CONTRIBUTIONS FROM THE MUSEUM OF PALEONTOLOGY

(Continuation of Contributions from the Museum of Geology)

UNIVERSITY OF MICHIGAN

VOL. IV, No. 1, pp. 1–56 (7 pls., 45 text figs.) DECEMBER 1, 1932

A COLLECTION OF STEGOCEPHALIANS FROM SCURRY COUNTY, TEXAS

BY

E. C. CASE

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A COLLECTION OF STEGOCEPHALIANS FROM SCURRY COUNTY, TEXAS

By E. C. CASE

THE second expedition from the Museum of Paleontology of the University of Michigan, in the summer of 1931, to the locality in Scurry County, Texas, recovered a large amount of material of the stegocephalian, *Buettneria bakeri*, which permits amplification and some emendation of the original description.

The exposures of the Triassic beds in Scurry County have much the same facies as the exposures elsewhere on the eastern side of the Staked Plains. The dominant capping sandstone, previously identified by the author as the equivalent of the Shinarump (Case, 1928), is directly underlain by gray shales and sandstones, which rest on red beds, probably of Triassic age, since no exposure of red beds of Permian age has been proved in this region. As in most terrestrial deposits, the beds are not all continuous or consistent in character or thickness.

Previous to 1930 no Triassic vertebrates had been recovered from Scurry County; the nearest localities were in southeastern Howard County and eastern Crosby County. A few scattered fragments have been found a few miles from Post, in Garza County. Evidently sporadic occurrences of Triassic vertebrates may be found in any part of the exposures, but the majority of the areas are exasperatingly barren.

The locality here called "the Elkins Place bone bed" is about twenty-three miles north of Snyder, in Section 32, Block 4, of the H. and G. N. Survey. The author has previously expressed his acknowledgments to the owner of the property, Mr. P. L. Fuller, for his kindness in permitting and aiding the work of the expeditions from the Museum of Paleontology, but takes this occasion to reiterate his thanks. Examination of the material shows a scientific value even greater than at first expected.

The general level of the country for miles around the locality is determined by the coarse, grayish, Shinarump sandstone. Upon this stand isolated hills, locally called mountains, of Lower Cretaceous rocks, and to the west rises the Tertiary escarpment, the "Cap Rock."

The discovery of the bone bed was accidental (Case, 1931); a search during the summer of 1931 over many miles of adjacent country revealed no similar deposits, nor even a trace of bone. The exposure of the bed occurs in the face of a cliff formed by the cutting of a small water course. The lower part is covered by talus, but about twenty-five feet are exposed vertically.

The following section and the accompanying diagram (Fig. 1) show the character of the exposure:

SECTION OF THE EXPOSURE CONTAINING THE ELKINS BONE BED

TOP	FEET	INCHES
Heavy-bedded sandstone, with fine-grained, irregularly bedded patches of pebble conglomerate (Shinarump sandstone) . .	16 (more or less)	
Coarse clay conglomerate with pebbles and mud lumps; scarce occurrence of water-worn bones; layers two or three inches thick, of channel sandstone, with brown streaks and poor traces of plant material.	4	6
Hard sandstone.	1	2
Coarse sandstone with pebbles and mud lumps; layers of harder channel sandstone; scattered bones, coprolites, and poor indications of plants; bone bed at bottom.	2	2
Red clay, mottled and streaked with green; bottom not seen. Four feet exposed in the vertical face above the talus. Remainder seen in adjacent gullies.	61+	

In this section the gray sandstone and clay between the capping sandstone and the red clay are nearly twice as thick as in any place within a radius of several miles. The majority of the bones lay closely packed together at the base of the twenty-six-inch bed of coarse sandstone; a smaller number were found in upper portions of this layer and a few in the bed of clay conglomerate above.

The sandstone containing the bones is grayish and is com-

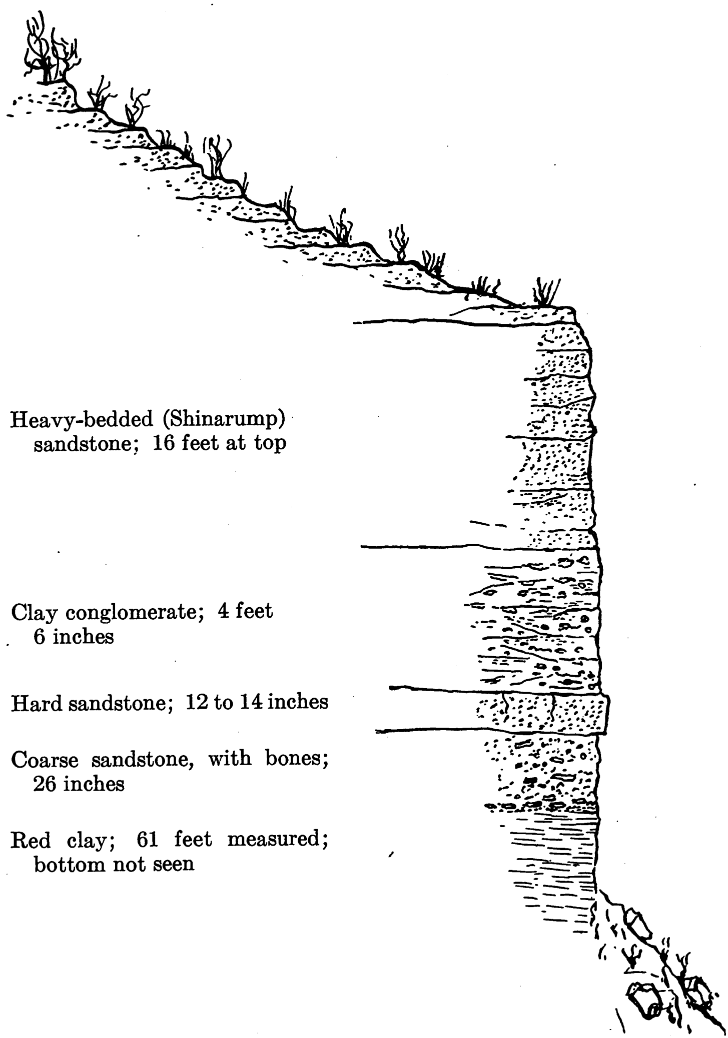

FIG. 1. Diagrammatic section at Elkin Place bone bed

posed dominantly of subangular, frosted grains of pure quartz, ranging from minute to a millimeter or more in diameter. The larger number are about a half-millimeter in diameter. Mixed with the quartz grains are many grains of other material. There is a considerable quantity of fine clay in flakes and in localized lumps, and many fragments of quartz and other material reach a length of twenty millimeters. Much of the sand is loose and may easily be scratched away with an awl, but there are spots and streaks where it has been cemented by silica into a very resistant mass. Hydrochloric acid gives a free but very short effervescence, showing a small amount of $CaCO_3$. The sandstone affords no evidence of current action or of bedding other than a few thin layers in the upper part which have the appearance of oblique channel sandstone.

Throughout the sandstone and the clay conglomerate above there are numerous, irregularly cylindrical structures standing vertical in the matrix. These range from one to two centimeters in diameter and are more darkly colored than the surrounding material and are very hard; none contain the larger fragments. The cylinders are without internal structure and show no indication of rooting or branching. They frequently start from the surface of a bone and extend upward for several centimeters, but also occur independently of the bones. In only a single case was one found to bend, slightly, around the edge of a bone and continue below. In two cases a cylinder was continued through a posthumous fracture in a thin plate.

The layer of sandstone lies directly upon the red clay; the parting is so sharp that in many places the bones were impressed in the clay below, but there is always a thin layer of sand between them and the clay.

The larger number of the bones lay at the bottom of the sandstone in a layer not over three to four inches thick. Here the flat skulls and the platelike clavicles and interclavicles were in a horizontal, or nearly horizontal, position. The bones are singularly perfect. The paper-thin edges of the interclavicles and clavicles and the sharp sculpture upon these and the bones of the skulls are perfectly preserved and are minutely sharp.

No parts of the skeleton, except some of the skulls and a single jaw with a skull, were found in association.

The material is almost entirely of one species of Stegocephalia, described in a preliminary paper as *Buettneria bakeri* (Case, 1931). Aside from the abundant remains of this species there were found, mostly in the layer of clay conglomerate, four dinosaur teeth, a phytosaur tooth, two vertebrae, and some fragments of a lower jaw of a small phytosaur, and a fragment of the jaw of a large stegocephalian. Most of these were from the upper part of the twenty-six-inch layer and some show considerable wear. No traces of fish were found except in some of the abundant coprolites, which contain scales of ganoid fish and small bones, probably of fish. In the coprolites there is no trace of a spiral valve, but many have the longitudinal striations and markings which suggest their amphibian origin, since some amphibia are known to have longitudinal plications in the rectum.

The interpretation of the conditions described above is not easy. The occurrence of a large number of individuals of the same species in an isolated locality suggests the gathering of a group of animals, probably of the same brood, in one of the last pools of a desiccating body of water, probably a stream course, but the absence of any traces of a food supply suggests that they were not in their usual habitat.

The extreme perfection of preservation in a coarse, unsorted sandstone presents the greatest difficulty. Had the bones been transported in water carrying such material they would have been broken and worn. If the skeletons or parts of them had been found associated, an hypothesis of sudden burial of undecayed carcasses in a quicksand or suddenly inpoured material might be entertained, but in neither the bones nor the condition of the matrix is there evidence of current action.

In explanation of the occurrence, the position of the bones may give a clue. Three complete skulls and a half-skull were found near together, within a few centimeters of one another. In the same space were several complete lower jaws, clavicles, interclavicles, and other bones. A mass of bones a short distance away consisted of isolated skull and jaw bones, sharp and unworn, with clavicles, interclavicles, and other elements. It may be supposed that a group of stegocephalians in a small pool were overcome by a relatively sudden inrush of coarse sand mingled with larger fragments and fine clay, due to a violent storm such as is characteristic of arid regions; the majority of animals were killed and sank to the bottom, where the cadavers decayed; certain individuals, represented by the complete skulls, were less completely macerated before burial than others, of which there were only isolated skull bones. Decay would be a matter of a very few hours in warm water. After burial the slumping and other movements of readjustment in the coarse sand would be sufficient to disturb and separate the bones of the macerated skeletons. Such movements would be of the mass of the matrix and would not be sufficient to break or wear the bones.

Some of the animals of the pool survived the first catastrophe only to perish later and be entombed at a slightly higher level.

That the spot was one of continued sedimentation is shown by the clay conglomerate above, with its relatively few and worn bones and traces of vegetation. The cylindrical bodies were formed after the deposition of the bones. They may represent decayed roots, worm burrows, or even gas vents. The beds below the capping sand were somewhat disturbed by slight movements subsequent to the petrifaction of the bone; this has broken many of the bones with greater or less displacement of parts. Many bones were so much fragmented in the matrix that they were rejected in the collection of material.

Description of the Material

Skull. — There are now in the collection of the Museum of Paleontology four complete skulls: number 13055, the holotype of the species, numbers 13820, 13823, and one yet uncleaned and uncataloged;[1] a half-skull split lengthwise and so anatomically perfect, number 13822; three incomplete skulls showing the posterior half, numbers 14098 and 14154, the paratypes of the species, and number 13596; and an anterior half of a skull, number 14262. Aside from this material there are many separate bones found as isolated elements of completely macerated skulls.

[1] After having been studied a fifth complete skull, previously numbered 13821, was given in exchange to the Museum of Comparative Zoölogy, where it now carries the number 1054.

There are four complete lower jaws: number 13823, found associated with the skull of the same number, and numbers 13944, 13946, and 13947; two posterior halves, numbers 13948 and 13949; and two anterior halves, numbers 12970 and 13945.

The distinguishing characters of the species have been given as the elongate form of the sculpture on the frontal and postorbital regions, the incomplete sensory canal system, and the extension of the palatal vacuities anterior to the orbits. To these must be added the exclusion of the lachrymal from the orbit and the nares, and the presence of an accessory row of small teeth on the inner side of the dentary adjacent to the symphysis. The last character may be common to the two species of *Buettneria*, but, unfortunately, is not shown in any of the larger jaws from other localities. It is present in two small jaws from Crosby County, which may be *B. bakeri*.

The holotype skull was somewhat fractured, and portions of the right side were restored from the left side. Study of the perfect skulls, numbers 13820, 1054 M.C.Z., and 13823, reveals little to change in the description and figures. Figures 3, 4, 5, and 7, compared with Figures 2 and 6 of the type specimen, show that the completion of the outline of the bones in the preorbital region is practically correct and confirms the exclusion of the lachrymal from any part in the rim of either the orbit or the nares. The tabular proves, as expected, to have a prominent process defining the inner edge of the otic notch.

The course of the sensory grooves needs but little change. The portion between the orbit and the nares is shown by the additional specimens to be sharply divided into two grooves by a very narrow ridge. The course of the grooves on the postorbital and jugal bones is bent at very sharp angles in two places.

The variations in the outlines of the different bones and in the course of the sensory grooves in the different skulls are not of larger order than those which occur in the clavicles and interclavicles described below, and are all well within the range of conceivable individual variation. A study of the text figures and the plates will reveal more clearly than a lengthy description the variations which occur. In the discussion and description

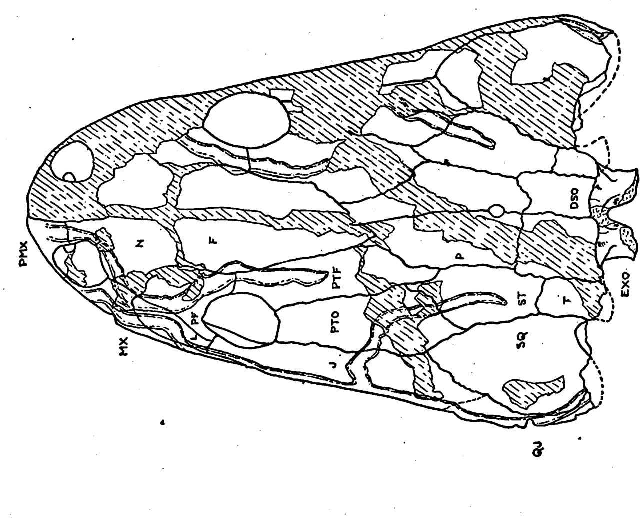

Fig. 2. Upper surface of the type specimen, *B. bakeri*, number 13055. × ¼

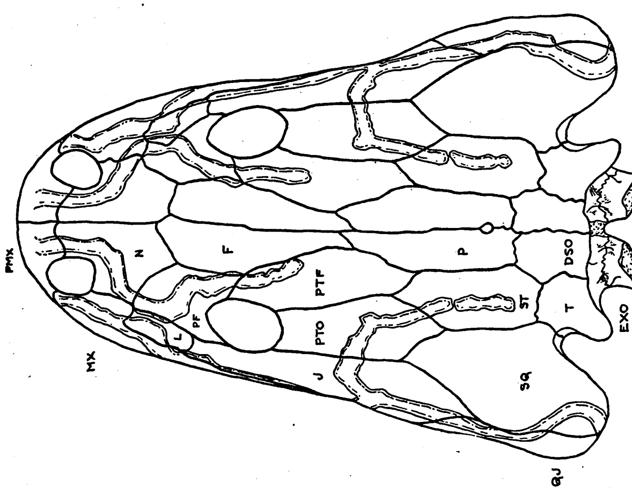

Fig. 3. Upper surface of number 13820. × ¼

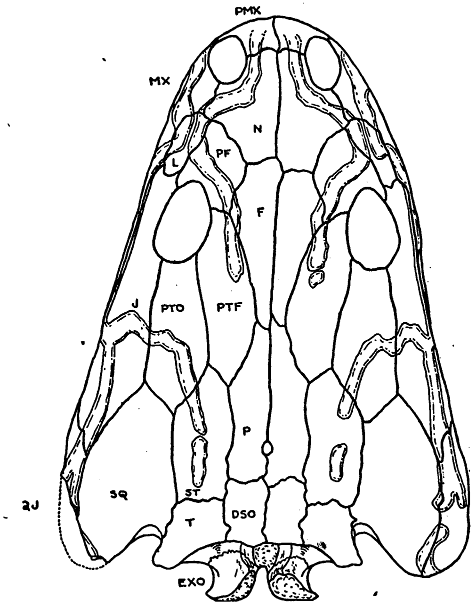

Fig. 4. Upper surface of number 1054 M.C.Z. × ¼

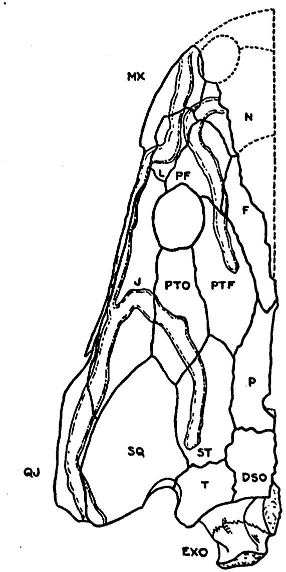

Fig. 5. Upper surface of number 13822. × ¼

Explanation of Lettering

DSO, dermsupraoccipital; EXO, exoccipital; F, frontal; J, jugal; L, lachrymal; MX, maxillary; N, nasal; P, parietal; PF, prefrontal; PMX, premaxillary; PTF, postfrontal; PTO, postorbital; QJ, quadratojugal; SQ, squamosal; ST, supratemporal; T, tabular

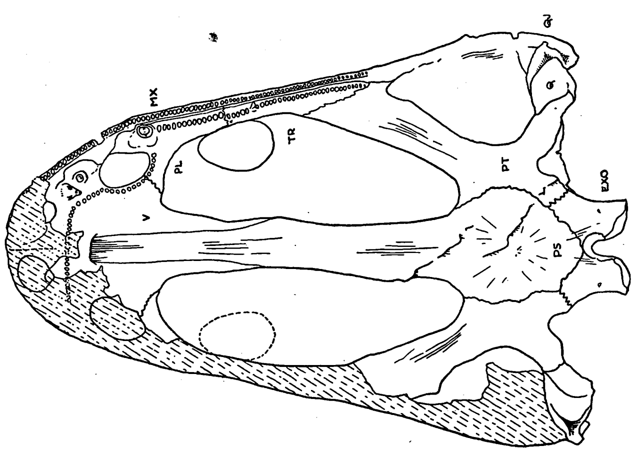

Fig. 6. Lower surface of the type specimen, *B. bakeri*, number 13055. × ¼

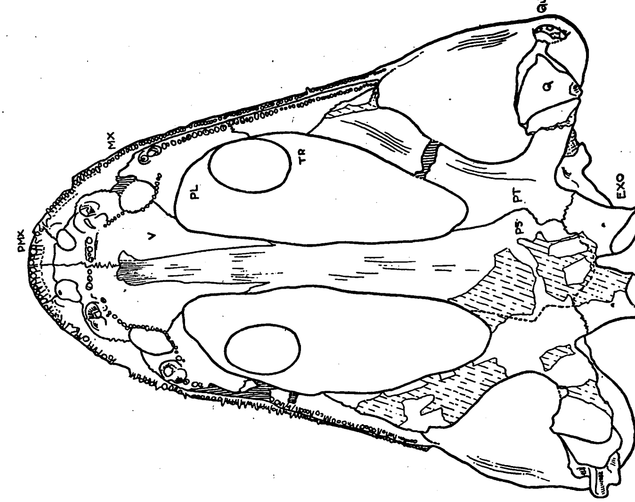

Fig. 7. Lower surface of number 13823. × ¼

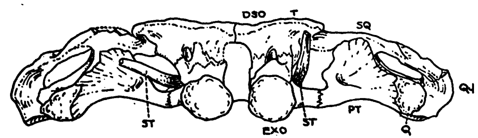

FIG. 8. Posterior surface of skull, number 13820. × $\frac{1}{4}$

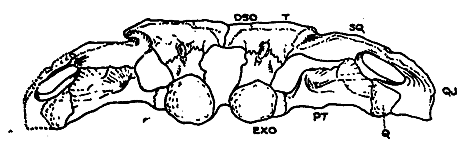

FIG. 9. Posterior surface of skull, number 1054 M.C.Z. × $\frac{1}{4}$

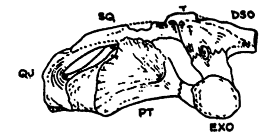

FIG. 10. Posterior surface of left half of skull, number 13822. × $\frac{1}{4}$

EXPLANATION OF LETTERING

EXO, exoccipital; MX, maxillary; PL, palatine; PMX, premaxillary; PS, parasphenoid; PT, pterygoid; Q, quadrate; QJ, quadratojugal; SQ, squamosal; ST, stapes; TR, transverse; V, vomer of the individual bones use has been made of the numerous isolated elements recovered.

The course of the sensory grooves is shown in the figures and plates. The portions of the infraorbital and the supraorbital grooves (according to the nomenclature of Moodie, 1908, Fig. 1) anterior to the orbits are separated by a narrow but very sharp and distinct ridge; there is no suggestion of a commissure such as that which occurs in *Buettneria perfecta.* The supraorbital grooves end posteriorly near the middle point of the postfrontal, but a modification of the sculpture, consisting of large and somewhat less sharp reticulations, leads across the postfrontal to the center of the postorbital, where it meets the post-temporal groove. This is very distinct in skull number 1054 M.C.Z., but is less evident in the other skulls. The temporal groove runs from near the posterior end of the supratemporal forward to near the center of the postorbital, where it turns sharply outward across the postorbital and jugal; near the center of the outer edge of the jugal it is sharply recurved and joins the jugal groove. In skull number 1054 M.C.Z. the posterior portion of the temporal groove is cut off from the rest on the right side by a short space of undisturbed sculpture. There is an indication of the interruption on the left side of this skull and on the other skulls. There is no indication of an anterior commissure; an occipital cross commissure is suggested by a few irregularly spaced, enlarged reticulations, but this is very indefinite. The jugal groove continues backward from the center of the jugal to the junction of the jugal with the squamosal and the quadratojugal, and then follows the suture between those bones, which lies in the groove, to the posterior edge of the skull.

It is noticeable that the bottoms of many of the pits in the sculpture are perforated by small foramina, especially in the region of the dermsupraoccipital and tabular bones, but such minute foramina occur in other regions of the skull, and it cannot be said that they are associated in any definite way with the course of the sensory system.

The form and relations of the individual bones as they appear on the upper surface are shown in the figures and plates and are confirmed by comparison of the various skulls, but are further confirmed by a selection from the isolated bones of those of approximately the same relative size and by building up a nearly complete skull roof. The descriptions of the lower surfaces of the bones have been drawn, in part, from the isolated bones. The posterior surface of the skull is shown in Figures 8–10.

Dermsupraoccipital. — The descending process which borders the cavity occupied by the cartilaginous supraoccipital turns slightly outward as it descends to meet the inner part of the rising process of the exoccipital. The outer edge of the process borders the opening between it and the descending process from the tabular. The lower end of the process is incomplete in all the isolated bones, but it evidently became very thin and joined the exoccipital by a close suture. On the lower surface of the dermsupraoccipital a low rugose ridge, or a series of slight rugosities, runs forward and outward; the sides of this ridge are marked by various foramina, but in each of the six isolated specimens examined the foramina vary in size and position. The surface of the bone on the outer side of the ridge is concave and, joining a similar concavity on the inner surface of the tabular, forms the upper portion of the oval space which sheltered the cartilaginous otic capsule. The suture between the two bones lies in the bottom of the space. The reasons for considering the otic capsule to be entirely cartilaginous have previously been given (Case, 1931). A specimen showing the under surface of the roof of the skull of *B. perfecta*, number 9716, reveals a roughened area between the two ridges of the tabular and on the adjacent surface of the squamosal, which afforded attachment for the capsule.

Tabular. — The descending process turns inward as it descends to meet the outer portion of the rising process of the exoccipital. The processes from the dermsupraoccipital and the tabular do not meet below; the lower border of the opening between them is formed by the exoccipital. Neither in any of the isolated examples of the tabular or of the exoccipital nor in any of the skulls has any evidence been found for the presence of an opisthotic element. It was thought that a small remnant of this bone could be detected in the holotype specimen of *Buettneria perfecta*, but no trace of it occurs in the specimens of *B. bakeri*.

The inner face of the descending process of the tabular is marked by two ridges dividing it into three faces (see Fig. 11). The outer surface forms the inner border of the otic notch. The median face is concave and sinuous in outline; the surface is rough for the attachment of a strong cartilage, probably of the otic capsule. This is found in all specimens of *Buettneria* in which the region is observable. The inner face is concave and, with the concave face of the dermsupraoccipital, forms the space for the cartilaginous otic capsule, as described above. Just on the inner side of the inner ridge there is a small foramen, in exactly the same position in three specimens; this corresponds to the large foramen on the lower face of the same bone in *B. perfecta*. It may be the place of entrance into the bone of the terminus of the endolymphatic duct, which no longer penetrates to the surface of the skull.

FIG. 11. Lower surface of left tabular, number 13799. × 1

Exoccipital. — There are nine isolated exoccipitals in the collection besides fourteen attached to more or less perfect skulls. The exoccipital of number 14098 has been described in detail, with the position of the foramina penetrating it and the probable course of the canals into which they lead (Case, 1931). The original description is here repeated:

> *Exoccipitals.* — On the lower surface the exoccipitals are separated by the parasphenoid, which extends to the posterior edge of the floor of the brain case. There is no evidence of an ossified basioccipital, but the two bones have broad inner processes with rough faces which were evidently attached to a cartilage which partially filled the space between them. From the upper surfaces a broad pillar rises to connect with the descending processes of the dermsupraoccipital and the tabulare, and forms the wall of the foramen magnum. This pillar is triangular in section with one, median, face looking into the foramen magnum, one, anterior, looking forward into the brain cavity, and one, posterior, looking backward. On the median face, near the base,

are two foramina. (In specimen 14098 there is a third, smaller, one posterior to the other two.) It has been possible to clean out the larger, more posterior, of the foramina in two specimens and to demonstrate that the canal passes directly through the condyle to open on the outer side. The smaller, anterior, foramen leads downward and outward. It has not been possible to clean out the canal, since all the smaller passages are filled with calcite instead of sand grains after a short distance, and the hardiness of the calcite is so close to that of the bone substance that it is impossible to distinguish between them with the probe. The canal has been followed to the center of the condylar portion of the bone.

On the anterior face there are two foramina, the lateral much larger than the mesial. The larger canal has been traced downward and a little backward to the center of the bone; from the direction of this canal and that of the anterior foramen on the median face it seems impossible that they could have united. The smaller, mesial canal opens after a short distance into the larger one.

On the lower face there is a large foramen about the center of the condylar portion. The canal rises almost directly into the bone for a short distance and then turns forward in the exoccipital portion of the floor of the brain case just outside of the suture between the exoccipital and the parasphenoid. A fortunate break through the neck of the condyle revealed the calcite filling of this canal, which was cleared out to connect with the foramen, but could not be removed anterior to the break.

The additional material permits a more detailed examination. Of the six exoccipitals included under number 13819, two, because of fortunate breaks and the unconsolidated character of the matrix, have permitted complete exploration of the various canals. It is shown that the canal extending laterally through the rising process is a persistent feature; it has variously placed lateral branches within the body of the bone. The two specimens most thoroughly explored show that the foramen on the inner face of the process may shift to the anterior face. The canals of the two foramina, generally one on the inner and one on the anterior face, unite after a short course and then join with the canal leading upward from the foramen on the lower face of the condylar process. From near the point of union of these three canals a larger canal leads forward into the body of the exoccipital and then into the parasphenoid. A left exoccipital, number 13684, from the Rotten Hill bone bed in Potter County, Texas, confirms in most points the evidence obtained from those of *B. bakeri* from the Elkins Place bone bed. The inner half of the bone has been destroyed by decay, leaving the canals exposed. The foramen on the anterior face leads to a canal in the center of the bone, which is also joined by the canal from the foramen on the lower face of the bone. The common canal leads forward within the portion of the exoccipital which forms a part of the floor of the brain case.

The only point that cannot be seen in this naturally opened series of canals is the connection between the transverse canal at the base of the rising process and the large central canal, but this does not negative its presence, which might be revealed in a deeper section. The rising process of the exoccipital contains a central cavity with branches leading from it to several minute foramina on the surface of the bone. This cavity was evidently occupied by a large vessel or a plexus of vessels, all probably nutrient in function (see Fig. 12).

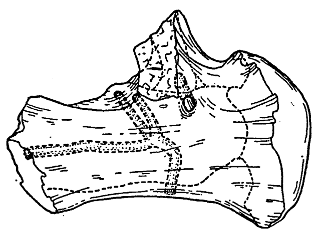

FIG. 12. Diagram of an exoccipital, number 13819, showing the course of the main canals. × 1

Squamosal. — There are seven isolated squamosals. One of a lot, number 13817, from the right side, and one of a lot, number 13816, from the left side, show the descending plate nearly perfectly. These, with the incomplete skulls, numbers 14098 and 14099, make the arrangement of the posterior wall of the skull very clear. The author is now able to demonstrate that his former belief, that the quadrate portion of the rising plate of the pterygoid was bifurcate and received the descending process of the squamosal, was an error. The isolated squamosals and skull number 14099 show that the articular surface on the lower edge of the squamosal process is entirely upon the posterior face and that the process overlapped the anterior face of the pterygoid process for a short distance vertically. The squamosal plate rises from the outer portion of the posterior edge, as previously described, and runs downward and outward. Its outer portion is separated from the squamosal by a deep notch, described as the squamosal portion of the quadrate foramen, but a misnomer in that the opening is inclosed by the squamosal and quadratojugal exclusively. The apparent bifurcation of the pterygoid process is produced by the crushing of the thin upper edge of the plate and by the presence in the plate of a considerable vacuity probably occupied in life by a plexus of blood vessels, as is so common in the bones of the skull. Figures 13–14 and also 6–10 show the relation of the bones in this region of the skull. The

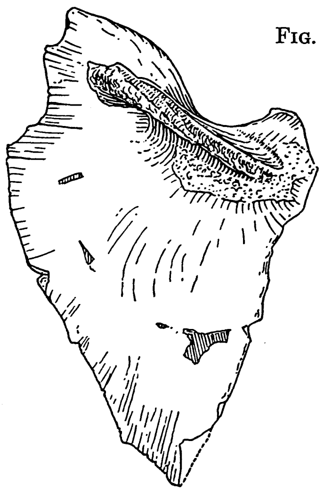

FIG. 13. Lower surface of a left squamosal, number 13816. × ⅔

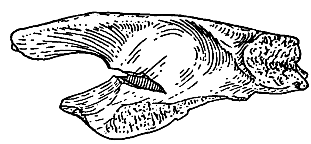

Fig. 14. Posterior surface of a left squamosal, number 13816. × ⅔

lower surface of the squamosal is entirely smooth, except for a few obscure, rugose spots that indicate muscular or cartilaginous attachment; they do not show the roughened area adjacent to the tabular seen in specimen 9716.

Quadratojugal. — There are eight isolated quadratojugals, five from the right side and three from the left. The quadrate process is deeply cleft to receive the quadrate, sending processes down on the anterior and inner faces of the quadrate. The inner process meets the outer end of the squamosal plate, completely inclosing the quadratojugal (?) opening (see Figs. 15–16).

Quadrate. — Specimen 13810 is a perfect and completely isolated quadrate from the right side; specimen 13969 is a nearly complete left quadratojugal, with the quadrate in position. The quadrate is irregularly tetrahedral and is very difficult to describe clearly. If placed in its proper position, it shows an upper articular surface for strong attachment to the inner projection of the quadrate process of the quadratojugal, which meets the squamosal on this face. The process does not meet the outer edge of the pterygoid in specimen 14098, but comes very close to it and probably does touch in some specimens (see Fig. 9). The upper half of the anterior face of the quadrate is free, but the lower half carries a strong articular face for the outer projection of the quadrate process of the quadratojugal. The inner half of the posterior face has a strong articulation with the process from the pterygoid. The edge of the bone between the face for the pterygoid and the outer process of the quadratojugal attachment is thick, in specimen 13810 six millimeters in the thinnest part, concave and rough for the attachment of cartilage; it stands out abruptly from the anterior face of the pterygoid. The outer half of the posterior face is also rough for cartilaginous attachment and ends in a point at the inner extremity, where the upper (quadratojugal) and the posterior (pterygoid) faces come together. The lower face, which is nearly flat, broader externally, and narrower internally, gives a firm surface for the articular (see Figs. 17–19).

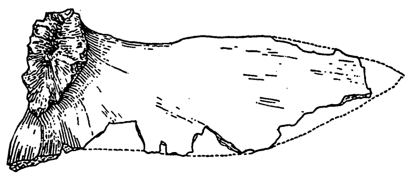

FIG. 15. Lower surface of a right quadratojugal, number 13806. $\times \frac{2}{3}$

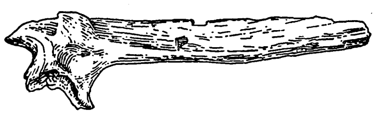

FIG. 16. Outer surface of a right quadratojugal, number 13806. $\times \frac{2}{3}$

Pterygoid. — There are five isolated, more or less complete, pterygoids. There is little to be changed in the description of the pterygoid previously given. The canal running forward in the exoccipital passes into the pterygoid portion of the floor of the brain case, but after a short distance breaks up into smaller canals. There is no evidence that it connects with the canal in the parasphenoid assigned to the internal carotid artery. In the preliminary description the author said (Case, 1931): "The pterygoid portion of the floor [of the brain case] lies within the [pterygoid] rising plate and the epipterygoid. The lower end of the anterior edge of the rising plate is notched, as described above, and from the upper edge of the notch a shelf runs inward toward the opening of the internal carotid artery. This

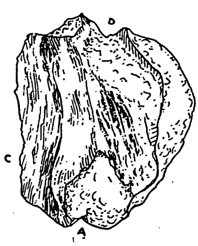

FIG. 17

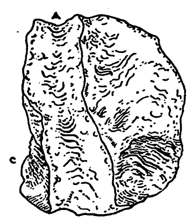

FIG. 18

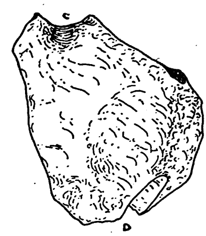

FIG. 19

FIG. 17. Anterior (left side of figure), upper and part of the posterior face of a right quadrate, number 13810. × 1

FIG. 18. Posterior face (right side of figure), the free edge for cartilage between *a* and *b*, part of the face for the outer prong from the process of the quadratojugal. Same specimen. × 1

FIG. 19. Lower face, same specimen. × 1. All figures are so placed that 18 and 19 come into view if 17 is rolled forward toward the observer. *a*, *b*, *c*, and *d* mark the same points in all the figures

shelf is perforated by a foramen which opens into a much larger one below the shelf. The common canal leads into the body of the bone and may communicate with the canal in the exoccipital." The isolated pterygoids, which permit examination because of fortunate breaks, show that the foramen above the shelf does not communicate with the space below, but leads directly into the cavity of the bone; the space below the shelf does not terminate in a foramen, but is closed, with the possible exception of minute nutrient foramina. On the outer side and a little in front of the opening of the space below the shelf several of the pterygoids reveal a small rugosity just where the epipterygoid is connected, which probably aided in its cartilaginous attachment (see Fig. 20).

Parietal. — There are five complete, isolated parietals and a pair of incomplete ones. All show the pineal foramen much larger on the lower surface than on the upper. A ridge begins near the center of the posterior edge, passes outside the foramen, and then runs obliquely inward until it reaches the inner edge at about the midlength of the bone and lies adjacent to the ridge on the bone of the opposite side. In one specimen this ridge reaches a considerable height just anterior to the foramen.

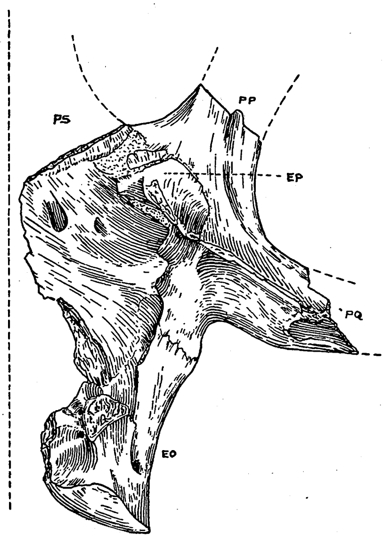

Fig. 20. Upper surface of right half of the floor of the brain case, number 14098. × $\frac{2}{3}$. EO, exoccipital; EP, epipterygoid; PP, palatine process of pterygoid; PQ, quadrate process of pterygoid; PS, parasphenoid

Epipterygoid. — A single imperfect epipterygoid of the left side, number 13787, was recovered. The upright portion is complete, but the lower horizontal plate had been broken away; removal of adherent matrix shows the broken edges. A small foramen appears on the outer side of the broad lower end, and two or three small foramina occur on the inner side; comparable foramina are not present on the epipterygoid in number 14154, in which the bones are complete and in position.

Lower surface of the skull. — The several complete skulls permit a very satisfactory determination of the lower surface. Figures 6–7, and also 3–4, Plate I, represent the lower surfaces of skulls numbered 13050 and 13823. The several illustrations show the variations in the skulls and confirm the preliminary illustration (Case, 1931). In number 13823 a root unfortunately grew through the skull and decayed and disturbed somewhat the supratemporal, the pterygoid, and the right side of the basis cranium, but they are intact upon the left side. The right quadrate has slipped a little, mesially, from its true position and the quadrate process of the left side has been crushed and lost. These parts are mutually corrective from the two sides and can readily be readjusted. The sutures of the antorbital region may now be placed with certainty. The relations of the pterygoid and transverse are as originally figured, but it is shown that the pterygoid extends behind the transverse to meet the jugal and the maxillary. The suture between the palatine and the transverse is opposite the center of the orbit, but runs forward and outward rather than directly outward, as figured in 1931. The pterygoid extends nearly to the anterior edge of the transverse. The suture between the palatine and the maxillary runs directly forward to the palatine tusk, passes outside it, and then turns inward to the edge of the nares. The suture between the vomer and the palatine runs from the posterior inner corner of the nares backward and inward to the palatine vacuity. The palatine carries the posterior end of the series of small teeth which crosses the vomer mesial to the narial opening. The suture between the vomer and the maxillary rises near the anterior outer corner of the narial opening, leaving a portion of the outer edge of the opening to be formed by the maxillary. The suture runs forward outside the vomerine tusks, but close to them, to the edge of the anterior pits. The vomers form the posterior edge of the pits and join the premaxillary by a directly transverse suture. The series of vomerine teeth runs transversely from the midline outward to near the tusk, bends around it on the inner side, and passes backward to the anterior inner corner of the narial opening, clinging to the edge of the opening for its full length and then crossing the vomero-palatine suture to continue on the palatine. In specimens 13820 and 1054 M.C.Z. the vomerine teeth are separated by a considerable space in the midline; in 13823 they nearly meet; in an anterior half of a skull, number 14262, they are separated by a small space. This seems a variable character. The vomers meet each other in the median line for a short distance and then diverge around the anterior end of the parasphenoid, extending backward on the edges of that bone to a point posterior to the center of the orbit.

The edge of the vomer posterior to the teeth in the median line was described as separated by a space from the anterior end of the parasphenoid which, in number 13055, appeared to rise in the skull. This point is not clear in skull number 13823, but in others the separation and the presence of a vacuity is very evident.

Sclerotic plates. — In cleaning skull number 13823 a large number of small, irregularly rounded bits of bones were encountered in the region of the right orbit. Careful examination revealed that these were not accidental splinters; each one showed a thicker center and a gradual thinning toward the periphery. A few were found which seem to be in some sort of a continuum, but this is perhaps accidental. No such elements were found on the opposite side of the skull, nor in the other skulls. As nearly as can be determined these are complete elements and are in the proper position for sclerotic plates. It is not surprising that such elements should not be preserved, since they occur so commonly in the Stegocephalia and frequently in the form of a mosaic of small scutelike bones (see Plate II, Fig. 5). Dr. Edinger (1929) has summarized the occurrence of sclerotic plates.

Lower Jaws. — There are eight lower jaws in the collection. Four are complete, numbers 13823 and 13944 of the left side and numbers 1056 M.C.Z. and 13947 of the right side. Number 13823 was associated, and in position, with the skull of the same number. Numbers 12970 and 13945 are anterior halves of jaws of the left side; number 13949 is the posterior half of a left jaw; number 13948, a posterior half of a right jaw. From this material all details can be made out. Only the one jaw, mentioned above, can be definitely associated with a skull, but all were found very close to the complete skulls, numbers 13823, 13820, and 1054 M.C.Z., and the half-skull number 13822.

All the jaws have been crushed in the region of the Meckelian cavity, and somewhat fractured, but with little displacement, and comparison of the different specimens permits certain distinction between cracks and sutures wherever the latter are in doubt.

Articular. — In specimen 13823 the nodular articular is preserved; in specimen 13944, its lower portion. In all the others which show the posterior end this element has disappeared. The author has previously reported the presence of the articular in two specimens from Crosby County, Texas (Case, 1922). The element fitted loosely and with much cartilage between the prearticular and the surangular; it was quickly freed from its attachments by decay. It was wedge-shaped below, lying between the two supporting bones; the upper surface is concave and extends forward to the middle of the cotylus (see Fig. 21). This bone has been described with the same form and relations in *Koskinodon,* by Branson and Mehl (1929).

Prearticular. — This is visible on the inner face of the jaw only, except for a portion of the upper edge which forms the inner border of the cotylus and may be seen from the outer side. The posterior end (see Fig. 21) does not reach the posterior end of the jaw, but terminates as the border of a cavity further outlined by the angular. This cavity was evidently filled by a cartilaginous plug, since the borders of the prearticular and angular outlining it are rugose and striate. The cavity occurs in all specimens, the largest as well as the smallest, showing that the presence of the cartilage was a persistent, not a juvenile, character. Between the divergent faces of the two bones the lower end of the articular may be seen ending in the form of a wedge. The upper edge of the prearticular forms the inner border of the cotylus and, anterior to the cotylus, the major portion of the inner edge of the upper Meckelian opening. Anteriorly the prearticular joins coronoid I in a suture which runs obliquely downward and forward to the upper edge of the lower Meckelian opening. The lower edge lies upon the angular. The suture between the two runs almost straight forward to the posterior edge of the lower Meckelian opening.

Coronoid I. — This joins the prearticular as described. It forms the inner and outer borders of the anterior end of the upper Meckelian opening (see Fig. 21), and joins the surangular on the upper and outer side; on the inner side the upper edge runs forward horizontally for a short distance and then obliquely downward and forward to meet the lower edge in a point. The

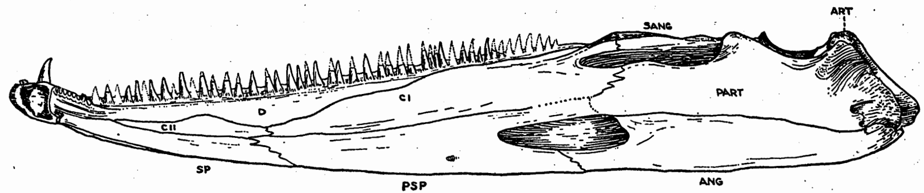

FIG. 21. Inner side of a right lower jaw, number 13823. × ⅓

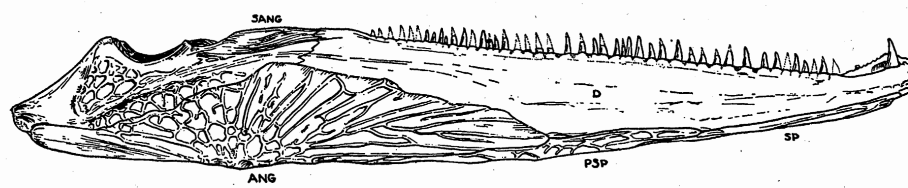

FIG. 22. Outer side of the jaw shown in Figure 21

EXPLANATION OF LETTERING

ANG, angular; ART, articular; C I, coronoid I; C II, coronoid II; D, dentary; PART, prearticular; PSP, postsplenial; SANG, surangular; SP, splenial lower edge meets the upper edge of the postsplenial, which runs almost directly back, terminating in contact with the prearticular.

Coronoid II. — This small bone lies between the dentary and the splenial. It ends in a sharp point anteriorly.

Splenial. — This forms the lower border of the anterior portion of the jaw and appears on both the inner and outer faces. Its anterior end reaches nearly to the symphysis.

Postsplenial. — This forms the lower border of the jaw from the posterior end of the splenial to a point opposite the middle of the lower Meckelian opening. It occupies only a small space on the outer surface of the jaw, but is there marked by strong linear rugosities. The inner portion expands posteriorly, closing

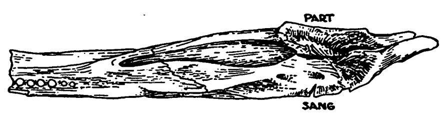

FIG. 23. Upper surface of the posterior half of a left lower jaw, number 13949. × ⅓. The articular absent. Lettering as in Figures 21 and 22

the anterior end of the lower Meckelian opening and forming much of its upper and lower borders.

Dentary. — This has a wide upper edge, forming a shelf with the teeth confined to the outer border. The symphysis between the bones of opposite jaws was cartilaginous. The outer surface is somewhat roughened, but does not carry any of the sculpturing of rugose ridges so strongly developed on other bones (see Fig. 22).

Angular. — This forms much of the posterior half of the outer face. The sculpture of irregularly radiating lines originates on the lower edge at a point opposite the middle of the upper Meckelian opening (see Figs. 22–23).

Surangular. — This forms the posterior angle of the jaw and the outer border of the cotylus and much of the outer border of the upper Meckelian opening. The part forming the posterior portion of the cotylus flares outward, forming a surface for contact with the articular similar to, but larger than, the face for the articular upon the prearticular.

Sensory groove. — This lies upon the surangular above the contact with the angular, then runs along the suture between the angular and the dentary, and then straight forward on the dentary.

Teeth. — In the most nearly perfect jaw, number 13823, thirty-three teeth are preserved; with allowances for vacancies, there were at least forty-five. There is a single enlarged tooth, near the symphysis; this is preceded by one or two smaller teeth. The teeth are rather oval in section, with the longer diameter transverse to the jaw, which is especially notable in the younger teeth. The lower portion of the crown is marked by definite vertical striations, but these become less pronounced near the apex, in correlation with the less complex folding of the dentine. The outer edge of the dentary rises above the alveolar platform, and the teeth are attached to it, pleurodont.

One of the characteristic features of the species, perhaps of the genus, is the presence of a row of teeth on the inner edge of the dentary just opposite the enlarged tooth. The series consists of from eight to ten teeth somewhat smaller than those of the main dentition. It extended from the symphysis, or near the symphysis, backward in a curve conforming to the outline of the anterior end of the jaw. The series starts and ends abruptly on the smooth surface of the bone.

Structure of the teeth. — The finer structure of the teeth is typically labyrinthodont. Figures 1–2 of Plate III are a photograph and a diagram of a section of a large tusk from near Amarillo, specimen 13972, probably of *B. perfecta,* taken from near the middle of the height. Figures 3–4 of Plate III are a photograph and a diagram of a section of a lower tusk of *B. bakeri,* specimen 13975, near the base, and Figures 5–6 of Plate III are a photograph and a diagram of a section of one of the smaller teeth of the same jaw, nearer the apex. All the photographs were taken from polished surfaces by reflected monochromatic light. As will be seen from the tracings of the course of the folds, the pattern is very similar in all of them. That of the larger tooth, number 13972, is closer, and the infolds are much more numerous, being about sixty; that of number 13975, though apparently nearer the base, is more open and there are thirty-two infolds. It is possible that the section of the first is nearer the base than realized because it is obvious that the infolds start at the base and grow upward.

In the section of a small tooth, number 13975, taken nearer the apex, the infoldings are fewer, being only twenty-seven, and of these many are incipient; a section taken close to the apex shows only a few simple infoldings. It is possible that number 13972 reveals another specific difference from *B. perfecta* in its more complex folding. The illusory appearance of regularity in the pattern led to repeated attempts to discover some law in the infolding, but this could not be carried beyond a point of mere approximation.

Axial skeleton. — There are forty-five vertebral centra preserved. These were scattered through the bed and none can be associated with other bones. An axis, number 13792 (see Plate IV, Figs. 1–2), with the neural arch and spine perfectly

FIG. 24. Left side of a neural arch, number 14205. × $\frac{2}{3}$

FIG. 25. Posterior face of the same neural arch. × $\frac{2}{3}$

preserved, shows two deeply concave faces for the condyles of the skull and a single posterior face, shallow and transversely oval. Neither face has any trace of the notochordal pit or groove, which is an obvious feature in most of the other vertebrae. There is no facet for rib attachment. The spine is short, inclined backward, and terminates in a blunt distal end. The apex is depressed, and this depression continues on the posterior face of the spine, probably for a strong cartilaginous attachment. A single neural arch, number 14205 (see Figs. 24–25), was found. This is very similar in form to the three neural spines, number 10155, associated with centra, found near Amarillo, but much smaller. The distal end of the spine is wide and concave, and roughened for cartilaginous attachment. The sides of the arch flare out broadly, with no indication of attachment to the ribs. The faces applied to the centrum show the presence of a considerable mass of interarticular cartilage. There are large anterior zygapophyses with nearly flat surfaces looking almost directly upward. Queerly enough, there are no posterior zygapophyses corresponding to the large anterior ones, though the arch is complete. The neural canal is relatively large.

There is one caudal vertebra with the bases of the haemapophyses attached. This differs materially from the abundant dorsal vertebrae in that the outline in side view is triangular, the lower portion broad antero-posteriorly, and the upper portion drawn almost to a point (see Plate IV, Fig. 3). The major obliquity is on the upper half of the posterior face; the lower part of each of the faces is nearly vertical. It seems certain that there must have been an upper posterior element, or pair of elements, the interdorsals (pleurocentra). This is the condition found in the caudal region of *Mastodonsaurus* by Huene and figured by him (Huene, 1922, p. 403, Fig. 2). In the same paper (p. 427, Fig. 30) he describes three such vertebrae, with pleurocentra in position, found in association with an interclavicle of *Plagiosuchus pustuliferus* Fraas. This specimen was originally considered part of the vertebral column of a rhachitomous form. Huene ascribes it to the caudal region of a stereospondylous form and remarks upon its value as indicating the derivation of the latter. It is apparent that a similar condition existed in the caudal region of *Buettneria*. There is no indication of rib attachment on the centrum. The articular faces are concave, and there is a distinct notochordal canal which is open above, with irregular edges showing that the notochordal canal and the neural canal were separated by cartilage.

The haemopophyses rose from the whole length of the lower face, but the anterior edge is sharply oblique backward and downward, so that the haemopophysis lay below the posterior half of the centrum and probably extended back below the succeeding vertebra. The haemal canal was oval and large. The base of the centrum is excavated between the branches of the haemopophysis and the lower edges of the anterior and posterior faces of the centrum, forming a pit of considerable size. There is a single imperfect fragment of a haemopophysis, number 13779, which shows that the element terminated in a long distal spine.

There is another isolated element, number 13780, of uncertain position, which may be interpreted as a haemopophysis.

The two proximal halves are heavy and rough, indicating cartilaginous attachment. The canal was relatively narrow. The two halves unite in a spine, narrow-oval in cross-section. At the opposite extremity, anterior probably, there is a small spine.

A single, very small and imperfectly ossified centrum shows the presence of a notochordal canal unclosed above (see Plate IV, Fig. 3). This has the appearance of coming from a very young or even an embryonic individual.

Most of the dorsal centra, which form the bulk of the collection of vertebrae, show a distinct notochordal pit, and many of them the trace of a channel connecting with the neural canal, which evidently closed late in life. This seems peculiar to this species, since it is not found in any of the numerous centra from other localities in the Triassic of Texas now in the possession of the Museum of Paleontology of the University of Michigan.

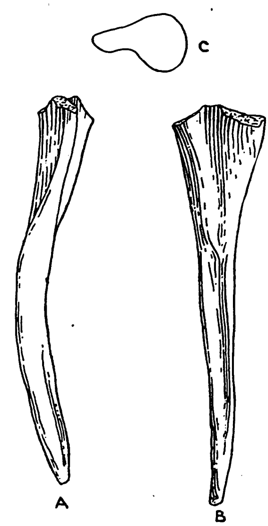

FIG. 26. A rib, number 13776. × $\frac{2}{3}$. *A*, lateral view; *B*, horizontal view; *C*, outline of proximal end

Of the numerous dorsal centra of different sizes and thicknesses six or eight are distinctly convexo-concave. The remainder are biconcave; a few are transversely oval, but most are circular in outline. All but a few, which have suffered by erosion or decay, show a distinct facet for the ribs continuous with the posterior face, and but slight, if any, evidence of extension to the anterior face. It is impossible to allocate the dorsal vertebrae to any definite position in the vertebral column (see Plate IV, Fig. 3).

Ribs. — There are six complete ribs, numbered 13776, and twelve nearly complete, numbered 13788, besides several less nearly perfect specimens. All have a slight curve, but not enough to suggest an approach to an inclosure of the thorax. The proximal end is heavy, with a distinct division into a larger anterior (?) portion and face and a narrow posterior (?) portion and face; the two faces are, however, continuous. The head narrows rapidly to a slender shaft terminating in a blunt end with a face for a cartilaginous continuation, or in a sharp point. There are decided variations in the length and shape of the shaft and termination, but, since it is impossible to assign the various ribs to position, any detailed description would be useless (see Fig. 26).

There is a unique element included under number 13788 as a possible rib, which may belong elsewhere, but it is so different from anything before recorded that its position is most uncertain. One end, apparently the proximal, is divided by a deep

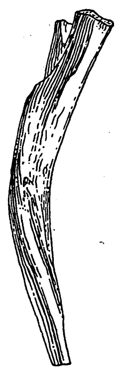

FIG. 27. Lateral view of unknown element, number 13788. × $\frac{2}{3}$

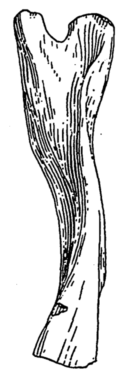

FIG. 28. Horizontal view of the same bone. × $\frac{2}{3}$

notch into two distinct heads, with ends for cartilaginous attachment (see Figs. 27–28). The shaft is flattened and slightly curved. The concave face is smooth; there is a strong ridge on the convex face, rising to its maximum height in the middle of the shaft and disappearing on its flattened distal end. It is so unlike the ribs that it hardly seems possible to place it among them, but it seems equally impossible to place it elsewhere.

Singularly, no bones that could be interpreted as scapula, coracoid, ischium, or pubis were found in the abundant material; six complete bones and several incomplete ones are in all probability well-formed ilia with good surfaces for attachment to ischium and pubis. A single fragment unlike any other found may be the distal end of a scapula-coracoid or of a pelvic element, but this is uncertain. It seems, a priori, improbable that there was no more complete ossification of the elements of the girdle, especially if there were well-formed ilia and since there are well-ossified limb bones, but in the extensive collections from Texas in the Museum of Paleontology, there is no certain evidence of such bones, and none has been reported by workers on similar material from other regions.

Branson and Mehl (1929) in their description of the specimens from Lander, Wyoming, comment on the absence of bones of the girdles and limbs and suggest the possibility of these stegocephalians being limbless. Their comments are well made, for it is surprising that no trace of either the limbs or girdles,

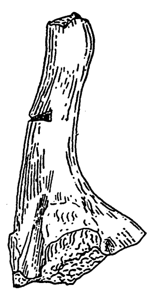

FIG. 29. Outer view of an ilium (?), number 13789. × $\frac{2}{3}$

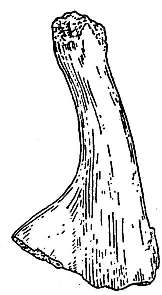

FIG. 30. Inner view of the same bone. × $\frac{2}{3}$

other than a single femur originally mentioned as a humerus (Case, 1922, p. 25) and a probable ilium, had been found before the expedition from the Museum of Paleontology to the Triassic beds in Scurry County, Texas, in 1930. The author has recently described (Case, 1931) two humeri from the beds near Amarillo, and the excavation in Scurry County has brought together many more limb bones. Of the girdles only a single element, represented by six complete specimens, number 13789, and two incomplete ones, and an incomplete specimen of another element, can be referred to the girdles. All the bones of the arm and leg and some of the phalanges are represented.

Ilium. — Six complete specimens closely resemble the bone figured by Branson and Mehl as a possible ilium. As shown in Figures 29–30, there is great probability that their assignment was correct, but this makes the absence of any trace of an ischium or pubis even more puzzling. The blade is slender and not expanded at the upper end; there is no facet for attachment of a sacral rib; most of the specimens show a sudden and decided flattening of the upper end, and there is a definite flattened space on the inner side, but in two specimens this is marked by the extension upon it from below of a rugose ridge, and in three others the space is without a ridge; in one the flattening is absent or nearly so. None show any roughening of this space. If there was any attachment to a sacral rib, it must have been slight and loose.

The lower end of the bone, as described by Branson and Mehl, is thickened and expanded, presenting a broad and strong

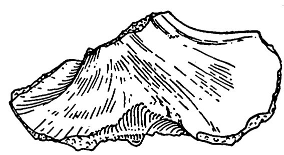

FIG. 31. Inner (?) view of a pubo-ischium (?), number 13786. × $\frac{2}{3}$

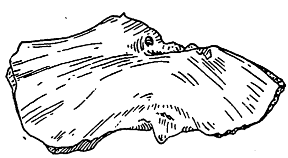

FIG. 32. Outer (?) view of the same bone. × $\frac{2}{3}$

face for attachment to some other element or elements. The face is concave and rough, indicating a strong cartilage. There is no division into two faces by the presence of distinct facets. On the outer side there is a strong oval face roughened as for cartilage. This has all the appearance of a portion of a cotylus for the femur; it is more prominent at the upper end, as if it served as a buttress to receive the thrust from the femur. Assuming this to be so, the lower edge of the bone is heavier behind, in the place for the ischial attachment, and narrower anteriorly, the place for the pubic attachment. If these bones are in reality ilia, as seems probable, the pubis and the ischia must have been cartilaginous, since some trace of them would certainly have been found in the abundant material recovered had they been resistant enough to become petrified.

A single imperfect element, number 13786, was recovered in 1930. This is shown in Figures 31–32. The portion preserved is a fairly thin oblong plate, with evidence of a cartilaginous attachment on the lower (?) edge. The upper (?) portion shows the broken surface of a continuation of a (probably) narrow blade. At the base of the blade is a strong groove coming in from one side and terminating opposite the middle of its base. There is no evidence of a symphysial attachment of the plate to one of the opposite side. It is not possible to assign this element to its position with certainty. Although it cannot be adjusted to the ilium (?), it is tentatively regarded as a possible ischium or pubo-ischium.

Humerus. — There is one complete humerus of the right side, number 13775, and an imperfect one of the same side, num-

FIG. 33 FIG. 34 FIG. 35

FIG. 33. Posterior view of a right humerus, number 13775. × $\frac{2}{3}$
FIG. 34. Anterior view of the same bone. × $\frac{2}{3}$
FIG. 35. Lateral view of the same bone. × $\frac{2}{3}$

ber 13772. These resemble very closely the specimen from near Amarillo recently described (Case, 1931), but are smaller and less pronounced in every way. The articular ends are depressed and roughened, indicating a greater proportion of cartilage. The deltoid ridge is slender, with a slight expansion and rugosity of the lower end, and the entepicondylar process is much less prominent. The radial prominence is evident, but there is no condylar development, the extremity of the process being concave and evidently filled with cartilage during life (see Figs. 33–35 and Plate IV, Fig. 4).

Femur. — There are three femora preserved under the number 13773, the smallest just about half the size of the largest. The two larger are probably from the left side; the smallest is probably from the right side. There is no decided head, and there is but a slight rugosity near the proximal end on the posterior surface. The distal end is flattened antero-posteriorly and the distal face divided by a broad, shallow groove on the anterior face into a broader, inner (tibial) portion and a narrower, outer (fibular) portion. The proximal and distal faces are elon-

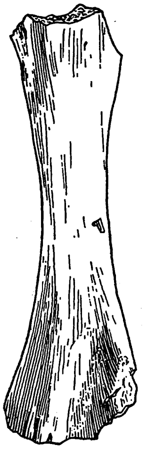

FIG. 36. Anterior view of a left femur, number 13773. × $\frac{2}{3}$

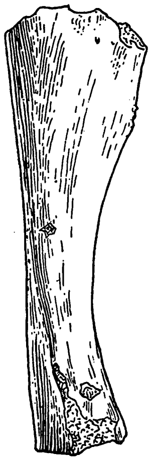

FIG. 37. Lateral view of the same bone. × $\frac{2}{3}$

gated practically at right angles to each other. There are no ridges or areas of rugosity except those near the proximal end. The muscular attachments were apparently weak. The smaller femur is less well marked. The proximal face is nearly circular and the distal end has a pronounced low ridge in the middle of the anterior face; evidently the shape of the bone changed materially with age (see Figs. 36–37). Two much larger femora from the bone bed have been previously described and figured (Case, 1931).

Ulna. — Four bones, number 13774, are probably ulnae. The proximal end of each is expanded with an oblique face, suggesting the usual attachment to the humerus. There is no distinct articular face nor any suggestion of an olecranon process. The distal end is much smaller, with the face elongate in the same direction as that of the proximal end (see Fig. 38).

Radius. — Four very slender bones, number 13784, with slightly expanded ends, are regarded as probable radii. The two ends of each bone are of nearly the same size, and the whole bone is a featureless rod. The specimens are too large to be metacarpals or metatarsals and hence are tentatively assigned as radii (see Fig. 39).

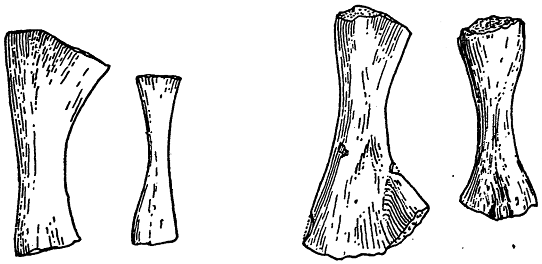

FIG. 38 FIG. 39 FIG. 40 FIG. 41

FIG. 38. Ulna, number 13774. × $\frac{2}{3}$
FIG. 39. Radius, number 13784. × $\frac{2}{3}$
FIG. 40. Fibula, number 13781. × $\frac{2}{3}$
FIG. 41. Tibia, number 13782. × $\frac{2}{3}$

Fibula. — Two bones, number 13781, are apparently fibulae of opposite sides. The proximal end of each is flattened with a narrow, transversely elongate face. The whole shaft is flattened. The outer half of the distal end is nearly horizontal, but the inner half is oblique. The whole distal end is concave posteriorly and convex anteriorly, and the face is set at a slight angle to the proximal face (see Fig. 40).

Tibia. — A single bone, number 13782, seems to be a tibia. The proximal end is enlarged into a very broadly oval shape. The distal end is flattened and obscurely divided into two faces set at a very low angle to each other (see Fig. 41).

Metapodials. — Two very small bones, number 13785, are regarded as metapodials or phalanges. The larger is twelve millimeters long, the smaller seven. They are simple, flattened rods, with slightly expanded ends, terminating in faces for cartilaginous attachment. There seems no reason to regard these as immature or embryonic specimens of the proximal limb bones.

It is apparent that all species of *Buettneria*, as well as the contemporaneous allied genera of Stegocephalia, were provided with weak limbs, comparable to those of *Metoposaurus*. The absence of girdle bones suggests a cartilaginous condition of the pectoral and pelvic elements, except the ilium and perhaps the pubo-ischium. It would be indeed surprising if in all the collections from the American Triassic some trace of these elements should not have been found had they been ossified sufficiently to permit petrifaction, but the collector who deals with the Triassic soon becomes hardened to the unexpected in either the occurrence or the absence of material.

Interclavicles. — There are twelve interclavicles complete or so nearly so that they permit comparative measurements. These were all closely associated with the other material in the bone bed. The form is shown in Plate IV, Figures 5–6, and Plate V.

The extreme periphery of the portions which articulated with the clavicles is almost paper-thin, and was only partly saved. In laying bare the specimens in the quarry preparatory to treatment the slightest disturbance caused the thin edges to break into minute fragments. Such portions as were successfully laid bare were shellacked and then reënforced by pasting long-fibered Japanese rice paper to the specimen with shellac. This saved many parts which at first it seemed impossible to collect.

Specimens 13027, 13029, 13905, 13910, and 13912 are very nearly perfect; specimens 13906, 13907, 13908, 13911, 13913, 13914, and 13915 show all or the larger portion of the sculptured area, i.e. the portion not covered by the overlapping clavicles.

At first glance there seem to be easily recognizable differences that would warrant placing the bones in two or more distinct species, especially if they had been found at remote localities or at different levels. With more careful study, and by means of comparative measurements as given below, it is found that the differences are really minor, and the group serves as an illustration of the ease with which individual differences may be interpreted as of specific value.

There is a recognizable difference between a broader and a narrower form, as is well shown in specimens 13027 and 13028

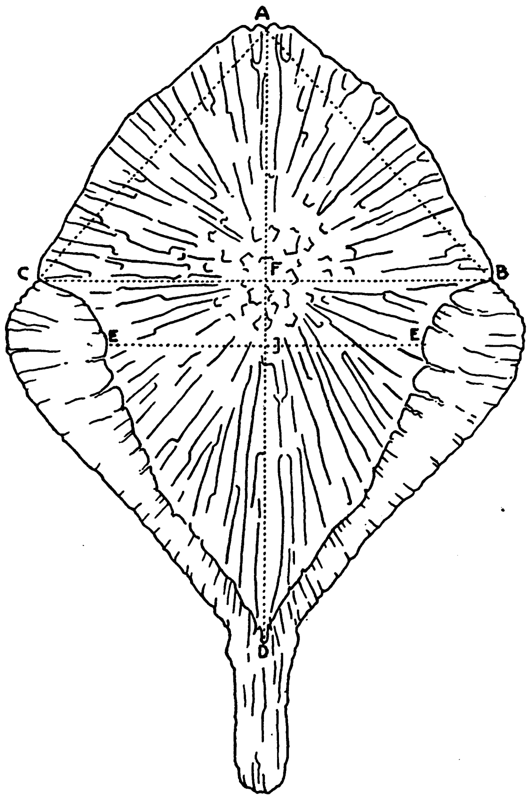

FIG. 42. Outline of an interclavicle, showing dimensions and angles used in comparative measurements

and almost as well in 13906 and 13910, but, as indicated by the measurements, there are intermediate stages making a very good series.

The most obvious differences are in the contour of the sculptured area. The angle formed by drawing lines from the edge of the sculpture at the posterior end of the clavicular facets to the apex of the posterior end, angle *CAB* in Figure 42, is very nearly the same in all the specimens, but the contour of the bone along the lines *A–C* and *A–B* is markedly different in different specimens. It is most notable in comparing specimens 13907 and 13910, in which the contour is most regular, with specimens 13906 and 13908, in which there is a sharp convexity in the middle of the outline.

The ratio of the length of the sculptured area, *A–D*, to the greatest breadth of the sculptured area, *C–B*, differs only a little, but the ratio of the length to the portion anterior to the center, *A–D* to *A–F*, differs more, i.e. the posterior end is more extended in some than in others. Compare specimen 13906 with 13908.

The contour of the sculptured area on the anterior edges, *C–D* and *B–D*, is different. In most the posterior end of the edge for attachment to the clavicle is notably indented and the remainder is nearly straight to the anterior end, *D*, but in some, as in specimen 13912, this indentation is almost absent. The edge of the sculptured area posterior to the indentation is nearly straight in most, but clearly convex in some and concave in others.

The sculpture is reticulate near the center, *F*, extending posterior and lateral to this point much more than anterior to it. This reticulation changes to a sculpture of nearly linear radiating ridges and grooves toward the edges of the bone. It is apparent that the area of reticulated sculpture is larger in some than in others. Measurements are difficult because of the indefinite boundary, but on comparing the diameter of the reticulate area as nearly as can be determined with the breadth *C–B*, there is found to be a difference in the ratios of nearly 33 per cent. A slight difference in estimation or measurement would alter this materially.

It is apparent that the differences are largely those of contour and sculpture, which are just such as would be most responsive to individual variation. The proportions vary far less.

It would be idle to discuss the reason for these differences.

It is easy to eliminate any accidental causes, since most of the specimens have not suffered from fracture or distortion, and ample allowance may easily be made for the breaks and mending. The similarity in size makes it highly improbable that the variations are due to age, but in the smallest, specimen 13912, it seems impossible that the contour could have changed into that of the largest. There is nothing that would suggest difference due to sex, and the series does not permit of breaking up into two groups that could be so assigned. It seems fairly obvious that the group of approximately equal size illustrates a rather wide range of individual variation which might easily lead to the error of false specific distinction.

In contrast with the material from Snyder is a specimen of approximately the same size from Crosby County, which has been called *Buettneria sp.* This specimen, number 7368, as figured in Plate VII, Figure 1, is notably shorter, posterior to the central point, *A–F*, than *B. bakeri;* the contour of the articular edge for the clavicle lacks the indentation almost entirely. The differences shown by this specimen may be sufficient to indicate a distinct species. See the tabular statement of measurements below and the consideration of their significance.

Clavicles. — There are twelve clavicles from the bone bed, five from the right side and six from the left. Specimens 13824, 13898, 13902, and 13903 are perfect; the others, 13208, 13825, 13896, 13897, 13899, 13900, 13901, and 13904, are nearly so. The thin inner edge and the thin buttress of the cleithral process are broken and somewhat imperfect in several specimens.

The most striking point about these clavicles is the very clear impression of a sensory canal, similar in all respects to the impressions of sensory canals upon the skull. This is traceable upon all the clavicles and is very distinct on most of them; it is also present upon a small right clavicle, number 13943, from the vicinity of Amarillo, Texas. The occurrence of any trace of the sensory canals upon the clavicles of the Stegocephalia has not, to the author's knowledge, been previously observed. The recognition of their presence led to a search for similar occurrences upon the many larger clavicles from different localities in Texas, and faint traces were found on some, as on specimen 12887, but not on others. It was apparently obsolescent in the larger forms.

The groove appears near the inner border of the posterior edge, running outward toward the outer border and then turning forward to disappear about the middle of the length of the bone, where the reticulate sculpture becomes linear. It is very clearly shown in Figure 43 and in the figures of Plate VI.

The significance of the presence of well-developed sensory canals on the ventral surface of this species, *B. bakeri*, and its absence or reduction in larger forms, is not apparent. There

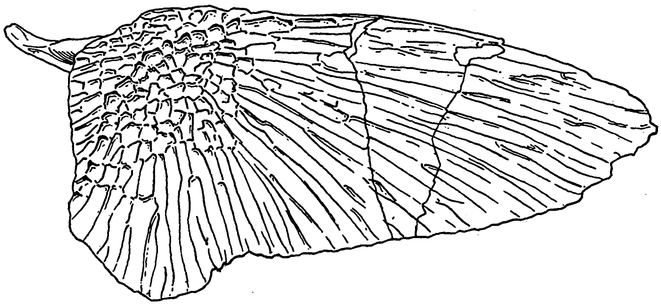

FIG. 43. Right clavicle, number 13898, showing course of sensory groove. $\times \frac{2}{3}$

is a branch of the sensory system ventral to the pectoral limbs in the larval salamander, which is a swimming form and which has not the pectoral region closely pressed to the ground, as has the adult salamander and as the heavier, weak-limbed Stegocephalia must have had. Perhaps the presence of the groove is indicative of a more persistent aquatic life in *B. bakeri*.

The reticulate sculpture is confined to the posterior outer surface and passes into a series of linear radiating grooves and ridges toward the anterior and inner edges.

The linear ornamentation is somewhat different in the series; in some, as in specimens 13824 and 13903, the distal ends of the ridges near the outer edge are bent sharply outward; in others they continue almost straight to the anterior ends. There seem to be all gradations between.

The outline of the bone is rather more obviously different from that of the interclavicles. Specimens 13824 and 13903 are nearest the average proportions. Specimen 13028 is notably short and broad (a very minor portion of the shortening may be due to a slight crushing of the anterior end); specimens 13897 and 13900 are notably long and slender. These differences are brought out in the table of measurements and proportions below. The inner edge has an expansion, more or less well marked in different specimens, corresponding to the indentation of the clavicular border on the interclavicles. This expansion is supported by a thickening of bone in the form of a low, rounded ridge running directly outward. The strongest attachment between the clavicles and the interclavicles was in the posterior portion, and the clavicles are the heaviest in this region, where they gave origin to muscles actuating the forelimb.

The cleithral buttress begins anterior to the middle of the outer edge and rises obliquely to full height and then runs backward, with an almost horizontal edge, to the origin of the free cleithral process. The latter extends backward and slightly downward in a gentle curve. The apex is roughened for the attachment of a ligament. The whole buttress is very thin and deeply concave on the outer face near its middle portion.

Restoration. — The restoration offered (see Fig. 44) is very provisional, but indicates the general proportions, and such indications are borne out by material from other localities. The proportions are based upon average dimensions of bones taken from the Elkins bone bed. The skull is based upon specimens 13055, 13820, 1054 M.C.Z., and 13823, which have a maximum divergence in length of 23 mm. from nose to posterior edge of the dermsupraoccipital. The proportions of the clavicles and the interclavicles are based on six specimens, the ribs on seven, the humerus on two, the radius on five, the ulna on four, the femur on three, the fibula on two, the tibia on one, and the ilium on six. The dimensions of the vertebrae are averaged from a dozen or more. The three femora show the greatest divergence, 46 mm. and 85 mm., with the intermediate one 63 mm. Since it is impossible to allocate any bones of the body

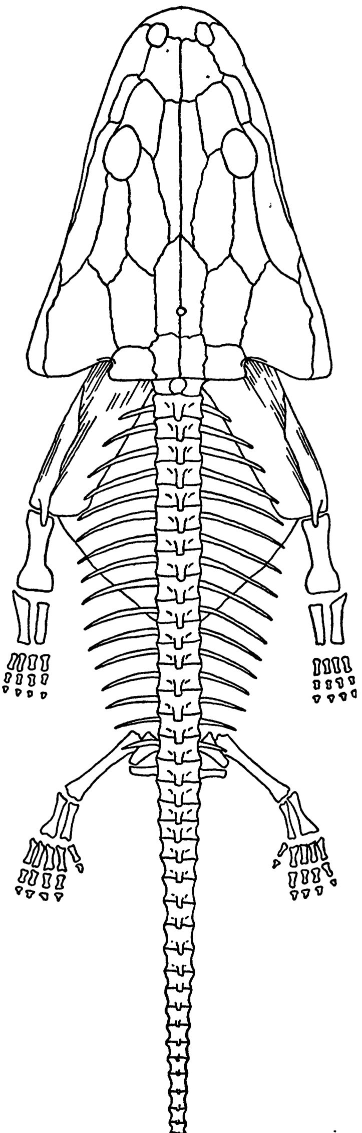

FIG. 44. Attempted restoration of the skeleton of *B. bakeri*, from average measurements

to any particular skull, the restoration can be only approximate, but it serves to show the disparity between the head and the thorax and the length of the limbs. The number of vertebrae and the proportions of the presacral and postsacral regions are taken from Fraas' specimen and restoration of *Metoposaurus.* It is obvious that the feet were of little use except for swimming or for very clumsy attempts at progression on land. The aquatic suggestion is in accord with that made by the presence of the sensory grooves upon the clavicles.

An attempt to determine change of proportions with age meets with only partial success, but is very striking in one or two trials. If we arrange the skulls in a series according to length and compare the proportional distance from the posterior edge of the orbit to the posterior edge of the skull, we have the following results:

Number	Length in mm.	Postorbital length in mm.	Ratio
13822	272	133	1:.488
1054 M.C.Z.	299.5	142.5	1:.475
13055	284	151	1:.531
13820	304	166	1:.546
13823	307	165	1:.537

This is a nearly continuous series showing a progressive lengthening of the skull in the middle portion. Specimen 13822 displays in all proportions noticeable difference from all other skulls. Attempts to show other series have not been satisfactory. The proportions of width and breadth are vitiated by the different degrees of crushing and consequent flattening and broadening of the posterior region. It would seem that the length of the palatine vacuities should reflect the changing proportions, but the results are not entirely satisfactory:

Number	Length in mm.	Length of palatine vacuity in mm. *	Ratio
13822	272	139	1:.511
1054 M.C.Z.	299.5	157	1:.520
13055	284	157.5	1:.554
13820	304	161	1:.529
13823	307	160.5	1:.522

* Average of the two sides where possible.

If we neglect number 13822, which is exceptional in proportions, there is a progressive series indicating a proportional shortening of the vacuities with increasing size. Such measurements and proportions when from fossil material so nearly identical in size can be only suggestive, but they do indicate what might be supposed, that proportional changes took place in the process of growth.

No such change in proportions is detectable in the interclavicles.

All the specimens from the Dockum Triassic and, apparently, from the Popo Agie beds of Wyoming show a decided reduction of the osseous walls of the brain case. This progressive secondary chondrification is probably but a part of the evolutionary trend which resulted in the reduction of the limbs. Comparison of the upper Triassic stereospondylous Stegocephalia with those of the Permian and Carboniferous indicate how far this process had gone. Proportional to its size, *B. bakeri* shows the same compensation for the loss of cranial walls in the development of the dermal plates of the skull, jaws, and thoracic shield.

The recovery of such a large amount of fossil material which by all qualitative morphological and associative characters must be assigned to a single species has led to an attempt to apply a statistical test in an endeavor to determine how far the proportional dimensions may be a check upon qualitative characters. The identification of species in vertebrate paleontology is commonly unsatisfactory because of the scarcity of material, the post-mortem and postpetrifactive changes induced by pressure and other distorting agencies, and the lack of information on age and sex. In the case of fossils of reptiles and amphibia, especially, almost every specimen might be honestly described as at least a new species. The opposed procedures of placing together uncertain specimens or separating them upon minute characters of questionable origin are equally unsatisfactory.

It is possible with this collection to show how far individual variation extended in one very coherent group. The obvious criticism that the number of specimens is too small to be determinative is to be answered only by the statement that it is the largest number that has yet become available, and that to double the accuracy the square of the number of specimens is necessary. It is very improbable that such a number of comparable specimens will ever be recovered.

In the tables given on pages 46–51 only the complete or nearly complete skulls, clavicles, and interclavicles have been considered, since these were the only elements found in sufficient number to afford usable measurements. All measurements are in millimeters, and all specimens, unless otherwise noted, are from the one locality and in the collection of the Museum of Paleontology of the University of Michigan.

In interpreting the information assembled in the tables the procedure has been to take measurements of identical dimensions in the various specimens, to calculate the average measurement, and to determine the departure of each individual from the average. Then the average departure has been calculated and reduced to terms of percentages of the average dimension. In a decidedly minor number of instances the measurements have been estimated where a bit of the edge of a bone has been lost or where a fracture may have altered the proper dimension, but the estimates are, in the author's experience, very closely accurate, since the amount added in each case was small and the estimate could be checked by the number of perfect specimens. Because the departures were in only a few cases far from the average departure, and never consistently so in one specimen, it seemed safe to absorb these in the sum total.

As has been shown, there are no certain conclusions to be drawn from comparative measurements in regard to change of proportions with size and presumptive age. Only two series of measurements in the skull show any consecutive change with relation to size. This is perhaps due to the fact that the animals are all of one brood. Could definite age stages be found, the results might be more evident.

Since everything, size as well as conditions of preservation, points to animals of equal age, it is possible to evaluate to some degree the amount of individual variations and to consider its relation to possible specific difference. There can be no question

TABLE I

MEASUREMENTS OF FIVE SKULLS OF *B. BAKERI* AND THAT OF *B. PERFECTA*, THE GENOHOLOTYPE

	13822	M.C.Z. 1054	13055	13820	13823	*B. perfecta* 7475
Length to posterior edge of skull, median line..........	272	279.5	284	305.5	307	386
Length to posterior end of condyle.....	297	315.5	307	328	332	443.2
Greatest width......	232	218	214	238	244	344.2
Width at posterior edge of orbit......	161	159	159	164.5	...	231
Length of orbit { left	36	44	41	43	44	44
Length of orbit { right	...	44	43	43	45	44
Breadth of orbit { left	27.5	26	29	27	29	31.4
Breadth of orbit { right	...	26	29	27	28	31.4
Distance from center of pineal foramen to posterior edge of skull, median line..	50	49	48	55	...	65.7
Distance from posterior edge of orbit to posterior edge of skull, median line } left	133	142	150.5	163.2	163	228.5
Distance from posterior edge of orbit to posterior edge of skull, median line } right	...	143	152	169.6	167	...
Orbitonasal bridge...	56.5	55	59	62	...	65
Internasal bridge....	32.5	33	30	32	...	43
Interorbital bridge...	...	72	71	76	71	111.4
Length of palatine vacuity { left	141	156	153.5	162	157	190
Length of palatine vacuity { right	...	158	161	160	164	190
Bread of palatine vacuity { left	...	51	55	46	59	90
Bread of palatine vacuity { right	...	53	56	58	57	90
Space between vomerine teeth..........	...	3.5	...	13.3	7	3

TABLE II

DEPARTURES FROM AVERAGE MEASUREMENTS IN FIVE SKULLS OF *B. BAKERI*

	Average	Departure from average					Average departure	Average departure percentage
		13822	M.C.Z. 1054	13055	13820	13823		
Length to posterior edge of skull, median line........	290	−18	−10	−6	16	17	13.4	4.6
Length to posterior end of condyle....	314	−17	2	−7	14	18	11.6	3.7
Greatest width.....	229	3	−11	−15	9	15	9.6	3.0
Width at posterior edge of orbit.....	161	0	−2	−2	3.5	...	2.7	1.6
Distance from center of pineal foramen to posterior edge of skull, median line	50	0	−1	−2	5	...	1.6	3.0
Distance from posterior edge of orbit to posterior edge of skull, median line	152	−19	9	1	15	13	9.4	6.0
Orbitonasal bridge..	56.5	0	−1.5	2.5	5.5	...	2.25	4.0
Internasal bridge...	32	0.5	1	−2	0	...	0.9	3.0
Interorbital bridge..	72.5	...	−0.5	−1.5	3.5	−1.5	1.75	2.4
Length of palatine vacuity..........	155	−14	2	2	6	2	5	3.2
Breadth of palatine vacuity..........	54	...	−2	1.5	2	4	2	3.4
Ratio 4 : 1.........	0.565	0.59	0.57	0.56	0.54	...	1.5	2.6
Ratio 11 : 1........	0.525	0.49	0.51	0.532	0.55	0.54	2	3.7

TABLE III

MEASUREMENTS OF THIRTEEN INTERCLAVICLES

	13905	13906	13907	13908	13910	13911	13912	13913	13914	13915	13027	13029	7368 *
A–D †............	207.8	216.5	218.3	206	247.3	242	188	....	....	...	186	214	247.3
Greatest breadth...	178	164.5	169.5	165.7	193.5	191.4	165	152.8	156	166	165	164	175
C–B.............	149.8	137.6	149.6	137.9	172.6	161.8	133.9	134	126	144	136	136.7	166.5
E–E.............	91.5	82.8	95.4	83.9	108	97.3	79.7	76	90.4	...	94.7	96.5	88.5
Angle A..........	93°	88°	86°	78°	94°	84°	85°	80°	90°	89°	86°	85°	94°
Angle D..........	50°	40°	53°	35°	44°	40°	48°	....	....	...	54°	51°	35°
Radius of reticulate sculpture........	37.8	45	40	39	44	33.5	32	32	30	41	35.6	35.6	....

* This specimen is from a different locality.
† Letters refer to Figure 42, p. 37.

TABLE IV

DEPARTURES FROM AVERAGE MEASUREMENT IN THIRTEEN INTERCLAVICLES

	Average	Departures from average												Average departure	Average departure percentage	7368*
		13905	13906	13907	13908	13910	13911	13912	13913	13914	13915	13027	13029			
A–D †.........	214	−5	2.5	4	−8	33	28	−26	..	..	..	−28	0	14	7	247
C–B..........	143	7	−5	7	−5	29	19	−3	−9	17	1	−7	5	9.5	6.7	166.5
E–E..........	91	0.5	−8	5	−7	17	6	−11	−15	0	..	4	6	7.2	8	88.5
Angle A.......	86.5°	6	−1	−1	−9	7	−3	−2	−7	3	2	−1	−2	4.5	5.2	94°
Angle B.......	45°	5	−5	8	−10	−1	−5	3	..	..	..	9	6	5.2	12	35°
Ratio CB : AD	0.684	4	−5	1	0	2	−1	3	..	..	..	5	−4	3.6	5.2	67.3
Ratio AF : AD	0.38	0	−5	1	4	−3	−2	1	..	..	..	4	1	2.3	6	32
Ratio AF : CB	0.548	−2	−2	2	2	−5	−6	−5	4	1	1	3	7	3.3	6	47

* This specimen is from a different locality.
† Letters refer to Figure 42, p. 37.

TABLE V

MEASUREMENTS OF ELEVEN CLAVICLES OF *B. BAKERI*

	13028	13824	13825	13896	13897	13898	13900	13901	13902	13903	13904	Average
Length..........	163	204	186	188.5	196	174.5	191.2	176.5	181.5	206	196	187.6
Breadth..........	87	101	84	82.5	82.5	84	76.2	95.1	93.2	107.5	95	83.5

TABLE VI

DEPARTURES FROM AVERAGE MEASUREMENTS IN ELEVEN CLAVICLES OF *B. BAKERI*

	Average	Departures from average											Average departure	Average departure percentage
		13028	13824	13825	13896	13897	13898	13900	13901	13902	13903	13904		
Length....	187.6	−24.6	16.4	−1.6	1	8.4	13	3.6	−11	−6	18.4	8.4	10.2	5.4
Breadth...	83.5	3.5	17.5	0.5	−1	−1	0.5	−7.3	11.6	9.7	24	11.5	8	9.6

TABLE VII

MEASUREMENTS OF VARIOUS ELEMENTS OF THE SKELETON OF *B. BAKERI*

	Mm.
Length of humeri	
Number 13775	57
Number 13772	69.5
Length of ulnae, 3 specimens	
Number 13774	45.5
	46.5
	46.5
Length of radii, 4 specimens	
Number 13784	34
	32
	29
	25.5
Length of femora, 3 specimens	
Number 13773	85
	63
	46
Length of fibulae, 2 specimens	
Number 13781	49
	35.5
Length of tibiae	
Number 13782	38
Length of ribs, 6 specimens	
Number 13776	80.5
	79.5
	78
	68.5
	64
	64
Length of ilia, 6 specimens	
Number 13789	65.4
	54
	51
	49
	46.5
	42
Vertebrae	
Average length	18
Average breadth	32

but that certain of the skulls and several of the interclavicles and clavicles come within limits of variation in form and proportions which have been used to distinguish species in vertebrate paleontology and which might very reasonably be so used had the specimens been found in different horizons or in localities remote from one another.

Although it must be admitted that the measurement of fossil material cannot be so accurate as that of recent material because of possible error due to fracturing and distortion, the material here described is so nearly perfect that such errors are reduced to a minimum.

If the tables of measurements of the skull are considered, it will be seen that one, number 13822, has noticeable peculiarities in proportions and in appearance, but even if we include this specimen in computing the averages and ratios, as has been done, the average ratios show a maximum of departure of 6 per cent from the average, and this amount in only one proportion. The others are 4 per cent or less. A further study of the table will reveal how little the greatest departure from the average, on either side, varies from the average departure. Although each skull might be described by morphological characters which would serve to distinguish it, it seems certain from the measurements that these can be only individual differences.

A consideration of the table of measurements of the clavicles and the interclavicles shows somewhat greater divergence. The percentage of average departure from the average ratios rises as high as 12 in the measurement of angle *D*, but this is the least susceptible of accurate determination of any of the features, owing to the variable contour of the line of contact of the clavicles with the interclavicle. The percentage of average departure of other ratios from the average varies between 5 and 8. Considering the noticeable differences in contour of the various interclavicles, the percentage ratio differences are small and surprisingly consistent. The differences between maximum and minimum departures from the averages seem at times high, reaching as much as 20 per cent, but they are in no wise consistent, and no grouping can be arranged upon such relations. From the study of the material, which, though limited, presents the first possibility of such an attempt, it is apparent that the range of individual variation in form and contour of the various bones was relatively large, but that the general proportions remain reasonably constant. Differentiation of species of the group by minor characters of form or even minor differences of proportion would seem inadvisable. Until some fortunate find may permit us to determine change of proportion with growth or to establish the lack of such change, this appears to be our best guide.

B. bakeri seems in general to resemble *Koskinodon* of Branson and Mehl fairly closely, but aside from the differences in size the following points may be indicated:

B. bakeri

1. Ratio of postorbital length to total length on midline, 55.5 (average): 100.
2. Dermsupraoccipital much longer than tabular.
3. Lachrymal excluded from orbit.
4. Anterior end of parasphenoid broader, between vomers.
5. Sculpture in parieto-frontal region more linear.
6. Ratio of length of palatine vacuity to total length 54.8 (average): 100.

Koskinodon princeps

1. Ratio of postorbital length to total length on midline 46.5 : 100 (Fig. 8) or 54.2 right, 52.3 left : 100 (Plate IV). Unfortunately, since Branson and Mehl make a point of the position of the orbits, the ratios do not agree in the figure and plate, the figure placing the posterior edge posterior to the midlength, the plate placing it anterior.
2. Dermsupraoccipital not greatly longer than tabular.
3. Lachrymal taking part in orbit.
4. Anterior end of parasphenoid narrow, between vomers.
5. Sculpture in parieto-frontal region not linear.
6. Ratio of length of palatine vacuity to total length 47.2 (45.7) : 100.

ADDENDA

There are in the collection of the Museum of Paleontology three undescribed specimens which are of interest in the study of the Stegocephalia.

Number 12887 is a perfect thoracic shield, consisting of the interclavicle and the clavicles associated and in very perfect condition. The specimen was found in Crosby County, Texas, in 1929 (see Plate VII, Fig. 4).

Two interclavicles (see Plate VII, Figs. 2–3), numbers 14240 and 14241, were found in the bone bed near Rotten Hill, on Cerita de la Cruz Creek in Potter County, Texas, in 1931. The second is of especial interest because of its lack of symmetry, indicating a very decided distortion of the thoracic region of the animal during life. So little is known of the complete form of the Stegocephalia that it is impossible to say how far the typical asymmetry of the skull may have extended into the body skeleton, but since this is the first interclavicle among the many in the collection of the Museum of Paleontology which shows such marked bilateral inequality, it is probable that it must be regarded as a case of individual peculiarity. Unfortunately, no other parts were found associated with it, so that it is impossible to tell whether the malformation extended to other parts of the body, or whether it was of congenital or traumatic origin.

The specimens are all of large forms and are assigned to *B. perfecta*. Measurements are as follows:

	12887 Mm.	14240 Mm.	14241 Mm.
Length of sculptured area	407	438	475
Breadth of sculptured area	347	383	362
Length of left clavicle	392		
Arc of broadest part of left clavicle	183		
Length of right clavicle	385		
Arc of broadest part of right clavicle	179		

The largest condyle in the collection of the Museum of Paleontology, number 13686, measures 54 mm. across the articular face. This is part of a complete and undistorted left exoccipital not associated with other material except as it occurs in the same bone bed with the interclavicles, numbers 14240 and 14241, mentioned above, and with an almost complete thoracic shield, number 1055 M.C.Z., nearly or fully as large as number 12887, and numerous isolated bones of the skull of a large *Buettneria*.

Experience has shown that exact measurements of the condyles are not entirely satisfactory because of the difficulty in determining the edges; although the error is small, in any estimate of size of the skull based on such measurements the error is multiplied many times. With such reservations in mind the most satisfactory comparison is with the type of *Buettneria.* In this specimen the right condyle is 31 mm. broad and the left, 30 mm. The length of the midline to the posterior edge of the dermsupraoccipital is 431 mm. When these figures are used in a direct proportion, the condyle 54 mm. broad would indicate a skull 770.6 or 750.8 mm. long, considerably larger than the largest skull in the collection, number 8854 from Crosby County, Texas, which is 565 mm. long.

It is interesting to note that when similar comparisons are made with one of the most perfect skulls of *B. bakeri*, the length indicated for skulls belonging to the large condyle is only 715 mm., a difference which suggests further proof in comparative measurements for the separation of *B. perfecta* and *B. bakeri.*

A single left palatine, number 13674, from Cerita de la Cruz Creek, in Potter County, Texas, is from an individual of about the size of the type of *B. perfecta.* It is peculiar in that there is no trace of any teeth upon the inner border of the narial opening, and in that the usual row of teeth upon the palatine is represented by a single tooth, as large as those upon the outer edge of the palatine (see Fig. 45). In *B. perfecta* the small teeth at the posterior edge of the opening are in a cluster rather than in a row, as in *B. bakeri*, and it is noticeable that in this specimen, number 13647, there are two small teeth just at the edge of the socket of the larger one. This is perhaps an individual variation rather than an indication of a new variety or species.

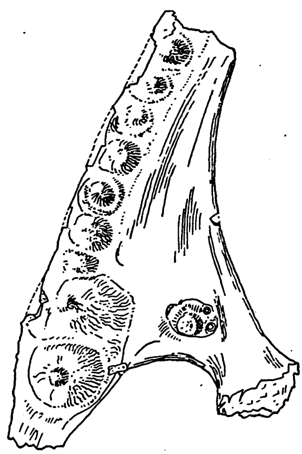

FIG. 45. A right palatine, number 13674. $\times \frac{2}{3}$

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PLATE I

FIG. 1. Upper surface of skull of *B. bakeri*, number 13055. × about $\frac{1}{3}$

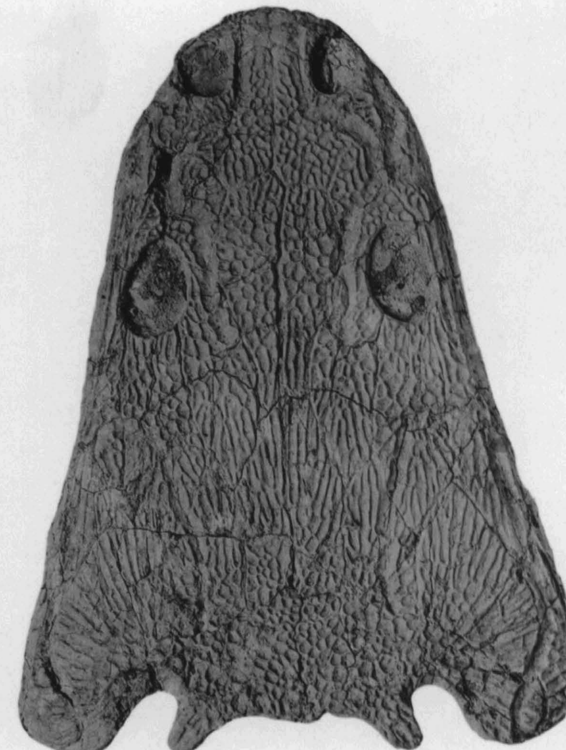

FIG. 2. Upper surface of skull, number 13820

FIG. 3. Lower surface of skull, number 13055. × about $\frac{1}{3}$

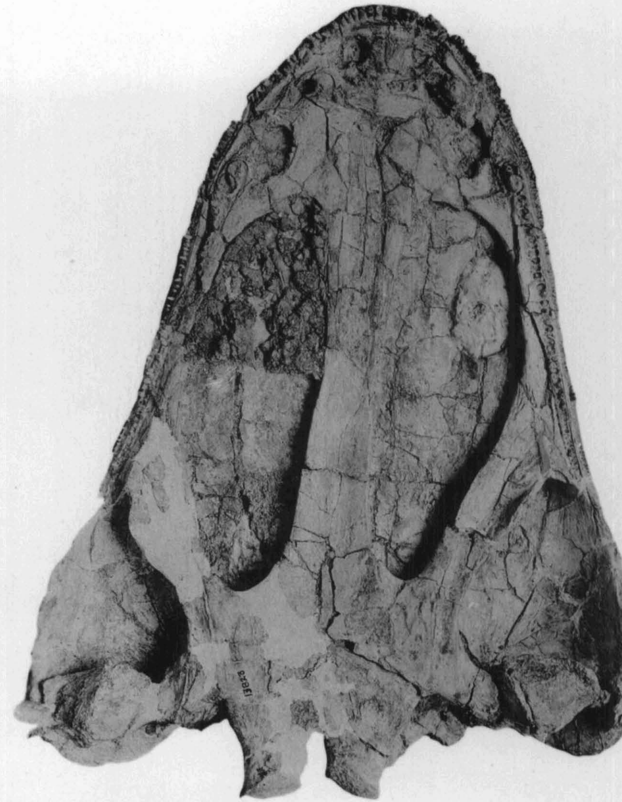

FIG. 4. Lower surface of number 13823. × about $\frac{1}{3}$

PLATE II

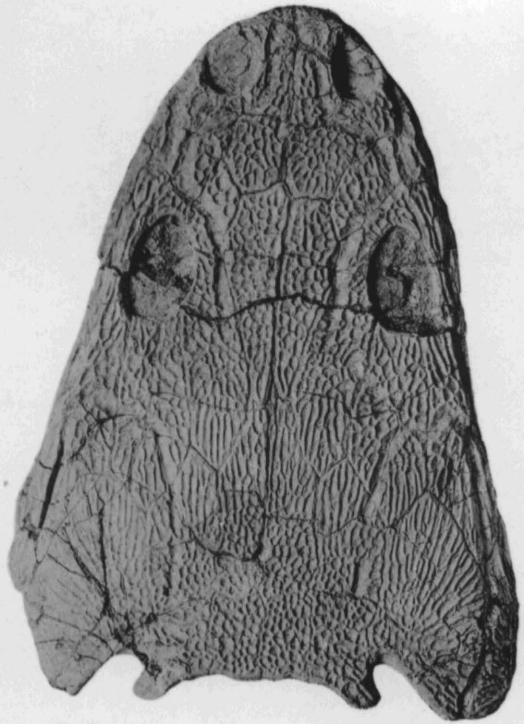

FIG. 1. Upper surface of number 1054 M.C.Z. × about $\frac{1}{3}$

FIG. 5. Portion of skull, number 13823, showing sclerotic plates. × about 1

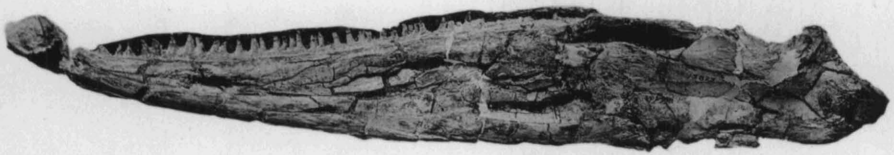

Fig. 2

Fig. 3

Fig. 2. Inner surface of right lower jaw, number 13283. × about $\frac{1}{3}$

Fig. 3. Outer surface of lower jaw, number 13947. × about $\frac{1}{3}$

Fig. 4. Upper surface of skull, number 13822. × about $\frac{1}{3}$

PLATE III

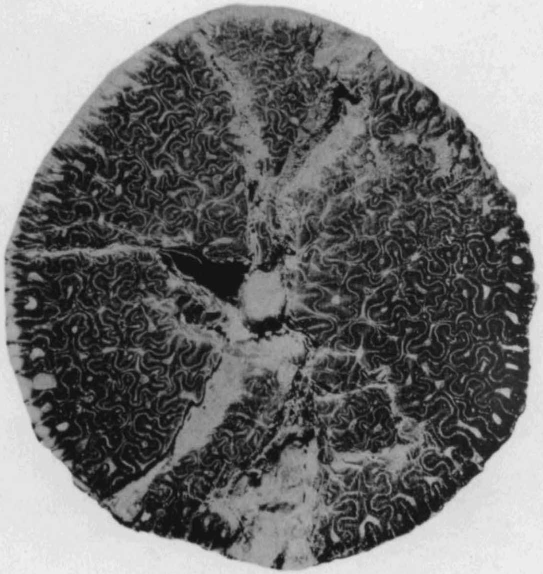

Fig. 1. Section of tusk, number 13972, probably *B. perfecta*. × 7

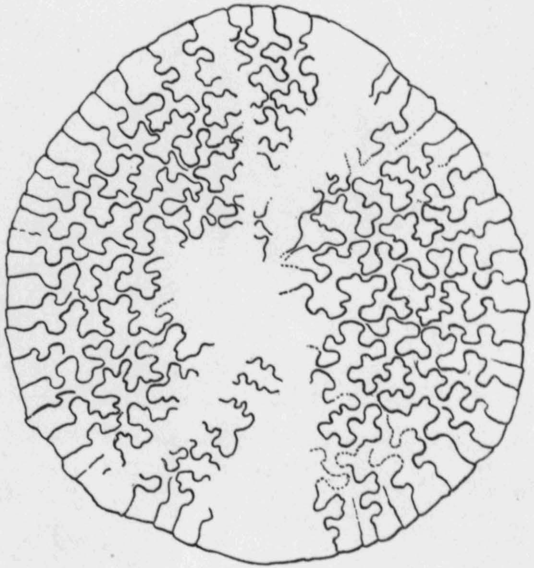

Fig. 2. Pattern of tusk shown in Figure 1

FIG. 3. Section of a lower tusk, number 13975, from near base. *B. bakeri.* × 7

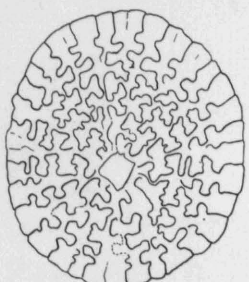

FIG. 4. Pattern of tusk shown in Figure 3

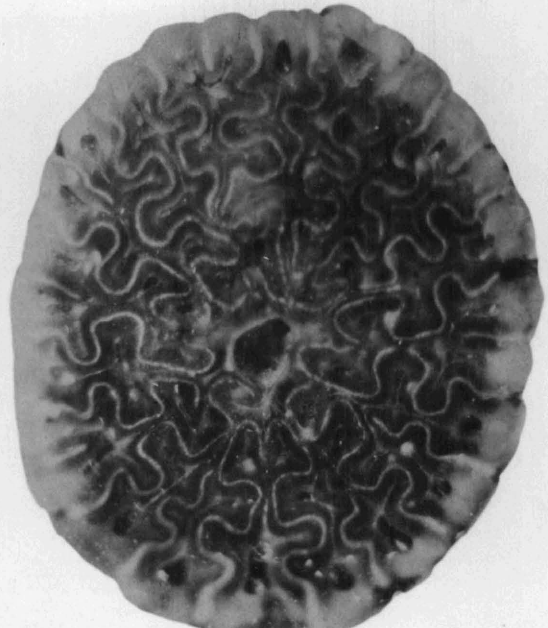

FIG. 5. Section of a small tooth, number 13975, from about middle. *B. bakeri.* × 25

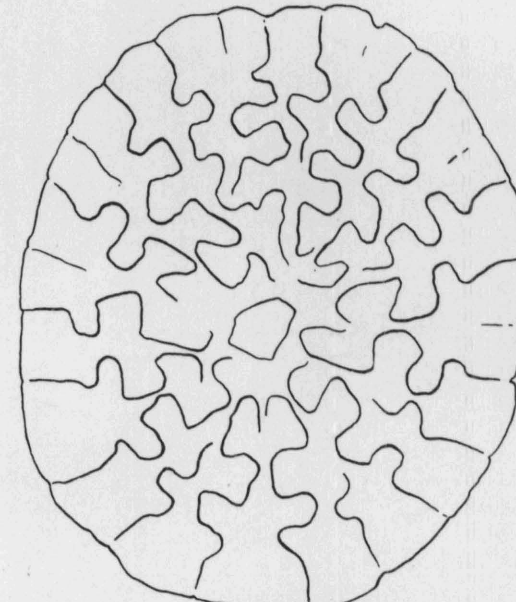

FIG. 6. Pattern of tooth shown in Figure 5

PLATE IV

Fig. 1. Anterior view of axis, number 13792. × about ½

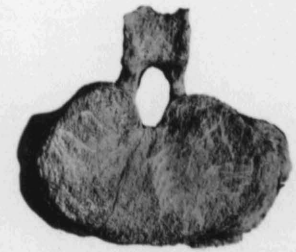

Fig. 2. Posterior view of axis, number 13792. × about ½

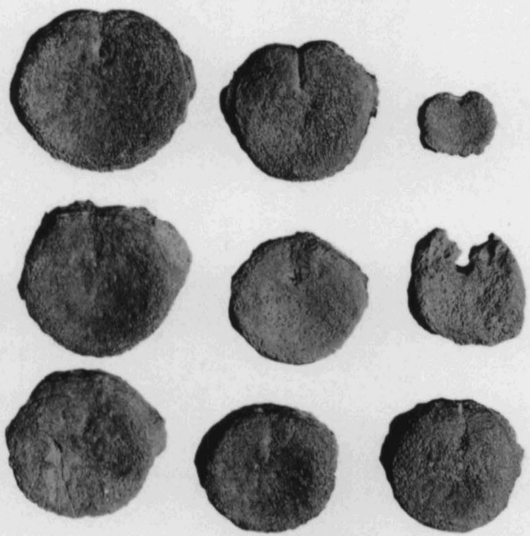

Fig. 3. Several vertebral centra showing the relation of the notochordal and neural canals. × about ½

Fig. 4. Humerus, 13775. × about ½

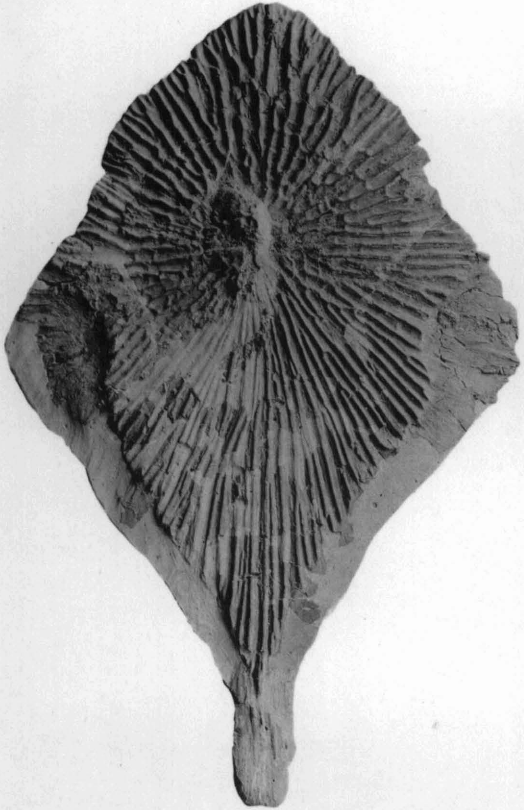

FIG. 5. Interclavicle, number 13209. × about $\frac{2}{3}$

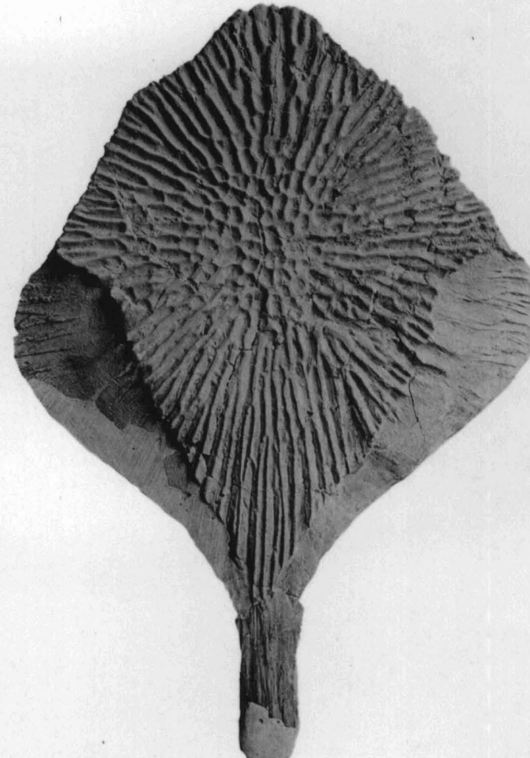

FIG. 6. Interclavicle, number 13027. × about $\frac{2}{3}$

PLATE V

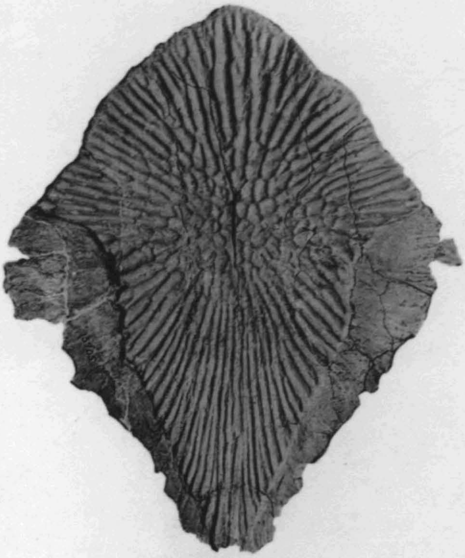

Fig. 1. Number 13905

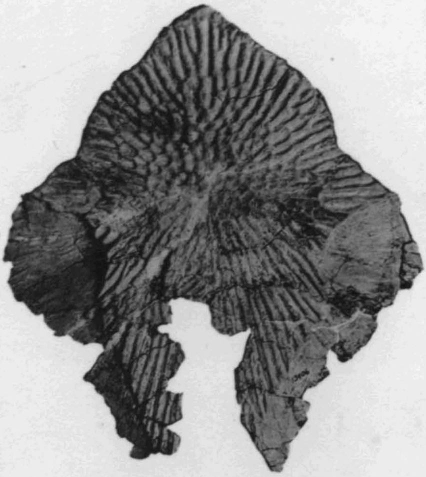

Fig. 2. Number 13906

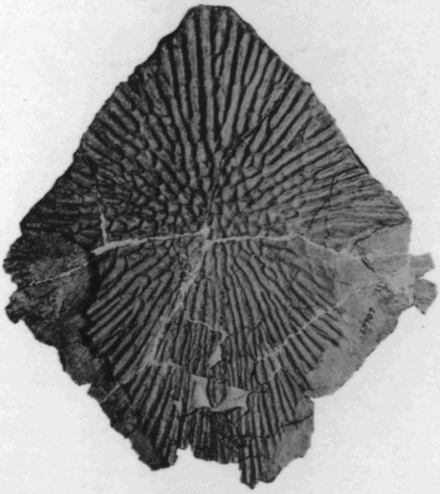

Fig. 3. Number 13907

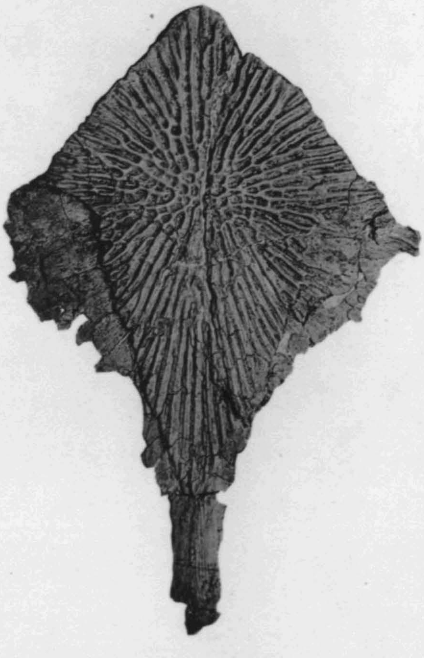

Fig. 4. Number 13912

INTERCLAVICLES OF *B. BAKERI*

× about $\frac{1}{3}$

PLATE VI

FIG. 1

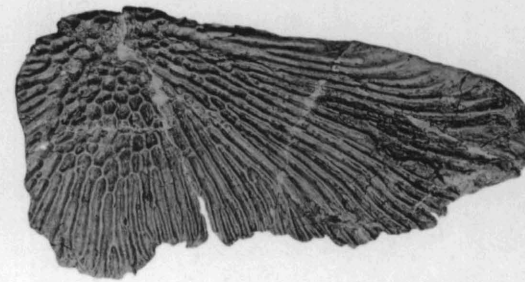

FIG. 5

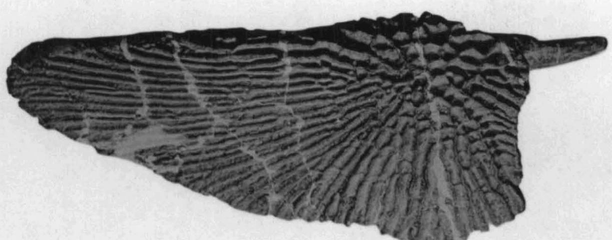

FIG. 2

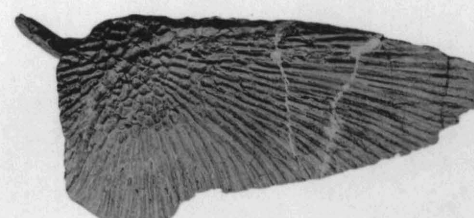

FIG. 6

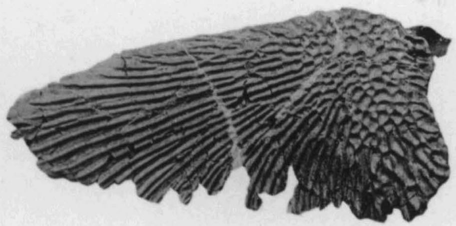

Fig. 3

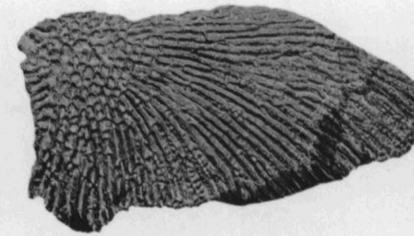

Fig. 7

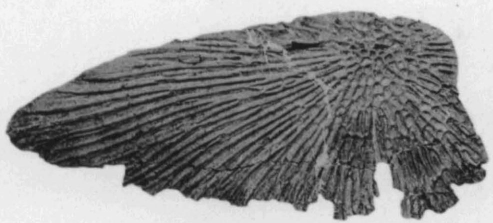

Fig. 4

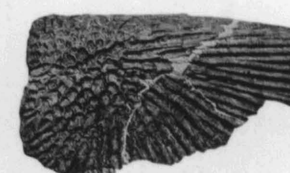

Fig. 8

Figs. 1–4. Clavicles of the left side. Numbers 13825, 13824, 13901, 13895

Figs. 5–8. Clavicles of the right side. Numbers 13903, 13898, 13028, 13943

PLATE VII

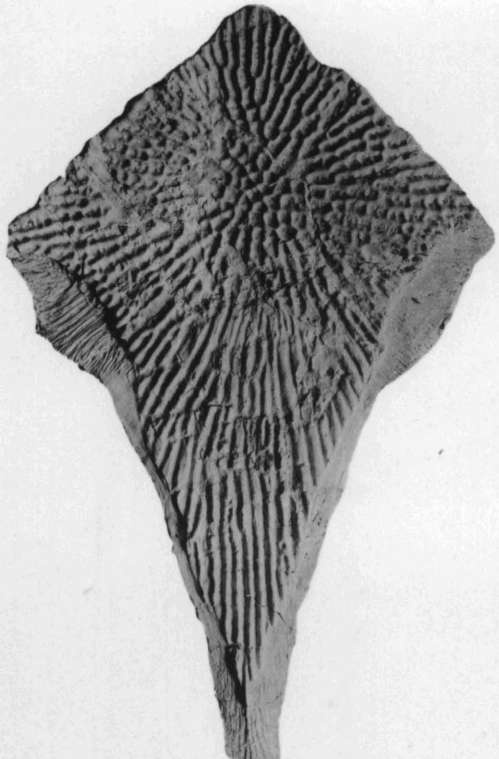

FIG. 1. Interclavicle, number 7368. × $\frac{2}{5}$

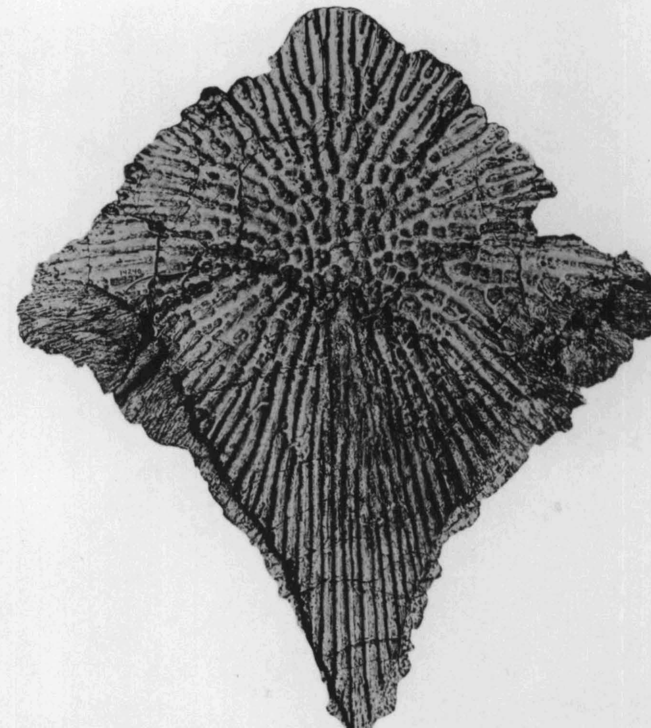

FIG. 2. Interclavicle, number 14240. × about $\frac{1}{5}$

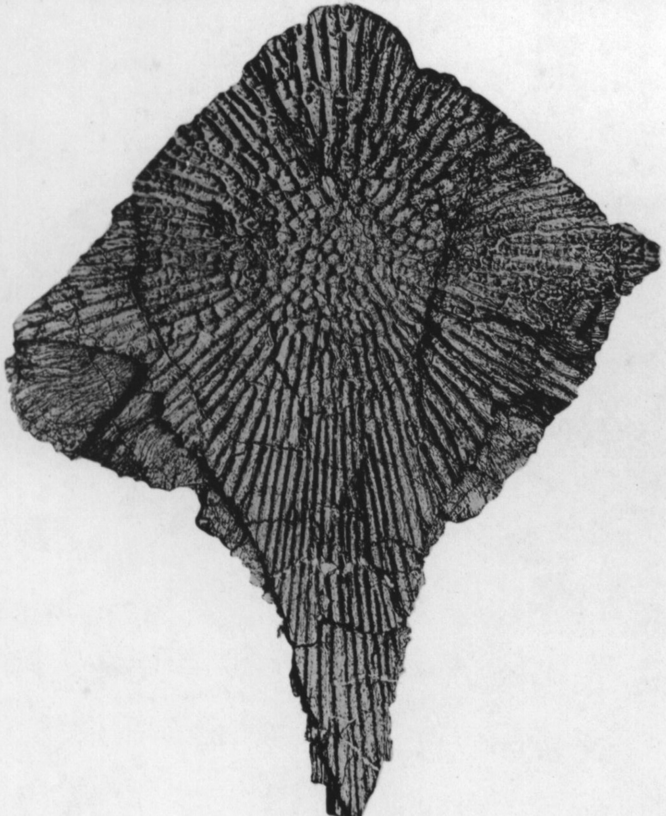

FIG. 3. Interclavicle, number 14241. × about $\frac{1}{4}$

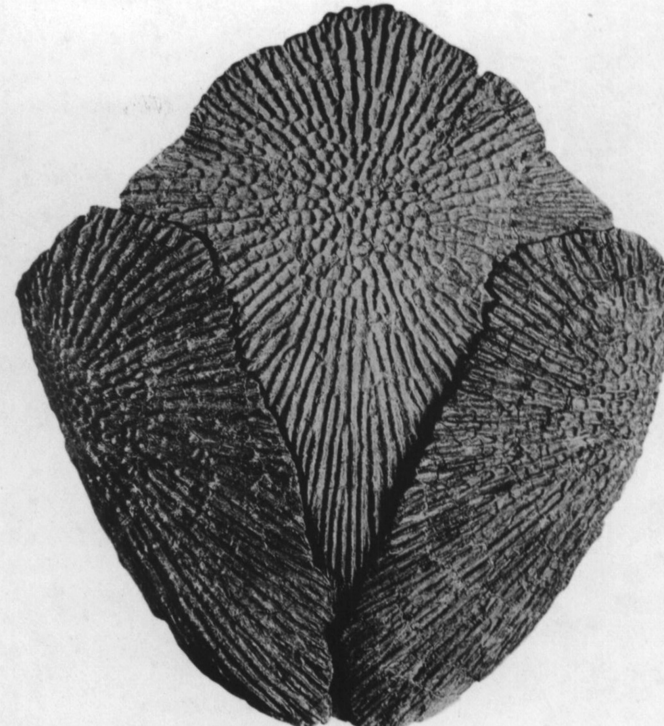

FIG. 4. Interclavicle and clavicles, number 12887. × about $\frac{1}{3}$

(*Continued from inside of front cover*)

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