

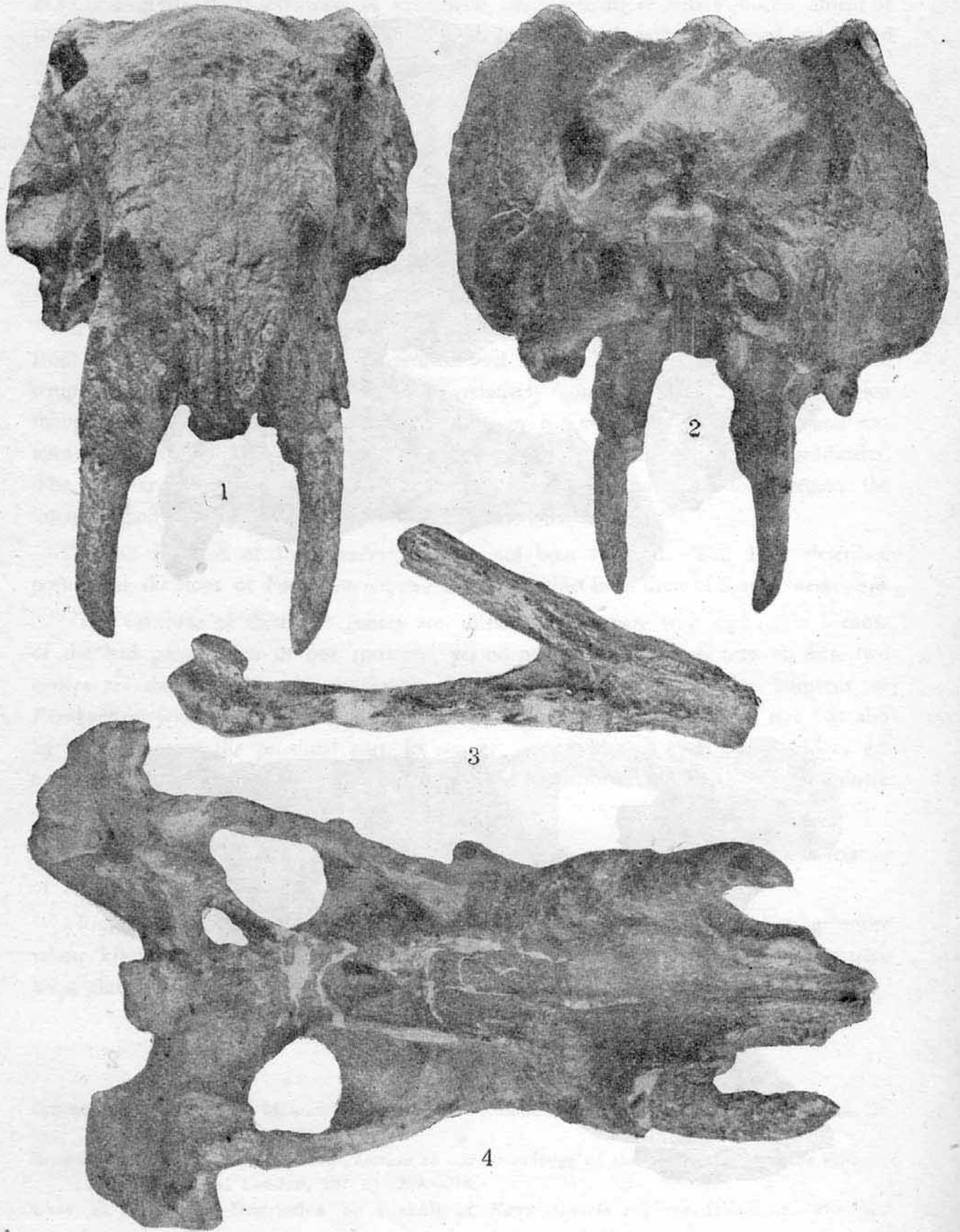
Viewed from above, it is more reasonable to consider our specimen as a close relative of *Kannemeyeria* and seems to be more primitive in certain respects.

Finally, the writer wishes to express her indebtedness to Prof. C. C. Young under whose kind direction this paper is written and to Dr. Minchin Chow for his valuable helps during the preparation of the manuscript.

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Explanation of Plates

Pl. 1. *Parakannemeyeria dolichocephala* Gen. et sp. nov. 1/4 nat. size.

1. Type skull in lateral view with the lower jaw.
2. Type skull in dorsal view.

Pl. 2. *Parakannemeyeria dolichocephala* Gen. et sp. nov. 1/4 nat. size.

1. Type skull in anterior view.
2. Type skull in posterior view.
3. Lower jaw in dorsal view.
4. Type skull in ventral view.