

**Article XIII.—SKULL CHARACTERS OF RECENT CROCODILIA,  
WITH NOTES ON THE AFFINITIES OF THE RECENT  
GENERA<sup>1</sup>**

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## INTRODUCTION

The present studies of the skull characters of modern crocodilians were made to afford a basis of comparison for fossil species. To the writer's knowledge no complete descriptions of the skulls of the various living crocodiles have been published, although many works of great value are available. Schneider, Wagler, Spix, Gray, Cuvier, Duméril and Bibron, Müller, Gadow, Huxley, and others have either summarized the characters of the living species, or described some of them in great detail. L. C. Miall's study of the crocodilian skull is a work of very great value; Brühl's atlas contains useful comparative figures and descriptions. Boulenger's catalogue is the most complete and up to date summary; it has been followed closely in the present studies, and the specific nomenclature and synonymy has been adopted, except in the case of the caimans, which Boulenger groups into one genus, and which are here considered as members of two genera, following the usage of Huxley. Schmidt's recent work on the Congo reptiles contains valuable figures of the African crocodilians, with notes on their structure and habits, besides a description of a new genus.

The writer is indebted to Prof. H. F. Osborn and Dr. W. D. Matthew for the opportunity to make the studies here summarized. Prof. Osborn, Dr. Matthew, and Prof. W. K. Gregory have all made valuable suggestions. The members of the Department of Herpetology have assisted in making the extensive collections of Recent Crocodilia available for study. Dr. Thomas Barbour placed the great collections of the Museum of Comparative Zoology at the writer's disposal for study, and has loaned many specimens of species otherwise unavailable. Dr. A. G. Ruthven, of the University of Michigan, has loaned several skulls of South American crocodilians, and Dr. A. S. Pearse, of the University of Wisconsin, has aided in securing material for study. The drawings were prepared by Mr. E. S. Christman and Mr. Wesley Seim.

In these descriptions characters common to all crocodilians have been omitted, so far as possible; the purpose of the descriptions is for comparison, and the attempt was made to render the descriptions of the various parts of the skulls comparative in nature.

Characters which have hitherto been used in limiting genera and species of crocodilians include the following list: size, proportions, especially in regard to the relative length and breadth of the snout, general form of the skull, size and relative positions of the supratemporal fenestræ, size and relative positions of the orbits, single or double character of the external narial aperture, shape of the premaxillo-maxillary



suture on the palate, shape of the maxillo-palatine suture on the palate, size and shape of the palatine fenestræ, irregularities on the snout, degree of ossification of eyelids, number, position, and relative sizes of the premaxillary teeth, the character of the spaces between the teeth, the manner of interlocking of premaxillary and maxillary with mandibular teeth, especially in regard to the presence of a pit or a groove on each side of the upper jaw to receive the fourth mandibular tooth, the number of teeth in the mandible, the length of the symphysis of the mandible, and the presence or absence of the splenial bones in it, the appearance or absence of the prevomers at the surface of the palate, the presence or absence of a small process of each quadrato-jugal into the infratemporal fenestra, besides many characters of the postcranial skeleton, and of the dermal covering, color, etc., with which the present studies are not concerned.

In addition to these characters others may be noted, namely: the contact or separation of the lacrymal bones with the nasals, the presence of the parietal along the posterior border of the cranial table or its absence, the extent of the supraoccipital upon the cranial table (correlated with the last-mentioned character), the shape of the cranial table, the size and shape of the external narial aperture, the size and shape of the small premaxillary foramen on the palate, the direction of the teeth, the position and form of the internal narial aperture, besides many small, but constant variations in the outlines and relations of most of the component bones.

Characters which might be explained as due to individual or age variation have been eliminated, or specially explained, so far as possible; they have been treated elsewhere as the subject of a separate study. Adaptive characters have been noted in some cases, but no attempt was made to consider this topic fully. In the descriptions a large number of individuals was used whenever possible, eliminating to a large extent the danger of describing age or individual characters as specific; in the species of which only one or two specimens were available, the characters were analyzed for possibilities of individual or age variation before incorporation in the specific descriptions. The comments on the relationships of the various genera are based upon an analytical study of the characters of the genera, keeping in mind distinctions between palæotelic and cænotelic characters, as emphasized by Professor Gregory.

Sixteen species are described more or less fully and fourteen are figured; the description of characters of the four species of which no material was available (*Crocodilus johnstoni*, *C. siamensis*, *Caiman palpe-*

*brosus*, and *Alligator sinensis*) is adapted from published descriptions, partly verified from alcoholic specimens.

In all forty-five specimens were carefully studied, and about fifteen more were examined for comparison and verification. The distribution of these specimens among the genera and species is as follows: *Gavialis gangeticus* 1, *Tomistoma schlegelii* 2 (+1), *Crocodylus cataphractus* 1, *C. intermedius* 1, *C. americanus* 11 (+6), *C. niloticus* 1 (+1), *C. porosus* 3 (+2), *C. rhombifer* 1, *C. palustris* 1 (+1), *Osteolemus tetraspis* 1, *Osteoblepharon osborni* 1, *Jacare niger* 2, *J. sclerops* 8, *J. latirostris* 1, *Caiman trigonatus* 1, *Alligator mississippiensis* 9 (+5 or 6). This does not include some dried and alcoholic specimens which were also used for verification of some characters.

### GAVALIS Cuvier

#### GENERIC CHARACTERS

The skull of this species is excessively long and slender. Boulenger states that the generic characters are: "27 to 29 upper and 25 or 26 lower teeth on each side, anterior largest, laterals subequal, not received into interdental pits; the first, second, and third mandibular fitting into notches in the upper jaw. Snout extremely long and elongate, dilated at the end; nasal bones comparatively short, widely separated from the premaxillaries; nasal opening smaller than the supratemporal fossæ; lower anterior margin of orbit (jugal) raised; [this raised margin also includes lacrymal and prefrontal] a very small anterior bony plate in the upper eyelid. Mandibular symphysis extremely long, extending to the 23rd or 24th tooth, comprising the splenial bones." Each quadratojugal possesses a small anterior process which projects into the infra-temporal fenestra.

The characters of the genus differ widely from those of the other living crocodilians. In spite of the fact that *Tomistoma* is in many respects intermediate between this genus and *Crocodylus*, there is *no appreciable gradation in characters between the gavial and the true crocodiles*, *Tomistoma* being much closer to *Crocodylus* than to *Gavialis*. The excessively long snout, the abrupt expansion at its base, the extremely large supratemporal fenestræ, the separation of the nasals from the premaxillaries, the large number of teeth, and the exceedingly long mandibular symphysis are all resemblances to the Mesozoic marine crocodiles. It is quite probable that *Gavialis* was either derived independently from the other Eusuchian crocodiles, or was separated from the primitive Eusuchian stem near its base. It certainly approaches their condition much more closely than does any other living crocodile.

**Gavialis gangeticus** (Gmel.)

The description of the skull of this species is based chiefly upon a single specimen in the American Museum Collections (Amer. Mus. No. 15176), and to a slight extent upon published descriptions.

**General Form**

The general form of the skull of this species is strikingly different from that of any other living crocodile. The detailed form of the various component bones is equally at variance with the typical crocodilian skull.

The snout is excessively long and narrow. Its length is over three times its breadth at the base. Boulenger states that young individuals of this species have snouts five and one-half times as long as broad at the base. From the base of the snout forward the latter narrows rapidly, so that throughout the greater part of its length its lateral borders are parallel. At the tip it is greatly expanded; the expansion extends back to a point a short distance anterior to the lateral vertical element of the premaxillo-maxillary suture. The postero-external borders of this expanded portion are convexly rounded, and are sharply separated from the lateral borders of the snout posterior to them; the antero-external borders of the expansion are nearly straight lines; they are excavated below the level of the surface of the snout for reception of the first mandibular teeth. On each side of the anterior expansion of the snout, on its superior surface is an irregular, more or less sharp process, and posterior to this a smaller one of like nature. The longitudinal profile of the snout is very slightly concave.

Anterior to, also slightly below each orbit is a prominent ridge of bone, made up of components of a number of the bones of the skull; this ridge elevates the external opening of the orbit a considerable distance above the level of the snout. The interorbital space is very broad. The cranial table is very broad laterally, but is relatively short antero-posteriorly. Its lateral borders are parallel; they are not simple edges, but are somewhat grooved. The posterior border is composed of two concave loops. At a lower level than the posterior surface of the cranial table the posterior surface of the skull extends backward in a complex process, or group of processes, all composed of the supraoccipital bone. In most crocodilian skulls these processes are largely hidden under the posterior edge of the cranial table.

On the palate a pair of bulbous expansions of the nasal passage occupy conspicuous positions at the posterior ends of the palatine fenestræ, and extend upward from them toward the roof of the skull.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—The supratemporal fenestræ are far larger in size than in any other Recent crocodilian. Each of them is much larger than the external narial aperture, which itself is large. The cavities are irregularly rounded, and their transverse diameters are greater than their longitudinal. They are separated a moderate distance from each other. They bear closer resemblance to the supratemporal fenestræ of some of the extinct tomistomoid crocodilians, or in fact to those of some of the Mesozoic marine mesosuchian crocodiles, than to those of any other living species.

**INFRATEMPORAL FENESTRÆ.**—These fenestræ differ very greatly from the infratemporal fenestræ of other modern crocodiles. They are not triangular, as in most species, but rounded; their length is greater than their height, and they are higher near their anterior than near their posterior ends. They are penetrated at their posterior ends by sharp processes of the quadrato-jugals, much as in the species of *Crocodylus* and *Tomistoma*; the processes are somewhat different in form from those of the other genera, however.

**ORBITS.**—The orbits are large and round; they are separated far from each other by a concave interorbital plate. Each of them is almost completely encircled by a rim of bone, which separates it off more or less sharply from the surrounding portions of the skull. At the posterior end this rim is the anterior portion of the cranial table, and is relatively low; the internal portion is somewhat higher, and the anterior and antero-inferior portions are very greatly elevated. The postero-inferior boundary of the orbit, or postorbital bar, is situated at a very distinctly lower level than the circumorbital ring.

**EXTERNAL NARIAL APERTURE.**—This cavity is very peculiar in its shape. It consists of two more or less distinct portions, a posterior one, which extends down into the nasal passage, and an anterior, shallow one, which does not extend into the nasal passage, and is more or less accessory to the posterior one. The posterior element of the aperture is large, and it is roughly triangular in outline, with the apex of the triangle directed backward. Its borders, except the anterior one, are nearly vertical. The anterior border forms the floor of the anterior element of the aperture. It is inclined in position, sloping downward toward the posterior portion. Its anterior edge, at the surface of the snout, is concave backward.

**PREMAXILLARY FORAMEN.**—The premaxillary foramen on the palate is very small, and is simple in outline. It has two borders only, and

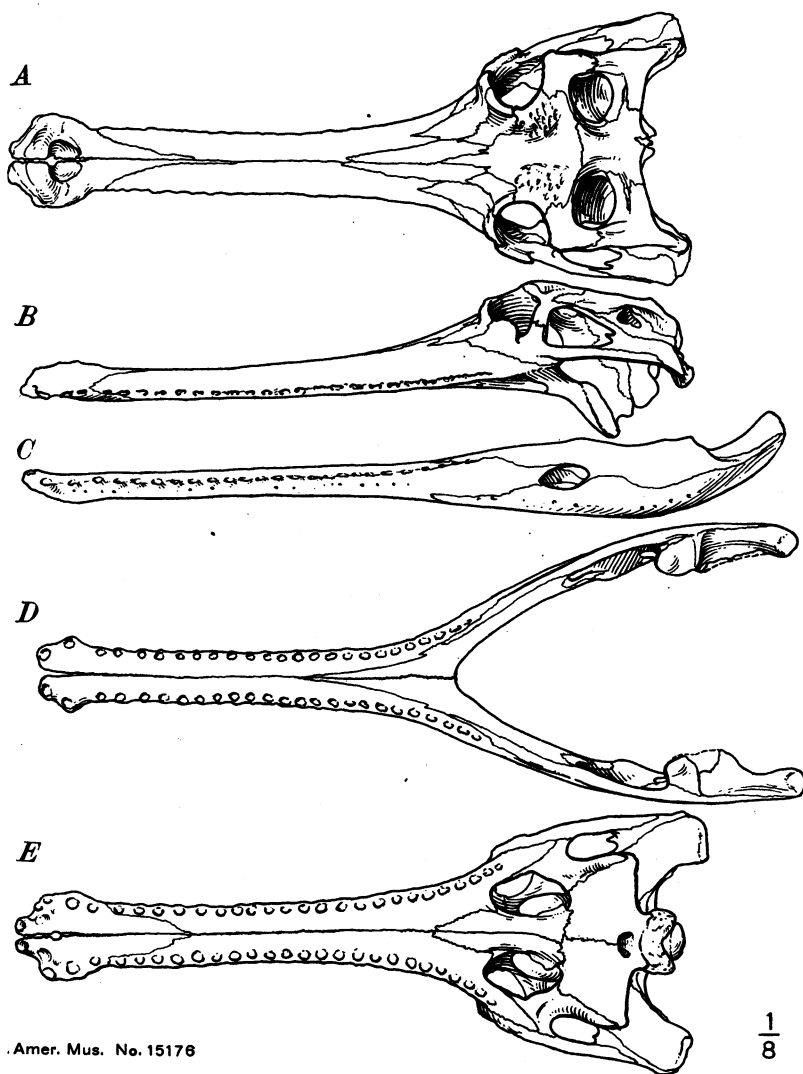


Fig. 1. Skull and jaws of *Gavialis gangeticus* Gmel. Amer. Mus. No. 15176, one-eighth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible, left side; E, inferior view of skull.

these are lateral in position; they are concave curves, which meet at the anterior and posterior ends, giving the cavity sharp anterior and posterior ends. The length and breadth of the cavity are equal.

**PALATINE FENESTRÆ.**—The palatine fenestræ are different in shape and in position from those of any other living crocodile. They are short antero-posteriorly, and are relatively broad, the length of each being considerably less than twice its breadth. They extend forward to the level of the twenty-second maxillary teeth. Their anterior ends are somewhat rounded, but are not far from being pointed. Their posterior ends are somewhat irregular. Their external borders are composed of two distinct portions, which are approximately equal in length; one of these is properly an antero-external border, and the other a postero-external border. The internal border, considered at the level of the palate only, and neglecting the great bulbous expansion of the nasal passage, is a simple concave edge. The great expansion mentioned above, however, spreads out laterally into each fenestra, and then bends toward the palatine surface; the lower surface of each side of this great expansion grades into the surface which forms the internal wall of the fenestra, greatly complicating the internal outline of the latter.

**INTERNAL NARIAL APERTURE.**—The internal narial aperture is relatively small. Its breadth is about twice its length; its length is about one-fifth of the median antero-posterior diameter of the combined pterygoid bones. It is not separated into two portions by a median septum, but it has a small median process projecting forward from its posterior wall. It is not protected from any direction, at the surface of the palate, by an elevated plate of bone.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are totally different from those of any other living crocodilian. Surrounding, as they do, the external narial aperture, they partake of its unusual characters. On the superior surface of the skull the premaxillo-maxillary sutures are somewhat different from those of other forms. They extend inward and backward from the sides of the snout for a short distance, on each side, then gradually turn farther and farther backward in direction, until near their posterior ends they are nearly antero-posterior in direction. Together they make a figure much like a letter V whose sides are not straight lines, but are curves which are convex toward each other, the curves being irregular and not smooth. In the skull studied the two premaxillaries differ very greatly in the backward extension of their posterior processes.

The right premaxillary extends back as far as the level of the fifth maxillary teeth; the left one extends back as far as the level of the seventh maxillary teeth; as the maxillary teeth are far apart this difference is considerable; it may be interpreted merely as the result of individual variation.

The two prominences on either side of the aperture are of course carried on the premaxillaries. In an antero-lateral direction from the aperture each premaxillary descends sharply downward in a nearly vertical plane. The ends of this plane are extended into prominences which lodge teeth, but the central portion is excavated to make space for the first mandibular tooth, which bites completely outside of the upper jaw. At their anterior ends the premaxillaries are extended forward into two processes which on their inferior surfaces lodge the first premaxillary teeth.

On the palate the premaxillaries extend backward to the level of the fourth maxillary teeth, the premaxillo-maxillary suture forming a flaring V. The teeth are not preserved in the specimen examined, but their alveoli indicate that there were five teeth in the left premaxillary, and four in the right. The fourth premaxillary teeth are evidently the largest, with the first and third only slightly smaller. The second is considerably smaller, and so is the fifth. The alveoli of all of these teeth point forward and outward. The first and second are far apart, and are separated by excavations which lodged the first mandibular teeth. The second and third, on the side in which the second is present, are very close together. The third and fourth are far apart, and are separated by spaces which are partly pits and partly notches; these lodge the second mandibular teeth. The fourth and fifth are moderately far apart. Posterior to the fifth alveoli are excavations which are partly in the form of notches, but which have pits at their internal margins; these lodged the fourth mandibular teeth; they correspond with the so-called canine notches of the true crocodiles. The palatal surfaces of the premaxillaries face outward as well as downward. The anterior portion of each premaxillo-maxillary suture is situated far out near the lateral margin of the jaw; the internal wall of the alveolus of the first maxillary tooth is partly composed of the premaxillary bone.

**MAXILLARIES.**—The maxillaries of this form are exceedingly long and slender. Their sutural contact with the premaxillaries has been described above. They differ from the maxillaries of all other living crocodilians in meeting each other along the median line, excluding the nasals from contact with the premaxillaries; the median contact of the

maxillaries with each other is moderately long. The contact of each maxillary with its neighboring nasal is slightly longer than the median maxillary suture. The suture with the lacrymal extends almost directly forward from the posterior end of the maxillo-nasal suture, then turns backward and slightly outward to the anterior end of the jugal; the maxillo-jugal suture extends more directly outward and downward in its anterior portion, then turns backward. From the outline of the maxillo-lacrymal suture it will be seen that a process of the maxillary extends backward from the main superior plate of the bone, wedging the lacrymal apart from the nasal; it does not separate the lacrymal from the nasal entirely, however. The posterior process of the maxillary is very slender. The teeth of the maxillaries are situated on small pedicles, which are separated by notches which lodge the mandibular teeth. The result of the alternation of the pedicles with the notches is a crenulation of the border of the snout, which is visible not only on the inferior and lateral surfaces of the skull, but also when the skull is viewed from above.

The suture of the maxillaries with the premaxillaries on the palate has been described above; the suture with the palatines is relatively simple. It extends inward and slightly backward from a point on the internal border of the palatine fenestra, very slightly posterior to its anterior end, for a very short distance, then turns directly forward to a point opposite the twenty-first maxillary tooth, then forward and inward, meeting the median line at the level of the eighteenth maxillary teeth, and in a symmetrical direction to the opposite palatine fenestra. The maxillaries thus form very small portions of the internal borders of the palatine fenestræ, as well as small portions of their external borders. Their sutures with the ectopterygoids reach forward to the level of the twenty-third maxillary teeth; from this point they extend backward and outward for a considerable distance on each side. The transverse profile of the maxillaries on their palatine surfaces is decidedly convex.

Each maxillary contains twenty-three teeth; they are all of approximately the same size, except the last two on each side, which are slightly smaller. All of the teeth are relatively small. The teeth themselves are not preserved in the specimen studied, consequently their exact form cannot be described; evidently they were long and slender, from the form of the alveoli and their intervening notches. The alveoli are directed downward, forward, and outward; the teeth evidently extend in the same direction, the maxillary and mandibular teeth crossing each other at oblique angles. The alveoli are all moderately far apart, except in the posterior region, where some of them are close together.



**NASALS.**—The nasal bones are very characteristic in form. They are very short, extending only as far forward as the level of the spaces between the thirteenth and fourteenth maxillary teeth. They broaden rapidly in the posterior direction, and reach their maximum spread at the level of the twentieth maxillary teeth; at this point, however, they are separated by the median anterior process of the frontals, which wedges them sharply apart for a distance equal to one-third of their entire length. On the right side the suture of the nasal with the lacrymal is about one-half the length of the suture between the nasal and the prefrontal. On the left side the suture of the nasal with the lacrymal is considerably longer than the irregular suture of the nasal with the prefrontal. At their posterior ends, between the median process of the frontal and the prefrontal borders of the nasals, the latter are penetrated on each side by a small, sharp, minute process of the frontal; the entire naso-frontal contact is therefore very irregular.

**LACRYMALS.**—The lacrymal bones of this species are large; they are also very unusual in their shape. Their sutures with the prefrontals are concave, in a very irregular way; the posterior portions of their sutures with the maxillaries, also their sutures with the jugals, are convex; their sutures with the nasals, and the anterior portions of their sutures with the maxillaries are nearly antero-posterior in direction. Their external and internal borders, therefore, consist of two nearly concentric edges, which converge anteriorly, giving the bones very sharp anterior ends. These anterior processes are separated from the nasals by the sharp posterior processes of the maxillaries mentioned above. The posterior, or orbital, borders of the lacrymals are abruptly elevated into the prominent anterior portions of the circumorbital ridges; the lacrymal portions of these ridges not only stand vertical, but for a short distance on each side slightly overhang. The anterior processes extend forward to the level of the eighteenth maxillary teeth.

**PREFRONTALS.**—The prefrontal bones are smaller than the lacrymals, but are somewhat similar in shape; they are relatively shorter, however, and their nasal borders converge posteriorly. Their orbital borders are considerably elevated.

**FRONTAL.**—This bone is very large. Its anterior process, which wedges apart the posterior ends of the nasals, is long and broad. The portion of the bone between the two prefrontals is broad, but is short antero-posteriorly. The interorbital plate of the frontal is excessively broad; it merges into the still broader postorbital portion, which extends back to the supratemporal fenestræ, and forms part of their anterior

borders. The interorbital and posterior portions of the bone are very rough from deep, greatly elongated pits.

**POSTORBITALS.**—The postorbital bones are of moderate size; in proportion to the small squamosals they are large. They occupy about two-fifths of the lateral borders of the supratemporal fenestræ; the sutures with the squamosals extend obliquely downward and forward along the edges of the thick roof of the cranial table. The orbital borders are nearly as long as the lateral borders, and are nearly at right angles with them. Each postorbital sends a long narrow process of bone inward between the frontal and the parietal, along the anterior wall of the supratemporal fenestra; this wall of the fenestra is thus composed of three bones, the frontal at the surface, the postorbital slightly lower, and the parietal still lower, besides the alisphenoid at a still deeper level. The distance between the orbits and the supratemporal fenestræ, across the postorbital bones, is considerably greater than the distance between the fenestræ and the posterior border of the cranial table, across the squamosal bones.

**SQUAMOSALS.**—The squamosals bones are small so far as surface area is concerned. On the superior surface of the skull they are triradiate in form, one process extending outward and backward, another forward, and the third inward. All of these processes are slender. Each squamosal occupies about one-third of the posterior border of the cranial table. The small triangular area where the three processes come together on each squamosal is deeply pitted. The squamosal bones of this species do not resemble those of any of the other modern crocodilians so much as they do some of the Tertiary tomistomoid species or the Mesozoic marine crocodiles.

**PARIETAL.**—At the surface of the skull the parietal is broader posteriorly than anteriorly, the reverse condition from most crocodilians; at a deeper level, however, the anterior ends spread out, and are broader than the posterior. The median portion of the bone, between the two supratemporal fenestræ, is narrow. The posterior part is over three times as broad as the interfenestral portion. The posterior portion extends backward as a median posterior process of the cranial table. It occupies about one-third of the posterior border of the cranial table, including a minute superior surface of the supraoccipital.

**SUPRAOCCIPITAL.**—This bone occupies only a very minute area on the superior surface of the skull, and extends back from it as a pair of slight median processes. The two processes which are usually covered by the overhanging surface of the cranial table project out beyond it in

this form. The breadth of the bone, on the posterior surface of the skull, is slightly over one-fourth of the total breadth of the cranial table. Vertically, the supraoccipital occupies about three-fourths of the distance between the superior border and the foramen magnum.

**BASIOCCIPITAL.**—This bone is rather more massive and compact than in most crocodilians; otherwise it is not especially characteristic.

**QUADRATES.**—The quadrate bones are rather short antero-posteriorly; their sutures with the quadrato-jugals are exceedingly irregular.

**EXOCCIPITALS AND BASISPHENOID.**—These bones are not especially distinctive.

**JUGALS.**—The jugals are very long antero-posteriorly, but most of their length is in their posterior portions. The anterior, or facial, portions of the jugals are very short; they do not extend nearly as far forward as the lacrymals. The infraorbital portions of the jugals are greatly expanded vertically, forming parts of the great circumorbital ridges, which partly cover the orbital cavities on their inferior borders. The posterior portions of the jugals are exceedingly long and slender.

**QUADRATO-JUGALS.**—The quadrato-jugals of this form are very characteristic. They are very short antero-posteriorly, and their sutures with the quadrates superiorly, and with the jugals inferiorly, are very irregular. The antero-superior process of each quadrato-jugal is long and slender, and has a rather long contact with the postorbital. The left one has a prominent process extending forward into the infratemporal fenestra, and there is a broken base of one on the right side. The anterior process differs considerably from that of the true crocodiles and *Tomistoma*. It is not a continuation of the inferior portion of the bone upward and forward as in the other genera, but is distinctly elevated above the level of the principal surface of the bone posterior to the border of the fenestra. It is rather stout, and it extends directly forward; it is moderately sharp. Below this anterior process the bone extends a considerable distance forward, and forms a part of the inferior border of the fenestra. This antero-inferior process is considerably longer than the process which penetrates the fenestra.

**PALATINES.**—The sutures of the palatine bones with the maxillaries have been described above. The anterior processes of the palatines which they partly enclose form a broad wedge, which extends forward to the level of the eighteenth maxillary teeth. The very short lateral processes form most of the anterior borders of the palatine fenestræ. From the bases of these lateral processes the palatines narrow in the posterior direction to a level a short distance anterior to their posterior

ends, then expand again. At the palatal surface this posterior lateral expansion is not great, but at a deeper level, the palatines support the great expansions of the pterygoids with thin downwardly deflected plates. The sutures with the pterygoids are relatively simple in their posterior palatal portions, but are complicated somewhat by their anterior extensions along the great pterygoid expansions. On each side the suture extends backward from a point immediately posterior to the superior process of the palatine which extends upward to meet the inferior process of the prefrontal, and turning at the level of the minimum breadth across the palatines, extends backward and outward across the floor of the pterygoid expansion; near the posterior end of the fenestra it turns sharply inward, backward, and upward to a point a short distance posterior to the posterior end of the palatine fenestra then extends in an irregular but gentle curve to the median line, at a point directly between the posterior ends of the two fenestræ, and thence in a symmetrical direction on the opposite side.

**PTERYGOIDS.**—The pterygoids of this form are unique among the Crocodilia. Their posterior, or palatal, portions differ only slightly from those of other species; this palatal portion is relatively flat, and is very broad in proportion to its length. The posterior narial aperture occupies only a small portion of the median line. The anterior portions, which extend forward over the palatines, are expanded into huge bulbous processes, which extend in every direction for considerable distances into the great pterygoid fossæ. Anteriorly they extend nearly to the vertical columns formed by the prefrontal and palatine bones, and the median anterior pterygoid process extends forward between these columns, articulating with the prefrontals. Each of the great expansions is shaped much like a hen's egg, and is similar in size. These great expansions are evidently correlated with the more completely aquatic habits of the animal, compared with other Recent crocodilians.

**ECTOPTYERYGOIDS.**—The anterior processes of the ectopterygoids are small, being both short and slender. The postero-inferior processes are broad, but are not especially thick; the superior processes are small. The sutures with the maxillaries are short themselves, but are long in comparison with the abbreviated length of the anterior processes; these sutures converge very sharply in the anterior direction.

### The Mandible

The mandible of the gavial is unique among modern crocodilians, and bears considerable resemblance to the mandibles of some of the Mesozoic marine crocodiles. The two rami together are very slender back to the level of the twentieth or twenty-first mandibular teeth, then broaden rapidly.

The symphysis is exceedingly long, extending back to the level of the twenty-third mandibular teeth. The splenial bones form very extensive portions of the symphysis. They extend forward to the level of the spaces between the thirteenth teeth; at the posterior end of the symphysis they are broad, together comprising at least two-thirds of the breadth of the symphysis; they thus wedge apart the dentary portions of the symphysis. Nearly half the length of the splenials is included in the symphysis.

Each ramus contains twenty-five dental alveoli. The first of these is the largest, the second next in size, and the fourth next. The remainder are all about equal in size and small. All of the alveoli are directed strongly forward, and slightly outward, as well as upward; the surface of the symphysis, between the two dental borders, is convex. The first teeth are considerably separated from each other. The mandible is as broad at this point as farther back near the fifth, or tenth teeth. The first teeth are separated by considerable spaces from the second; the two second alveoli are separated widely from each other, the broadest portion of the anterior end of the symphysis being between them. The second teeth are very widely separated from the third; the third are rather far from the fourth, and the fourth from the fifth. Back of the fifth the teeth are all approximately equally far apart, the distance being considerable between each successive pair. All of the alveoli are contained in slight pedicles, which are separated from each other by relatively flat areas. The pedicles extend outward slightly from the lateral borders of the symphysis, giving these borders a remarkably crenulated appearance.

The dentary bones are exceedingly long; the splenials are also very long, but the remainder of the mandibular bones are little, if any, longer than in other crocodiles. The external mandibular foramina are small.

The two rami of the mandible spread apart from each other considerably at their posterior ends. The skull and jaws of the gavial taken together have been described as resembling a frying pan in shape, the handle of the pan corresponding with the snout, and the basin of the pan with the cranial portion of the skull.

## Measurements Amer. Mus. No. 15176

Length of Skull, Tip of Snout to Supraoccipital	.680M.
Length of Skull, Tip of Snout to Ends of Quadrates	.712
Length of Snout	.500
Breadth of Skull, Across Quadrato-jugals	.284
Breadth of Skull, Across Cranial Table	.200
Breadth of Snout, at Base	.160
Breadth of Snout, at First Maxillary Teeth	.064
Breadth of Snout, at Third Premaxillary Teeth	.102
Length of Mandible, Total	.815
Breadth of Mandible, Total	.306

**TOMISTOMA Müller**

## GENERIC CHARACTERS

This genus has twenty to twenty-one upper teeth on each side, and eighteen to twenty lower teeth; these numbers may be increased somewhat if some fossil species are included; the lateral teeth are received into pits between the teeth of the opposing jaw; the premaxillaries have five teeth in the younger stages, but only four in the adult condition; the fifth maxillary tooth is usually somewhat enlarged as in *Crocodilus*. The snout is long and slender, but less so than in the gavial; it resembles that of *Crocodilus cataphractus* in general form. The nasal bones do not enter the external nares aperture, but they do have contacts with the premaxillaries, differing in the latter respect from the gavial. The mandibular symphysis is very long, extending back to the level of the fourteenth or fifteenth teeth, and including the anterior ends of the splenial bones. The supratemporal fenestræ are small. The quadrato-jugals possess sharp anterior processes which penetrate the infratemporal fenestræ. The prevomers appear on the palatal surface at the mid-line posterior to the maxillaries.

This genus approaches the true crocodiles in many characters, while its resemblances to the gavial appear to be more or less superficial; it is here considered to be an off-shoot of the central crocodilian stem, which has assumed habits somewhat like those of the gavial, and has developed secondary characters which resemble the characters of that form.

***Tomistoma schlegelii* Müller**

The description of the skull of *Tomistoma schlegelii* is based upon two skulls, one very large (Amer. Mus. No. 15177), and the other of medium size (Mus. Comp. Zool. No. 12459), also upon the published descriptions.

### General Form

The skull of this species is long and slender, but not to the same extent as in the Indian gavial; in general form the resemblance to *Crocodilus cataphractus* is considerable, but the details of the skull are different from those of the latter species.

The snout is especially long and slender; its length varies from two and three-fourths to three and two-thirds times its breadth at the base; it tapers gradually from its base to its tip, differing in this respect from the true gavial. The superior antero-posterior profile of the snout is very slightly concave; the vertical depth of the snout is considerable; the lateral borders of the snout are rather smooth when viewed from above; there is a very slight expansion in the premaxillary region, and a rather abrupt broadening, on a small scale, at the level of the fifth maxillary teeth, otherwise the borders are simple slightly concave lines. It is very slightly expanded posterior to the lateral portions of the premaxillo-maxillary suture. When viewed from the side the snout, especially in the premaxillary region, is very irregular along its inferior, or dental, margin, due to the great size of the pedicles of the teeth, and the depth of the spaces between them.

The cranial table is relatively small; in comparison with the Indian gavial it is very small. Its lateral borders are more or less irregular, but in general have a strong tendency toward convergence at their anterior ends. The posterior border is concave, and is indented at the median line; this indentation is both horizontal and vertical; in form it resembles a miniature glacial cirque. In transverse profile the cranial table is concave. The skull has the appearance, while long and slender, of being stout and strong.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—These cavities are of moderate size. In the large skull studied each fenestra is equal to, or slightly larger than, the external narial aperture; in the smaller skull the fenestræ are each somewhat larger than the narial aperture. The fenestræ are rounded on their posterior and postero-internal borders, but their external and antero-internal borders are nearly straight lines, which converge anteriorly, making a sharp angle at the antero-external corner of each fenestra. The interfenestral space is very narrow.

**INFRATEMPORAL FENESTRÆ.**—These cavities are rather large, about equaling the supratemporal fenestræ in size. Each of them is sub-triangular in outline; none of the borders are either horizontal or vertical

in position. Viewed from the side the vertical diameter of each fenestra is very much less than the antero-posterior diameter; this condition is slightly exaggerated by the slight upward trend of the jugal bones. Each fenestra is penetrated by a long sharp process of the quadrato-jugal, much as in the species of *Crocodylus*.

ORBITS.—The orbits are large; their longitudinal diameters are greater than their transverse. Their lateral borders converge slightly in the anterior direction, but their anterior ends are rounded and not sharp.

EXTERNAL NARIAL APERTURE.—The external narial aperture is relatively large. Its vertical depth is considerable; its postero-external and posterior walls converge slightly downward; its antero-external walls are vertical, and its anterior wall is slightly overhanging. It is longer than broad, and is broader near its anterior than near its posterior end. Its postero-external borders converge backward, but do not meet, there being a short posterior border between their ends. There is no forward extension of the premaxillaries at the posterior end at the level of the surface, but these bones do make a very slight process at a greater depth; the nasals are excluded from the aperture altogether by the premaxillaries. The borders of the aperture are not elevated.

PREMAXILLARY FORAMEN.—The premaxillary foramen on the palate is heart-shaped, and is exceedingly small in size. It is situated directly between the second (primitively the third) premaxillary teeth.

PALATINE FENESTRÆ.—These cavities are large; they are triangular in outline, differing in this respect from all other Recent crocodiles. Their borders are internal, antero external, and postero-external; the first of these borders is nearly straight, but is very slightly concave, and is nearly antero-posterior in direction; it is the longest of the three borders. The antero-external border of each is second in length, and the postero-external is the shortest, being about half the length of the antero-external. The two external borders make angles of slightly over 90° with each other. The anterior ends are accordingly sharp, the posterior ends less so, and the external angles almost right angles. The fenestræ extend forward to the level of the spaces between the twelfth and thirteenth maxillary teeth in the smaller specimen, and about to the level of the posterior edges of the thirteenth maxillary teeth in the larger specimen; the two fenestræ do not correspond with the teeth equally, or perhaps the teeth do not correspond with the fenestræ equally on the opposite sides of the larger skull.

INTERNAL NARIAL APERTURE.—This cavity is of moderate size, and is not far from round; in the smaller skull it is slightly longer than broad.



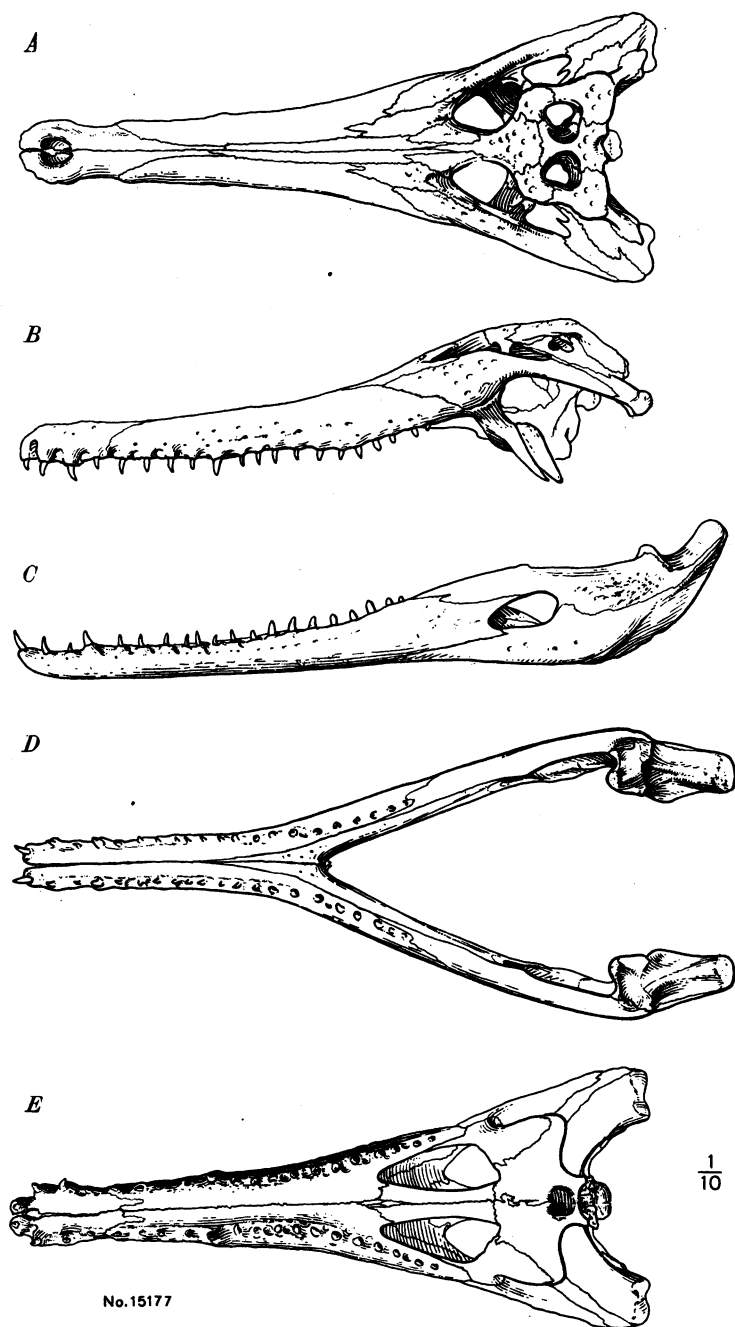


Fig. 2. Skull and jaws of *Tomistoma schlegelii* Müller. Amer. Mus. No. 15177, one-tenth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

In the larger skull it faces downward and slightly forward; in the smaller skull the aperture faces downward and slightly forward, but the roof of the nasal passage slopes backward in such a way that the passage faces slightly backward as well as downward.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are long and slender. In the smaller skull they extend back to the level of the sixth maxillary teeth, and in the larger one they extend to the spaces between the fifth and sixth maxillary teeth. Their sutures with the maxillaries become more and more near a longitudinal direction as they leave the borders of the snout. There are thus no sharply defined posterior processes separated off from the main masses of the bones. The median suture of the two premaxillaries with each other anterior to the nasals is long. The amount of lateral expansion of the premaxillaries, external to the narial aperture, is slight. The very deep notches between the first and second premaxillary teeth are clearly visible from above.

On the palate the premaxillo-maxillary suture forms a distinct letter W, the apex of which is directed forward. The posterior extension of the suture is directly opposite the second maxillary teeth in the smaller skull studied, and slightly farther back in the larger one. The apex of the W is opposite the first maxillary teeth in the larger skull, and very slightly farther back in the smaller one.

Each premaxillary has four teeth; this is equally true of both large and small skulls. Boulenger states that the young individuals have five teeth in each premaxillary, and that the second is lost with age, as in some species of *Crocodylus*. The elimination of the second teeth evidently takes place at a very early stage, as in the smaller of the two skulls studied the alveoli of these teeth are almost completely obliterated. The four premaxillary teeth are all widely spaced from each other, and are all situated upon elevated pedestals. Between these pedestals are very deep notches which lodge the mandibular teeth; these notches are very deep vertically, but with the exception of those between the first and second teeth do not excavate the lateral borders of the skull. Of the four premaxillary teeth of each side the third (primitively the fourth) is the largest.

**MAXILLARIES.**—The maxillaries are long and slender. Their most conspicuous feature is a prominent inrolling of their infero-lateral borders; this inrolling has gone so far that a portion of the external surface of each maxillary, posterior to the fifth maxillary tooth, faces downward and outward; this is especially conspicuous in the older skull.

The contacts of the maxillaries with the premaxillaries have been described above. The sutures with the nasals are relatively short, owing to the short anterior extension of the nasal bones. The sutures with the lacrymals are more complex in outline than in most crocodilians, and resemble somewhat those of *Gavialis*. Each suture leaves the nasal border at the level of the posterior edge of the tenth maxillary tooth in the smaller skull, and of the eleventh in the larger skull, and extends backward and slightly outward for a distance about equal to that between two of the maxillary teeth, then extends almost directly forward to a point a short distance anterior to its origin, and then outward and backward to a point above the space between the thirteenth and fourteenth maxillary teeth, where the maxillary, lacrymal, and jugal bones come in contact. A short posterior process of each maxillary wedges apart two anterior processes of the lacrymal. The suture of each maxillary with the jugal is more or less irregular.

The path of the premaxillo-maxillary suture on the palate has been described above. The maxillo-palatine suture is characteristic in outline; it extends little forward of the level of the anterior ends of the palatine fenestræ. From a point near the anterior end of each fenestra the maxillo-palatine suture extends backward and inward to a point opposite the thirteenth maxillary tooth in the small skull, and the fourteenth in the larger one, then inward and forward to a point opposite its origin. Its path is then slightly different in the two skulls; in the smaller one it continues in the same direction to a point slightly anterior to the twelfth maxillary teeth, and at the median line. The two portions of the suture together make a figure like a letter V. Posterior to the apex of this V, at the median line, the suture between the maxillaries and the palatines gives way to the minute sutures between the maxillaries and the prevomers; in the smaller skull these bones are scarcely distinguishable, but they do interrupt the contacts of the maxillaries and the palatines very slightly. In the larger skull the maxillo-palatine sutures are more complex, due to the arrangement of the prevomers. The sutures extend inward and backward from the anterior ends of the palatine fenestræ as in the smaller skull, then turn similarly forward and inward; and at the level of the anterior ends of the fenestræ turn almost directly inward. On the left side there is no process of the palatine anterior to the fenestra; on the right side a very small process wedges forward between the maxillary and the prevomer.

The contacts with the prevomers are nearly antero-posterior; they meet the median line about at the level of the twelfth maxillary teeth; they are unequally long on the opposite sides of the skull.

Each maxillary contains sixteen teeth. The fifth of these is much greater than any of the others, especially in the larger skull. The first four teeth, and the sixth to the ninth inclusive, are approximately equal in size; they are relatively long and slender, and are sharp-pointed. The teeth from the tenth to the sixteenth, inclusive, are much stouter than the anterior ones, but are not blunt. They increase in size from the tenth to the twelfth, which is only slightly smaller than the fifth, and then decrease to the sixteenth. The anterior five teeth are slightly curved, and point downward. Their convex borders are anterior in position. The teeth between the fifth and the twelfth have a tendency to point inward as well as downward; this is much more conspicuous in the larger skull than in the small one; it is correlated with the inrolling of the external surface of the skull at this level.

The first five teeth in each maxillary stand on prominent pedicles; from the fifth backward the pedicles are present, but are not conspicuously developed. They are separated by pits which lodge the mandibular teeth, as far back as the spaces between the fourteenth and the fifteenth. The mandibular teeth bite between the premaxillary and maxillary teeth, and in line with them. The anterior maxillary teeth are very far apart; back of the great fifth tooth the teeth on each side are situated irregularly closer and closer together, until the sixteenth is rather close to the fifteenth; none of the teeth are very close together.

NASALS.—The nasal bones of this form are very characteristic in outline. They are intermediate in form and position between those of the gavial and those of the true crocodiles. They articulate with the premaxillaries anteriorly as in *Crocodylus*, separating the maxillaries from a median contact with each other on the surface of the snout, such as is present in *Gavialis*. They differ from those of the true crocodiles, however, in being widely separated from the external narial aperture.

Their anterior extremities, along the median line, are above the spaces between the fourth and fifth maxillary teeth. The posterior ends of the premaxillo-nasal sutures are at the level of the fifth maxillary teeth in the smaller specimen, and slightly farther back in the larger one. The sutures with the maxillaries are relatively short; those with the lacrymals are relatively long; those with the prefrontals are shorter than those with the lacrymals, and are very irregular in outline.

From their anterior extremities backward the nasals broaden with only slight irregularities to the level of the tenth or eleventh maxillary teeth, where the bones reach their maximum breadth; from this point back, they retain this breadth, the lateral borders being parallel, to the

level of the space between the fourteenth and fifteenth maxillary teeth in the larger specimen, and of the thirteenth maxillary teeth in the smaller specimen. At this level they extend irregularly inward, then extend almost directly backward to their posterior ends in the form of long very slender processes; these processes are slightly wedged apart by the narrow, acuminate anterior process of the frontal. In the smaller skull the two posterior processes of the nasals are very unequal in breadth.

**LACRYMALS.**—The lacrymals are large, especially in the longitudinal direction. The maximum length of each is over four times its greatest breadth in the larger skull, and over five times in the smaller one. The two lacrymals converge only very slightly in the anterior direction. Their anterior extremities are not situated along the nasal border, but at the ends of anterior processes which wedge forward into the maxillaries, and are in turn separated from the nasal borders by posterior processes of the maxillaries. Each lacrymal carries a low, rough ridge, which extends forward, and very slightly inward from the anterior border of the orbit.

**PREFRONTALS.**—The prefrontals are long and slender, and of medium size. Their orbital and lacrymal borders make approximately equal angles with the longitudinal axis of the skull, and the latter border is longer than the former. The transverse portions of the prefronto-frontal sutures, and of the naso-prefrontal sutures, are short; the longitudinal portions of these sutures comprise nearly parallel antero-posterior internal boundaries to the prefrontal bones. Each prefrontal has a small finely rugose area on its posterior portion, over the orbit.

**FRONTAL.**—The frontal is of moderate size. Its anterior portion is very much smaller than its posterior. Its anterior process, between the prefrontals, is narrow, and has parallel borders; its anterior extremity, which wedges between the posterior ends of the nasal bones, is very slender and sharp. The interorbital portion of the frontal is of moderate width, and is slightly concave. The posterior plate of the frontal is broad, and extends rather far back posteriorly; it does not, however, extend back to the supratemporal fenestræ; in transverse profile it is slightly concave.

**POSTORBITALS.**—These bones are rather small in size. Their external and orbital borders are about equal in length, and merge into each other at the rounded antero-external angles of the cranial table. Their sutures with the squamosals are not directly transverse, but extend backward and inward.

**SQUAMOSALS.**—The squamosal bones are moderately large; they occupy about two-thirds of the posterior border of the cranial table, and an equal amount of each lateral border.

**PARIETAL.**—The parietal is nearly as broad at its posterior as at its anterior end. Its median bar, between the two supratemporal fenestræ, is long and slender. Along its posterior border the parietal is deeply indented, both vertically and horizontally; this is especially true in the older skull. The surface of the posterior plate of the bone is slightly concave.

**SUPRAOCCIPITAL.**—The supraoccipital comprises no part of the surface of the cranial table, but a small portion of it occupies the floor of the small cirque-like depression at the center of the postero-superior border of the skull. This floor is much broader than it is long.

On the posterior surface of the skull the supraoccipital extends downward about two-thirds of the distance from the posterior borders of the cranial table to the foramen magnum; laterally its breadth is slightly greater than one-third of the breadth of the cranial table.

**EXOCCIPITALS, BASIOCCIPITAL, AND BASISPHENOID.**—These bones possess no characters which differ sufficiently from those of other Recent crocodilians to require special description.

**QUADRATES.**—The quadrates are characterized only by their irregular sutures with the quadrato-jugals.

**QUADRATO-JUGALS.**—The sutures of the quadrato-jugals with the quadrates are exceedingly irregular; in their outlines they approach the condition of the gavial rather than that of the true crocodiles. Each quadrato-jugal possesses a sharp anterior process, which is intermediate between those of the true crocodiles and those of the gavial, but is closer to the former than to the latter. This process is long and slender; it rises from the anterior edge of the bone, and not from its external surface as in the gavial; its lower border is not, however, a direct antero-superior continuation of the contact of the quadrato-jugal with the jugal, but is separated from this border by an antero-inferior process of the bone. Each quadrato-jugal therefore forms a very small portion of the inferior border of the infratemporal fenestra, as well as its posterior border.

**JUGALS.**—The jugals are rather large; in general form they appear to be unusually long and slender, but each has a rather prominent superior process near the anterior end of the orbit; this process tends to constrict the posterior end of the orbit.

**PALATINES.**—The sutural connection of the palatines with the maxillaries has been described above. The palatines are slightly separated from each other at their anterior ends by the slender prevomers, which appear at the surface of the palate. The suture of the palatines with the pterygoids is irregularly transverse.

In form the palatine bones are very slender, although they have very slight anterior and posterior lateral expansions.

PREVOMERS.—These bones appear at the surface of the palate; the species therefore differs from all other Recent crocodilians except *Caiman niger*. In the latter species, however, the prevomers appear at the anterior end of the palate, along the boundaries of the maxillaries and premaxillaries, and not back near the palatines. In *Tomistoma schlegelii* they are situated posterior to the median portions of the maxillaries. In the smaller of the skulls studied they appear as thin slivers of bone, which separate the anterior ends of the palatines from each other; in the larger skull they partly replace the anterior processes of the palatines. Posterior to them is a median bone, also separating the palatines, which may be related to them in composition.

PTERYGOIDS.—The sutures of the pterygoids with the ectopterygoids converge sharply forward; they are irregular in outline. The median suture of the two pterygoids with each other along the palatal surface is exceedingly irregular. Each pterygoid forms a very small portion of the posterior border of the palatine fenestra. The posterior processes of the pterygoids are very large. The internal narial aperture is situated only partly on the general palatal surface, part of it being situated on a posterior extension of the bone, back of the level of its principal posterior border; the posterior processes extend back from this and partly embrace the basisphenoid. The notch at the posterior end of the pterygoids is horizontal only, not vertical also, as in most crocodiles.

ECTOPTERYGOIDS.—The anterior processes of the ectopterygoids are unusually small, both in length and thickness. The postero-inferior processes are large and thick, and the superior processes medium in size.

### The Mandible

The mandible of this species is distinctly intermediate in form and structure between the gavial and the true crocodiles. In general form it corresponds with the snout, being long and slender, and spreading rather abruptly at a point about one-third of its total length back from its anterior end. The symphysis is very long, extending back to the level of the fifteenth teeth; it is not as long as in the gavial, however. The splenial bones are very long, and together form a conspicuous portion of the posterior portion of the symphysis. They vary in their anterior extent on the opposite sides of both of the specimens studied; their anterior processes end at the ninth or tenth teeth. Their anterior symphyseal portions are much shorter than their posterior portions. The

mandible is very low vertically in its anterior portion, but is rather high posteriorly. The external mandibular foramen on each side is elongate; above it the surangular bone has a slight process on its superior border, extending inward and slightly upward.

Each ramus of the mandible contains twenty teeth. These are all rather far apart, and their intervening spaces are practically equal. There is a slight variation from this, however: from the first to the seventh or eighth they are rather far apart, the second and third being considerably so; the eighth and ninth are closer together; posterior to the ninth the teeth are all moderately far apart. The first tooth in each mandible is the longest; the fourth is second in size; the thirteenth or the fourteenth is also large. The teeth between the fourth and the thirteenth are small. In the larger specimen the teeth posterior to the fourteenth are rather large, but in the smaller specimen they are small; this difference is probably due to variations in the stages of development of the individual teeth. The anterior teeth are very slender and sharp; the posterior ones are stouter, but are still rather sharp. The larger teeth are rooted in pedicles, and all of the teeth are separated from each other by deep pits. Those of the posterior end of the series are directed slightly inward, as in the upper jaws, and the external surfaces of the mandible face slightly upward as well as outward. The upper and lower jaws together, therefore, are somewhat indented along the posterior portions of the dental borders.

#### Measurements

	Amer. Mus. No. 15177	Mus. Comp. Zool. No. 12459
Length of Skull, Tip of Snout to Supraoccipital	.765M.	.537M.
Length of Skull, Tip of Snout to Ends of Quadrates	.842	.586
Length of Snout	.577	.400
Breadth of Snout at Base	.204	.100
Breadth of Cranial Table	.188	.118
Breadth of Skull Across Quadrato-jugals	.352	.212
Breadth of Interorbital Space	.040	.023
Breadth of Space Between Supratemporal Fenestræ	.017	.010
Length of Mandible, Total	.935	.650
Length of Symphysis	.410	.310
Breadth of Mandible, Total	.372	.213

#### Remarks

In many respects this species is intermediate in character between the gavial, on the one hand, and the true crocodiles on the other. In the totality of its characters, however, the resemblance to the true croco-



diles is considerably the greater; the resemblances to the gavial may be largely explained as similar adaptations to corresponding modes of living.

### **CROCODILUS** Laurenti

#### GENERIC CHARACTERS

This genus includes a large proportion of the species of the living crocodiles. All of the living species, and many fossil ones as well, have seventeen to nineteen teeth in the upper jaw, and fifteen only in the lower; the fifth maxillary tooth is always enlarged. Typically the fourth mandibular tooth, on each side, fits into a notch in the upper jaw, along the lateral component of the premaxillo-maxillary suture; in some of the broader snouted species, however, this character varies somewhat, the fourth mandibular tooth biting into a pit as in the alligators. It is very probable that this condition varies to some extent with the age of the individual. The sides of the snout are prominently festooned vertically. The nasal bones usually reach and enter the narial aperture, but occasionally fall short of it. The quadrato-jugals always have sharp anterior processes which enter the infratemporal fenestræ. The supratemporal fenestræ are small and are usually close together. The cranial table is usually of moderate size; it varies considerably in size; a small bony plate is usually present in each upper eyelid. The mandibular symphysis is relatively short, not extending back of the eighth teeth in any species, and usually not back of the fifth; the splenial bones form no part of the symphysis.

This genus, which is variable in form at the present time, and appears to have been in the past, is evidently near the central line from which most of the existing crocodilians have sprung.

### **Crocodylus americanus** Laurenti

This description of the skull of *Crocodylus americanus* is based upon studies of a large series of skulls of this species. The material which comprised the principal source of information includes three very young skulls in the collections of the Museum of Comparative Zoology (Mus. Comp. Zool. Nos. 5002, 5007, and 5008, two somewhat older specimens, (Amer. Mus. No. 15182) and (Mus. Comp. Zool. No. 5032), four half-grown skulls in the American Museum collections (Amer. Mus. Nos. 15175, 7120, 7132, and 7121), and a huge old skull in the American Museum (Amer. Mus. No. 7139); in addition to these three other skulls, one half grown, one more than half grown (Mus. Comp. Zool. Nos. 5391, 10921), and the other large, were used for verification of these characters.

### General Form

The skull of *Crocodylus americanus* is usually identifiable from its form alone. The form is variable, however, and grades toward the form of the skull of *C. niloticus*. The cranial table is relatively small, and is not concave, even in old individuals. Its straight lateral borders converge slightly in the anterior direction, and the antero-external angles are rather sharp. The snout is usually long and slender; occasionally this character is not emphasized, two skulls studied having the snout relatively stout (Amer. Mus. No. 7121 and Mus. Comp. Zool. No. 10921). Boulenger states that the snout ranges from once and three-fifths to twice and one-fourth as long as broad at the base; in one of the skulls studied (Amer. Mus. No. 7139) the snout is about two and one-half times as long as broad at the base. A characteristic feature of the snout of this species is a median elevation a short distance in front of the orbits. This is absent in the very young individuals, but appears in an inconspicuous manner in a 11.6 cm. specimen (Mus. Comp. Zool. No. 5007). From this size up to the maximum in the series studied the elevation is prominent in most of the specimens. In a few, such as Amer. Mus. No. 7121 and Mus. Comp. Zool. No. 10921, it is not conspicuous; these skulls, however, differ somewhat from typical *C. americanus* skulls in a number of respects; one of them is a Cuban specimen, and it is quite likely that the other has come from a different locality than the larger part of the series, consequently the differences may be ascribed to geographic variation. This median elevation is unknown in other modern species of *Crocodylus*, and when typically developed makes the species easily recognizable. The elevation is composed for the greater part of portions of the nasal bones, but the surrounding bones, maxillaries, lacrymals, and prefrontals, also enter into it.

The lateral "canine" constriction is very deep, except in very young individuals, and the constriction posterior to the seventh maxillary teeth is rather deep. The vertical festooning is prominent in both upper and lower jaws. The teeth of the upper jaw frequently excavates conspicuous grooves on the margins of the lower jaw.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—These fenestræ are relatively small and close together. Except in the very young skulls they are nearly circular; in the latter they are oval. In the very young skulls they are larger than the external narial aperture; in the half-grown and adult skulls they are smaller.

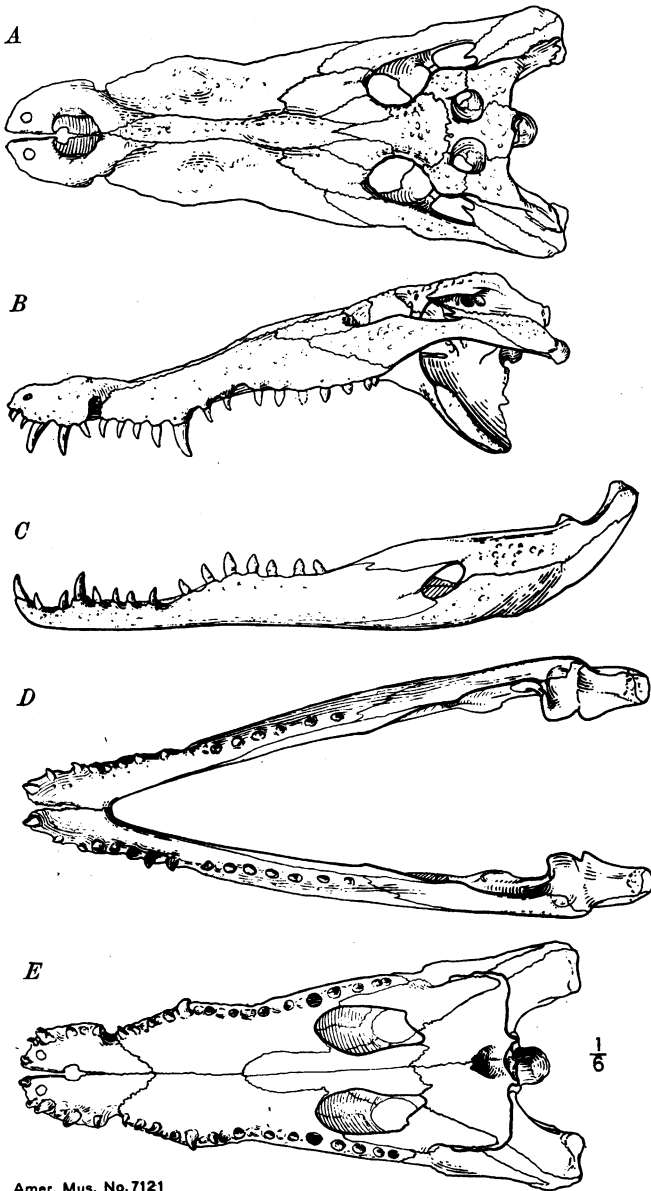


Fig. 3. Skull and jaws of *Crocodilus americanus* Laurenti. Amer. Mus. No. 7121, one-sixth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible, left side; E, inferior view of skull.

**INFRATEMPORAL FENESTRÆ.**—These fenestræ have the usual crocodilian subtriangular outline and partial division into two portions by the quadrato-jugal processes. They are slightly larger than the supratemporal fenestræ.

**ORBITS.**—The orbits are very large in the younger specimens and relatively smaller in the older ones. They are round in outline, and slightly longer than broad; they are moderately far apart.

**EXTERNAL NARIAL APERTURE.**—This cavity is moderately large, and is nearly circular in outline. It is usually penetrated by the anterior processes of the nasal bones.

**PREMAXILLARY FORAMEN.**—The premaxillary foramen is small; it is heart-shaped in outline, and its lateral diameter nearly equals its length.

**PALATINE FENESTRÆ.**—The palatine fenestræ extend forward as far as the tenth maxillary teeth. Their sides are nearly parallel, and their anterior ends are rounded. Their posterior ends vary from broadly rounded to pointed.

**INTERNAL NARIAL APERTURE.**—The internal narial aperture is partly divided by a median bony septum. It opens obliquely backward and downward.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are of moderate length. They never extend back of the fourth maxillary teeth, and usually not behind the third. They are sometimes slightly elevated around the narial aperture, and are frequently crossed, posterior to the narial aperture and anterior to the premaxillo-maxillary sutures, by a pair of low oblique ridges. The pits which lodge the first mandibular teeth usually penetrate through the superior plate of the premaxillaries.

On the palate the premaxillo-maxillary suture is variable in form. In some skulls it is V-shaped, in others it is W-shaped. In one skull (Amer. Mus. No. 7121) it extends back behind the level of the third maxillary teeth; in other skulls it does not extend back beyond the level of the second maxillary teeth. Each premaxillary contains five teeth, the second of which is small, as in most species of *Crocodylus* which possess five premaxillary teeth. The first and second are widely spaced apart, the second and third are close together, while the third and fourth, and the fourth and fifth are moderately far apart. The great pits, or foramina, which lodged the first mandibular teeth are situated slightly internal to the first and second premaxillary teeth, rather than in direct line with them. The pits which lodged the second and third mandibular

teeth are situated between the third and fourth, and fourth and fifth premaxillary teeth respectively, and not internal to them. In Amer. Mus. No. 7120 and No. 3070 the premaxillary teeth extend obliquely downward and forward.

**MAXILLARIES.**—The maxillaries are long and slender; they narrow slightly immediately posterior to the seventh maxillary tooth. They are elevated into prominent tuberosities over the spaces between the fifth and sixth maxillary teeth; these tuberosities lodge the elongated roots of the great fifth maxillary teeth. In the youngest specimen in the collections studied (Mus. Comp. Zool. No. 5002) they are nearer the orbits than the narial aperture; in the oldest specimen (Amer. Mus. No. 7139) they are situated about twice as far from the orbits as from the narial aperture. The intervening specimens have these tuberosities in intermediate positions.

On the palate the maxillaries are not very distinctive. The maxillo-palatine sutures extend inward and backward from the anterior ends of the palatine fenestræ, then turn sharply forward and meet at the median line opposite the seventh maxillary teeth. This suture varies considerably in form. In some skulls it extends forward as a straight line on each side, then turns abruptly and meets its opposite in an almost transverse direction at the level mentioned above; in other cases it curves gradually forward and inward, meeting its opposite in a rather sharp point. There are typically fourteen teeth in each maxillary, but one specimen (Amer. Mus. No. 7132) has only thirteen, and another (Amer. Mus. No. 7120) has thirteen on the right side and fourteen on the left. The teeth are all situated moderately far apart from each other, and are separated by pits, or in some cases, grooves, which lodge the mandibular teeth; these pits or grooves are all in line with the teeth, and not internal to them. The anterior teeth are long-crowned, sharp-pointed, and curved; the posterior ones are shorter-crowned, less sharp, and nearly straight; there is a gradation between the two conditions. Although the posterior teeth are not so sharp as those in the anterior portions of the maxillaries, they are not blunt as in some crocodilians, such as *Caiman sclerops*. The maxillary teeth increase regularly in size from the first to the fifth, then decrease more or less irregularly to the fourteenth.

**NASALS.**—The nasals are relatively narrow, except for a short distance not far forward of the orbits, in which distance they are expanded. This expansion extends along the area occupied by the median elevation of the snout; it reaches a maximum breadth slightly anterior to the level of the ninth maxillary teeth. At the posterior end the nasals are wedged

apart by the relatively broad anterior process of the frontal. At their anterior ends the nasals project into the narial aperture at the surface in some specimens, in others they are covered by the premaxillaries at the surface, but enter the aperture at a lower level.

**LACRYMALS.**—In the younger specimens the lacrymals approximately equal the prefrontals in surface area; in the older ones the lacrymals are considerably larger than the prefrontals. In both young and old individuals the sutures with the nasals are very short. In form the bones are irregular, and are not especially characteristic.

**PREFRONTALS.**—As noted above, the prefrontals equal the lacrymals in size in the younger specimens, but are much smaller in the older ones. Their sutures with the nasals are longer than the naso-lacrymal sutures in both young and old specimens. The prefrontals differ slightly from those of *Crocodilus niloticus* in that their lateral borders have opposite curves, both internal and external sides of the bones being convex, contrasting with the concave external borders and convex internal borders in the latter species.

**FRONTAL.**—The frontal bone is of moderate size, and is not especially characteristic in outline. Its anterior process equals in length its posterior plate. Its anterior wedge, between the posterior ends of the nasals, is short and broad.

**POSTORBITALS.**—These bones are of medium size; they are relatively long and narrow. They compose very small portions of the anterior walls of the supratemporal fenestræ.

**SQUAMOSALS.**—In the youngest specimen examined (Mus. Comp. Zool. No. 5002) the external and posterior borders of the squamosals are elevated into distinct ridges; these are lost in the remainder of the series. Each squamosal occupies about one-third of the posterior border of the cranial table.

**PARIETAL.**—The parietal bone occupies a considerable space anterior to, as well as between and posterior to, the supratemporal fenestræ. The supraoccipital enters the posterior portion of the parietal as a wedge in the younger specimens, but this wedge becomes progressively reduced with age, until in the oldest specimen (Amer. Mus. No. 7139) the parietal occupies the entire posterior border of the cranial table.

**SUPRAOCCIPITAL.**—As noted above, the supraoccipital occupies a small wedge-shaped area on the surface of the cranial table in the younger specimens. This wedge is comparatively long and narrow. With age it rapidly decreases in size, until in a half-grown individual it is scarcely visible from above; in the great adult specimen (Amer. Mus. No. 7139) it is absent from the cranial table altogether.

On the posterior aspect of the skull the supraoccipital occupies a large triangular-shaped area, which in the very young specimens extends downward nearly to the foramen magnum. This position, or extent, is retained until the skulls are about half-grown. At this stage the supraoccipitals in some of the skulls extend nearly to the foramen magnum, and in others they extend only about two-thirds of the distance down from the superior border. In Amer. Mus. No. 7139 it extends scarcely two-thirds of the distance down from the superior border to the foramen magnum.

**QUADRATO-JUGALS.**—The quadrato-jugals are characteristic only in that the anterior processes which project into the infratemporal fenestræ are very sharp, but are not long.

**QUADRATES, EXOCCIPITALS, BASIOCCIPITAL, AND BASISPHENOID.**—These bones are not characteristic in form.

**JUGALS.**—The jugal bones are of moderate length, and are neither thick nor thin. In the younger individuals they extend as far forward as the seventh or eighth maxillary teeth; in the older specimens they are situated progressively farther and farther back, until in the oldest specimen (Amer. Mus. No. 7139) they do not reach the level of the tenth maxillary teeth.

**PALATINES.**—The sutures of the palatines with the maxillaries have been described in discussing the latter bones. The suture with the pterygoids is somewhat variable in direction, at the same time having certain elements in common in all the specimens. In none of the specimens is it directly transverse. Typically it extends backward and inward on each side from a point near but not at the posterior end of the palatine fenestra, then irregularly inward across the median line, and in a similar direction on the opposite side. The external portions are constant in direction, but the inner portion is somewhat variable. In one specimen (Amer. Mus. No. 7121) this inner portion takes the form of a V, with the apex directed forward; in several other specimens it forms a very broad V; in still others it is irregularly curved.

The palatines are constricted somewhat about three-fifths of their length back from their anterior ends. This constriction is slight in the younger skulls, but is more pronounced in most of the older ones, and is very marked in Amer. Mus. No. 7139. In one half-grown skull (Amer. Mus. No. 15175) it is scarcely noticeable.

**PTERYGOIDS.**—The pterygoids occupy small but appreciable portions of the posterior ends of the palatine fenestræ. They are

# Measurements

	Mus. Comp. Zool.		Amer. Mus.	Mus. Comp. Zool.	Amer. Mus.				
	No. 5002	No. 5008	No. 5007	No. 15182	No. 15175	No. 7120	No. 7132	No. 7121	No. 7139
Length of Skull, Tip of Snout to Supra-occipital	.063M.	.088M.	.116M.	.193M.	.308M.	.379M.	.395M.	.403M.	.735M.
Length of Skull, Tip of Snout to Ends of Quadrates	.061	.090	.120	.205	.337	.416	.430	.443	.793
Length of Snout	.033	.052	.071	.126	.206	.256	.274	.280	.534
Breadth of Skull, Across Quadrato-jugals	.027	.039	.050	.084	.149	.1935	.183	.200	.368
Breadth of Cranial Table	.0212	.027	.033	.050	.084	.115	.123	.1155	.1815
Breadth of Snout at Base	.021	.027	.035	.057	.110	.115	.135	.146	.231
Breadth of Snout, Across Fifth Maxillary Teeth	.016	.021	.027	.045	.082	.086	.099	.120	.185
Length of Mandible	.068	.101	.135	.221	....	.473	....	.493	.895
Breadth of Mandible, Maximum	.026	.041	.051	.088	....	.192	.188	.227	.380



moderately long in proportion to their breadth, and their lateral borders, or sutures with the ectopterygoids, converge sharply in the anterior direction.

**ECTOPTERYGOIDS.**—These bones are not especially characteristic in form or proportions; the three processes of each are not far from being equal in size, though the superior process is somewhat smaller than the other two, and the anterior process is more slender than the inferior one. The ectopterygoids extend as far forward as the eleventh maxillary teeth, or as the spaces between the eleventh and twelfth maxillary teeth.

### Mandible

The mandible of this species contains the usual crocodilian number of fifteen teeth in each ramus. These are more or less unevenly spaced, and are often separated by grooves which lodged the superior teeth. The anterior eight or nine teeth are slender, while the posterior six or seven are broader in the antero-posterior direction, but are not blunt. In the older individuals several of the teeth rise from elevated pedestals. The anterior teeth extend outward as well as upward in some of the specimens, corresponding to the oblique position of some of the teeth in the upper jaws.

### **Crocodylus cataphractus** Cuvier

The description of this species is based upon a sixteen inch skull in the American Museum Collections (Amer. Mus. No. 10075).

### General Form

The skull of this species is exceedingly long and slender. In its general appearance it resembles the skull of *Tomistoma schlegelii*. The snout is especially long and slender. Boulenger states that it is twice and two-thirds to thrice and one-third as long as broad at the base. It is considerably expanded at its anterior end, and slightly expanded at the fifth maxillary teeth. The surface of the snout is low and relatively smooth.

The cranial table is small, especially in the lateral direction. It is flat, and its posterior border is formed of a double curve, the supra-occipital region extending outward as a short process and interrupting the concave border of the table. The lateral borders of the table are nearly parallel, but converge very slightly in the anterior direction. The antero-external angles of the table are rounded.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—These cavities are of medium size, and are rather close together. Each of them is about equal to the narial aperture in size. In comparison with the small size of the cranial table the cavities are large. They are irregularly subcircular in outline; their axes of maximum diameter converge posteriorly.

**INFRATEMPORAL FENESTRÆ.**—The infratemporal fenestræ are small. They are subtriangular in outline, and are partially divided into superior and inferior portions by the sharp process of the quadrato-jugals, which is unusually large.

**ORBITS.**—The orbits are moderately large; their antero-posterior diameters are considerably greater than their transverse. They are situated a moderate distance apart from each other.

**EXTERNAL NARIAL APERTURE.**—The narial aperture is subtriangular in outline; the apex of the triangle is at the posterior end, and the curved base at the anterior end. The antero-posterior diameter is greater than the transverse. The nasal bones do not reach the cavity, but the premaxillaries send forward a very short median process into it; this process does not reach the superior surface of the skull, but extends into the aperture at a deeper level only.

**PREMAXILLARY FORAMEN.**—This cavity is heart-shaped and is small in size; its transverse diameter is as great as its length.

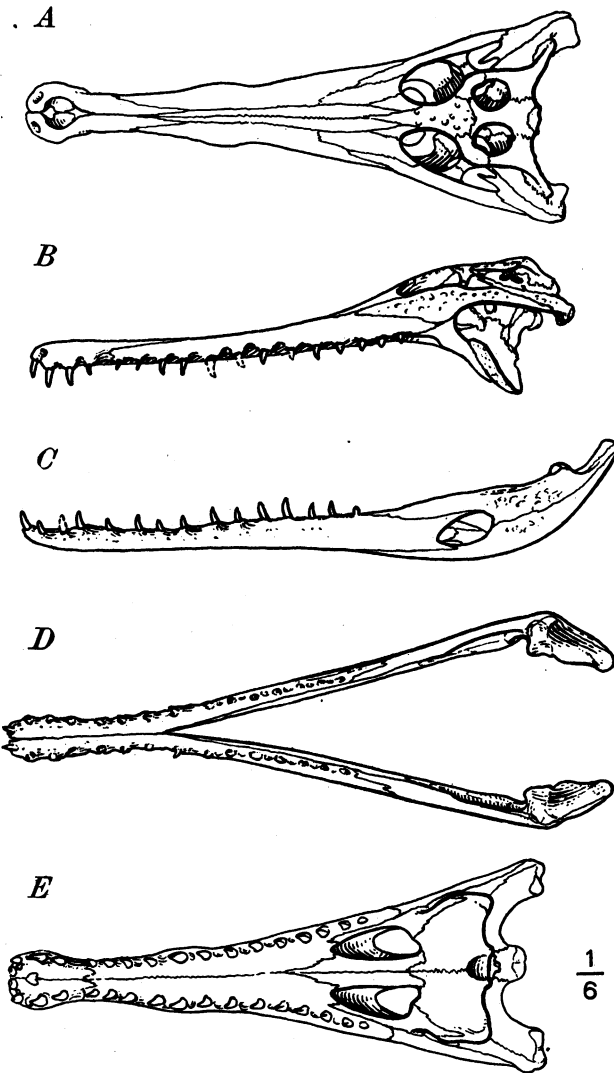
**PALATINE FENESTRÆ.**—The palatine fenestræ are long and narrow. Their anterior ends are sharp; the internal borders are concave, while the external borders are nearly straight lines; the external borders turn inward sharply near their posterior ends, and merge into the posterior borders, which are oblique in position. The fenestræ extend as far forward as the eleventh maxillary teeth. They differ from those of most crocodilians in extending farther back beyond the teeth than they do forward along side of the teeth.

**INTERNAL NARIAL APERTURE.**—This opening is relatively small.

It is directed sharply backward as in *C. porosus* and not downward as in most crocodilians.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are characteristic in form. Their anterior portions are expanded considerably, especially near the anterior ends of the narial cavity. At the "canine" notches the bones are somewhat constricted. The posterior processes are long and slender; they extend back as far as the level of the fourth maxillary teeth. Pos-



Amer. Mus. No.10075

Fig. 4. Skull and jaws of *Crocodilus cataphractus* Cuvier. Amer. Mus. No. 10075, one-sixth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

terior to the narial aperture the two premaxillaries meet each other along the median line, excluding the nasals from the aperture.

The premaxillo-maxillary suture on the palate is irregularly W-shaped; it does not extend back beyond the level of the second maxillary teeth, and the median apex of the W does not extend forward beyond the level of the first maxillary teeth. There are four teeth in each premaxillary, the second tooth of the more primitive crocodiles not being represented. The teeth are all far apart, and are about equally spaced. The pits which lodge the mandibular teeth are conspicuous, and are in line with the teeth themselves, and not internal to them. The pits which lodge the first mandibular teeth have pierced the surface of the skull, opening up two large foramina. The first premaxillary teeth are absent in the specimen, but their alveoli indicate that they are the smallest teeth in these bones. The second teeth are the largest, the third are second in size, and the fourth not much larger than the first.

**MAXILLARIES.**—The maxillary bones are long and narrow. Their sutures with the premaxillaries, nasals, and ectopterygoids are very long, and their sutures with the lacrymals and jugals moderately long.

On the palate their sutures with the palatines are peculiar. These sutures extend inward and slightly backward from the anterior ends of the palatine fenestræ, for a very short distance, and then inward and forward in irregular lines to the median line, where they meet opposite the ninth maxillary teeth. These sutures converge sharply, and have no suggestion of the more or less parallel arrangement observable in many crocodiles. The ectopterygoids extend so far forward that the maxillaries have only a very small place in the external borders of the palatine fenestræ. The suture with the premaxillaries has been described above.

There are only thirteen teeth in each maxillary. These teeth are more or less evenly spaced, and are all far apart. They are separated from each other by spaces which contain pits for lodgment of the mandibular teeth, except posterior to the eleventh, where the pits die out. The teeth themselves, especially the larger ones, appear to be elevated on small pedicles. The palatine surface of the maxillaries is decidedly convex in the transverse direction, and in consequence the teeth extend outward, somewhat as they do in *Tomistoma schlegelii*. The teeth increase in size in the maxillaries, regularly from the first to the fifth, then decrease. The anterior eight or ten maxillary teeth are very sharp and slender; the posterior teeth have relatively short crowns, and are not so sharp as those farther forward in the mouth. None of the maxillary teeth, however, are very blunt. Each maxillary extends backward a considerable distance beyond the last maxillary tooth.

**NASALS.**—The nasals are exceedingly long and slender. Posteriorly they are wedged apart by a short process of the frontal; a short distance anterior to this point they expand considerably in breadth, reaching their maximum breadth at the level of the ninth or tenth maxillary teeth. Anterior to this they become gradually more and more constricted, and finally disappear from the surface of the skull as very slender processes at the level of the second maxillary teeth. The sutures of the nasals with the lacrymals and prefrontals are both relatively long, and the former is about two-thirds as long as the latter.

**LACRYMALS.**—The lacrymal bones in this species are long and slender. They occupy about three times as much space upon the superior surface of the skull as the prefrontals, and portions of the orbital borders equal in extent to the prefrontal portions. They extend as far forward as the level of the ninth maxillary teeth.

**PREFRONTALS.**—The prefrontals are small; their internal and external borders converge anteriorly, so that the bones terminate in sharp points. Posteriorly they are rather broad.

**FRONTAL.**—This bone is relatively short antero-posteriorly in proportion to its breadth, as compared with the prefrontals and lacrymals. The anterior process does not extend very far forward between the nasals.

**POSTORBITALS.**—The postorbital bones are very small; they occupy perhaps one-third as much area as that occupied by the squamosals. The pits on them are large.

**SQUAMOSALS.**—The squamosals are large; they are smooth near their contacts with the parietals, but are deeply pitted elsewhere on the cranial table.

**PARIETAL.**—The parietal is relatively narrow. It occupies only a very small portion of the posterior border of the cranial table, owing to the considerable breadth of the supraoccipital; the pitting of the bone is somewhat different from that of the surrounding bones, having only a very few large, widely spaced pits.

**SUPRAOCCIPITAL.**—This bone is characteristic in form. On the cranial table its antero-posterior extent is very slight, but its lateral extent is considerable; consequently it occupies a large portion (nearly three-fourths) of the border of the cranial table between the two squamosals. On the posterior surface of the skull it extends downward about two-thirds of the distance from the superior border to the foramen magnum.

**QUADRATO-JUGALS.**—These bones are characterized by their parallel lateral borders.

EXOCCIPITAL, BASIOCCIPITAL, BASISPHENOID, AND QUADRATES.—These bones are not sufficiently characteristic of the species to warrant special description.

JUGALS.—The jugals are relatively long and slender, their length being over five and one-half times their greatest height.

PALATINES.—The palatines are characteristic. Their sutures with the maxillaries have been described above. Their sutures with the pterygoids extend inward and very slightly backward for about half the distance from the palatine fenestræ to the median line, then turn forward at angles of approximately  $45^\circ$  and meet on the mid-line opposite the ninth maxillary teeth, roughly paralleling the maxillo-palatine sutures in direction. The palatines assist the pterygoids in enclosing an enlargement of the nasal passage somewhat similar to that of *Crocodilus porosus*.

PTERYGOIDS.—These bones are only slightly concave on their palatal surfaces. As noted above, the pterygoids and palatines enclose an enlargement of the nasal passage.

ECTOPTYRGOIDS.—The ectopterygoids of *C. cataphractus* are characteristic. Their inferior processes are relatively stout, except at their distal ends, where they taper to points; their anterior processes are unusually long and slender; the superior processes are both short and slender.

### Mandible

The mandible is long and narrow like the skull; it is also low vertically, and the bones of which it is composed are individually slender. The symphysis is long, extending back beyond the seventh mandibular teeth. The splenial bones extend forward to the symphysis, but do not form a part of it.

The teeth correspond in form with those of the upper jaw, for the most part being slender and sharp-pointed; they are all separated a considerable distance from each other; these distances are approximately equal, except for the spaces between the eighth and ninth teeth, which are greater than the rest. Between most of the anterior mandibular teeth the jaw is excavated into notches for the reception of the maxillary and premaxillary teeth; posterior to the ninth teeth these notches are replaced by pits, which are situated between the teeth, and in line with them, to the end of the dental series. The number of the mandibular teeth is fifteen in each ramus, as in other species of *Crocodilus*.

The posterior processes of the mandible turn in sharply toward each other more than in most crocodilians. The nearest approach in this character is not in *Tomistoma*, or other long-snouted forms, but in *Crocodilus rhombifer*.

## Measurements Amer. Mus. No. 10075

Length of Skull, Tip of Snout to Supraoccipital	.393M.
Length of Skull, Tip of Snout to Ends of Quadrates	.423
Length of Snout	.293
Breadth of Skull Across Quadrato-jugals	.162
Breadth of Cranial Table	.085
Breadth of Snout at Base	.085
Breadth of Snout Across Fifth Maxillary Teeth	.045
Length of Mandible	.470
Breadth of Mandible, Maximum	.162

**Crocodylus intermedius** Graves

The following description of the skull of this species is based upon a single specimen, about twelve and one-half centimeters long, in the American Museum Collections (Amer. Mus. No. 8790). This is evidently a rather young specimen.

## General Form

The skull is long and slender, and in many respects resembles that of *C. cataphractus*. The snout is between twice and one-half and thrice as long as broad at the base; it is very low in transverse profile. Its anterior end, surrounding the external narial aperture, is expanded laterally. The constriction between the premaxillaries and maxillaries is slight, and that in the region of the sixth maxillary teeth is scarcely noticeable; the vertical festooning is also slight; the slight development of these constrictions and loops may be partly due to the immature age of the specimen, as well as being a characteristic of the species. The superior antero-posterior profile of the snout is slightly concave; this also may be partly an age character.

The cranial table is flat; its posterior border is slightly concave; its lateral borders are very nearly straight, and differ from the corresponding borders in most crocodilians in converging slightly in the posterior direction; this also may be associated with the young age of the individual. The antero-external angles are rounded. The relatively great breadth of the cranial table compared with the total breadth of the skull is another character which may be correlated with the young stage of the specimen.

## The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—The supratemporal fenestræ of the specimen described are elongate in outline, which is a character indicating youth; their comparatively great distance from each other is also largely due to the youthful condition of the specimen; the fenestræ are pointed

at their anterior ends, and their longitudinal axes make sharp angles with the longitudinal axis of the skull, the axes of the fenestra converging sharply in the posterior direction. Each fenestra occupies a slightly greater area than the external narial aperture.

**INFRATEMPORAL FENESTRÆ.**—These fenestræ are sharply triangular in outline, their borders being straight and not curved; their posterior borders are only slightly interrupted by the anterior processes of the quadrato-jugals.

**ORBITS.**—The orbits are large in size, and are close together, as in most young crocodilians. They are irregularly rounded in outline, and are slightly pointed at their anterior ends; their longitudinal diameters are somewhat greater than their transverse, and converge very slightly in the anterior direction.

**EXTERNAL NARIAL APERTURE.**—This cavity is not complete in the specimen, its anterior border having been partially destroyed during preparation. It is clear, however, that the length of the cavity was slightly greater than its breadth; it has no median process at its posterior end, the nasal bones being widely separated from it by the premaxillaries. The cavity is slightly pointed at its posterior end; this end is situated anterior to the level of the fourth premaxillary teeth.

**PREMAXILLARY FORAMEN.**—The premaxillary foramen is exceedingly small, being about two millimeters in length, and considerably less in breadth. It is situated between the second premaxillary teeth.

**PALATINE FENESTRÆ.**—These cavities are of moderate size. Their external and internal borders are concave, and converge in the anterior direction; their anterior ends are neither distinctly pointed nor rounded, but are somewhat intermediate in condition; the right fenestra is nearly acuminate, but the left one is very slightly rounded. Their external borders merge into the postero-external ones; the posterior ends are broadly rounded. The right fenestra extends as far forward as the tenth maxillary tooth, while the left one only extends to the space between the tenth and eleventh maxillary teeth; this is not due to an inequality of the fenestræ, but to an unsymmetrical arrangement of the teeth on the opposite sides of the palatal borders.

**INTERNAL NARIAL APERTURE.**—The internal narial aperture is long antero-posteriorly. It faces both downward and backward.

**FORAMEN MAGNUM.**—This foramen is large; it extends about one-half the distance from the superior border of the occipital condyle to the posterior border of the cranial table, and its breadth is somewhat greater than its height. Its large size is evidently correlated with the young stage of the specimen.



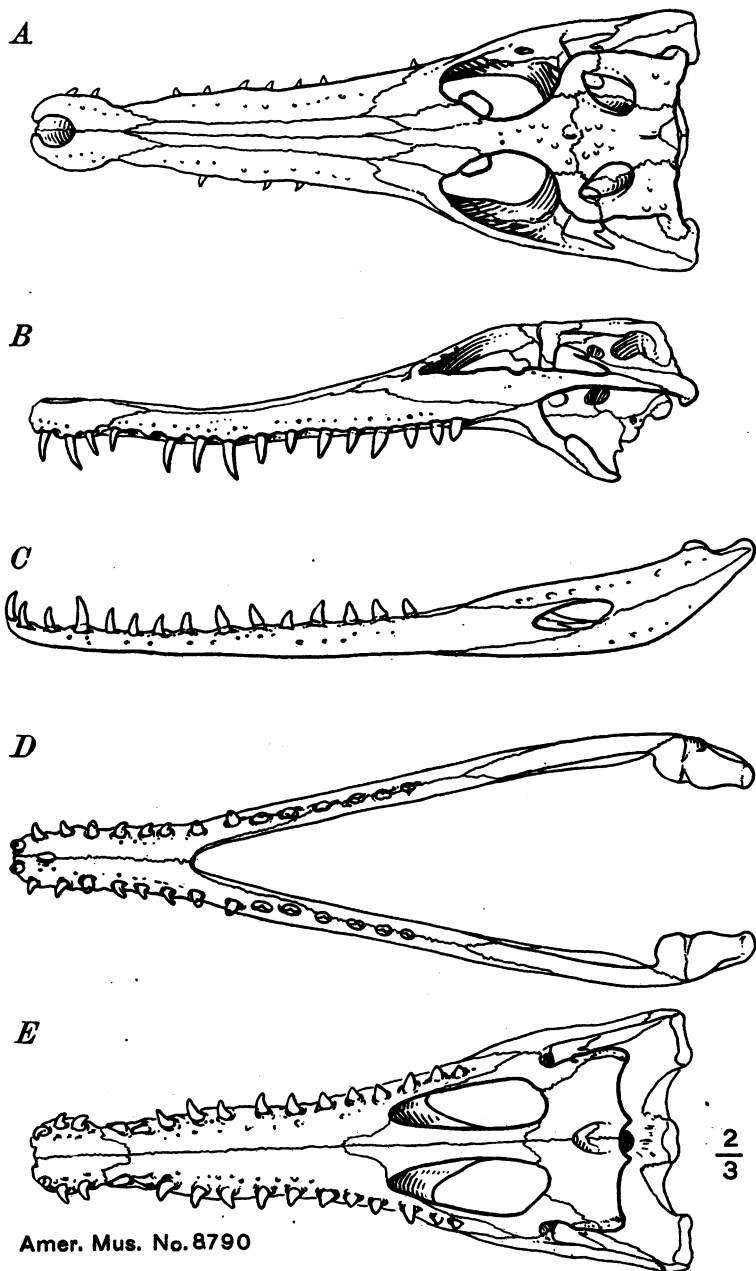


Fig. 5. Skull and jaws of *Crocodilus intermedius* Graves. Amer. Mus. No. 8790, two-thirds natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

### The Bones of the Skull

**PREMAXILLARIES.**—The anterior borders of the premaxillaries are incomplete; the bones are expanded laterally opposite the centers of the lateral borders of the external narial aperture. The two premaxillaries meet posterior to the aperture, completely excluding the nasals from the latter. The median suture of the two bones with each other, posterior to the aperture approximately equals the length of the aperture plus the length of the prenasal portions of the bones; the posterior processes, which wedge between the nasals and maxillaries, are broad and relatively short, extending only slightly further back than the level of the second maxillary teeth.

On the palate the premaxillaries are short. The premaxillo-maxillary suture extends on each side, directly inward from the "canine" notch, for a distance about one-fourth of the total distance across the palate at that level, then backward and slightly inward as far back as the space between the first and second maxillary teeth, then in an irregular transverse direction to the median line, and in a reverse direction to the opposite side.

Only three teeth are in each premaxillary in the specimen. Evidently there were four in the complete skull, as the nearly median first pair has obviously been lost during preparation. (Four are present in another specimen with the skin Amer. Mus. No. 10083). The dental borders of the premaxillaries are present anterior to the first teeth which are present, making it very unlikely that a tooth intervened in position on each side between this first tooth and the true first tooth of the jaw. The first tooth of the specimen, on each side, is therefore interpreted as being the second premaxillary tooth of the complete skull, homologous with the third premaxillary tooth of the crocodiles with five premaxillary teeth. The teeth are all spaced moderately far apart.

**MAXILLARIES.**—The maxillaries are long and slender. Their sutures with the nasals are nearly straight. Those with the lacrymals are irregular, being indented near their juncture with the nasals. The sutures with the jugals extend nearly directly forward throughout most of their length, then turn rather sharply inward. The combined maxillo-lacrymal and maxillo-jugal suture is very irregular in outline. Near their posterior ends the external surfaces of the maxillaries become vertical in position, in fact at their posterior ends they become reversed in position, so that the external surfaces are partially visible from below.

On their palatal surfaces the maxillaries are characteristic in form. Each maxillary possesses an antero-posterior ridge extending midway between the median line and the dental border. The dental border itself

is slightly elevated, consequently the palatal profile across both maxillaries consists of four elevations, with three intervening depressions. The dental surfaces of the maxillaries face outward as well as downward, consequently the teeth also face partly outward.

The right maxillary contains thirteen teeth; the left contains only twelve. The first tooth on the left side and the second and third on the right side in the specimen are pressed downward against the bones; this may have been caused during preparation. All of the maxillary teeth except the last two, which are close together, are evenly spaced. The space between the first and second on the left side is greater than the rest, but this is clearly an abnormality correlated with the loss, or failure to develop, of the left second maxillary tooth; the space is actually that between the first and third maxillary teeth. The teeth increase regularly in size from the first to the fifth. The latter is only slightly greater than the others on the left side; on the right it is smaller than the fourth, but this is evidently due to the recent shedding of the fifth, and only incomplete replacement at the time of the animal's death; the alveolus is much greater than that of the fourth. Posterior to the fifth the maxillary teeth decrease irregularly in size. The last three or four of these teeth have relatively short crowns, but none of them are blunt. The anterior teeth are all very slender and most of them are slightly curved. Pits for reception of mandibular teeth are situated between the maxillary teeth from the first to the ninth; these pits are directly in line with the teeth themselves.

The maxillaries form small portions of the external walls of the palatine fenestræ, but no parts of the internal walls. The maxillo-palatine suture, on each side, extends inward and forward from the anterior end of the foramen in an irregular concave curve, then very near the median line turns in sharply in a slight convexity, then obliquely inward and forward in a straight line to the median line. The concave portion of the suture occupies about nine-tenths of its total length. The opposite sutures meet at the median line at the level of the anterior borders of the ninth maxillary teeth. The sutures with the ectopterygoids extend forward past two maxillary teeth. The maxillaries extend backward considerable distances posterior to the last maxillary teeth.

**NASALS.**—The nasal bones are relatively short for such a slender skull. Their anterior processes end opposite the first maxillary teeth; they are entirely excluded from the narial aperture by the premaxillaries. They broaden from the anterior to the posterior portions, as far back as their contacts with the maxillo-lacrymal sutures, or at the level of the

ninth maxillary teeth. Posterior to this they narrow rapidly; at their posterior ends they are wedged far apart by the anterior process of the frontal.

**LACRYMALS.**—The lacrymals are relatively large; they extend, in antero-posterior direction, from the ninth to the twelfth maxillary teeth, and they occupy about twice as much area as the prefrontals. Their lateral borders are nearly parallel, and they converge in the anterior direction. Their anterior borders are irregular; they have been described above in discussing the maxillo-lacrymal sutures. The naso-lacrymal sutures are only slightly shorter than the naso-prefrontal sutures.

**PREFRONTALS.**—These bones are somewhat irregular in shape. Their internal borders, or sutures with the frontal and nasals, are slightly concave outward, and their external borders, or lacrymo-prefrontal sutures, extend forward and inward, the external and internal borders meeting anteriorly, opposite the space between the ninth and tenth maxillary teeth, in an acute angle. Their orbital borders are largely occupied by the supraorbital bones, or bony eyelids.

**FRONTAL.**—The frontal is long. Its anterior process, between the posterior ends of the nasals, is short and broad; posterior to the nasals, and anterior to the frontal borders of the orbits the frontal is long and slender; the interorbital plate is narrow and flat. The posterior portion of the frontal, which comprises part of the cranial table, broadens rapidly from the narrow interorbital plate.

**POSTORBITALS.**—The postorbital bones are small, each of them occupying about one-fourth of the area occupied by the corresponding squamosal. The orbital border of each is somewhat greater than its portion of the external border of the cranial table. The postorbital portion of the latter is about one-fourth of its entire length.

**SQUAMOSALS.**—The squamosal bones occupy at least three-fourths of the lateral borders of the cranial table, and two-thirds of the posterior border. Their portions of the borders of the supratemporal fenestræ are much greater than those of the postorbitals, and slightly greater than those of the parietal. Their postero-external processes do not extend far out over the quadrates.

**PARIETAL.**—The parietal is relatively large. It occupies considerably more area than the frontal, and also more than the two squamosals together. Its greatest breadth is at its anterior end. Along the posterior border of the cranial table the space between the two squamosals, or about one-third of the border, is occupied by the parietal and supraoccipital together. Of this portion the supraoccipital occupies the

median half (one-sixth of the total border) and the parietal the small spaces between the supraoccipital and the squamosals. The breadth of the parietal between the supratemporal fenestræ is very great. The relatively large size of the bone, and especially its large interfenestral portion, is largely due to the immature condition of the specimen.

**SUPRAOCCIPITAL.**—The supraoccipital extends forward for a short distance on the cranial table; as noted above, this bone occupies about one-sixth of the posterior border of the table; its antero-posterior diameter, on the cranial table, is less than its transverse.

On the posterior surface of the skull the supraoccipital, at its broadest point, occupies about one-third of the total breadth of the cranium. Inferiorly it extends downward about five-sixths of the distance from the superior border to the foramen magnum.

**BASIOCCIPITAL.**—The occipital condyle of the basioccipital bends sharply downward, and the bone occupies a considerable space posterior to it on the inferior surface of the skull. This is evidently a youthful character.

**BASISPHEOID.**—This bone is not especially characteristic, except that the Eustachian foramen, which it surrounds, is directed largely downward, rather than largely backward. This also is an age character.

**EXOCCIPITALS.**—The exoccipitals are not characteristic, except for the youthful character of their extending somewhat farther forward on the inferior surface of the skull than they do typically.

**QUADRATES.**—These are not characteristic.

**QUADRATO-JUGALS.**—In these bones the free borders, which form the postero-superior borders of the infratemporal fenestræ, make considerable angles with the quadrato-jugal-jugal sutures, instead of continuing forward in the same direction as the latter. The sharp processes which extend into the fenestræ appear more as separate elements, and less as integral parts of the bones themselves.

**JUGALS.**—These bones are relatively long and slender. They extend forward to points slightly anterior to the level of the tenth maxillary teeth.

**PALATINES.**—The palatine bones are characteristic in form. The peculiar form of the maxillo-palatine suture has been described above. The broadest portions of the palatines is at the anterior ends of the palatine fenestræ. They compose all of the internal borders of the fenestræ except very small portions near the posterior ends. Their sutures with the pterygoids are anterior to the posterior ends of the fenestræ; each of them extends inward and backward for an exceedingly short

distance, then turns forward and inward at an angle of about  $45^{\circ}$  with the longitudinal axis of the skull to a point very near the median line; then it turns inward and backward for a distance of about one-half millimeter, and meets its opposite at the median line. In general outline the palato-pterygoid suture parallels the maxillo-palatine suture in direction.

**PTERYGOIDS.**—The pterygoids are broad in proportion to their length. Each pterygoid occupies a considerable portion of the posterior border of the palatine fenestra. Posterior to the internal narial aperture the pterygoids send back a pair of short acuminate processes. Owing to the youthful stage of the specimen the pterygoids are situated rather far forward on the palate, the narial aperture being under the center of the cranial table.

**ECTOPTERYGOIDS.**—These bones are somewhat irregular in form. Their anterior processes are slender, and are not very long; they do not extend as far forward as the level of the eleventh maxillary teeth. The inferior processes are directed in a more posterior direction than usual; they are rather stout, but taper to subacuminate terminations. The superior processes are slender.

**SUPRAORBITALS.**—The supraorbital bones, or bony eyelids, are very small. It is possible that their small size may be due to the immature stage of the specimen. Specimens of other crocodilians of similar size, and of species which are somewhat larger than, or at least equally as large as *C. intermedius* in the adult stages, have very large bony eyelids. Consequently the small size is probably a specific character.

### The Mandible

The mandible is very long and slender. The symphysis is especially characteristic; it extends back to the level of the spaces between the seventh and eighth mandibular teeth. This is further back than in any other species of *Crocodilus* except *C. cataphractus*. The splenials extend forward as far as the level of the eighth mandibular teeth, not quite reaching the symphysis.

The usual fifteen mandibular teeth of *Crocodilus* are present. They are all evenly spaced, and are slender and sharp, especially those in the anterior portion of the jaw. Many of the anterior teeth point outward to a certain extent, as well as upward. The fourth is the largest of the mandibular teeth, but the specimen studied is somewhat distorted in outline, and the fourth tooth on the right side is curved inward, somewhat obscuring its true characters.

The amount of festooning of the jaw, and of pits between the teeth for lodgment of maxillary teeth, is almost negligible; the lateral borders of the jaw converge in the anterior direction, however, as far forward as the fifth mandibular teeth, anterior to which they are approximately parallel. The greatest vertical height of each jaw is at the posterior end of the external mandibular foramen. On the supero-internal border of each articular bone is a small, but conspicuous foramen.

The specimen studied is considerably distorted, as mentioned above. This distortion is so great in the anterior region that the symphysis appears to be oblique in position, and the right first mandibular tooth is median in position.

#### Measurements Amer. Mus. No. 8790

Length of Skull, Tip of Snout to Supraoccipital	.123M.
Length of Skull, Tip of Snout to Condyle	.126
Length of Skull, Tip of Snout to Posterior Ends of Quadrates	.1285
Breadth Across Quadrato-jugals	.050
Breadth Across Cranial Table	.032
Breadth of Snout at Base	.030
Length of Snout, Anterior End of Orbit to Tip	.078
Length of Mandible	.148
Length of Right Orbit	.0225
Length of Left Orbit	.0230

#### ***Crocodilus johnstoni* Krefft**

No material was available for a direct study of the skull of this species. The following brief description is quoted from Boulenger. "19 upper teeth on each side. Snout very slender, Gavial-like, about three times as long as broad at the base, without distinct ridges; mandibular symphysis long, extending to the sixth tooth; maxillaries forming a median suture above, behind the nasal opening." The last character mentioned, is evidently a mistake; no true crocodile has the *maxillaries* meeting at the median line as in the gavial; evidently *premaxillaries* were meant.

#### ***Crocodilus niloticus* Laurenti**

The present description of the skull of this species is based upon a medium-sized, somewhat over half-grown specimen in the American Museum Collections (Amer. Mus. No. 10081).

### General Form

The snout is moderately long, being slightly over one and two-thirds times as long as broad at the base. It is moderately broad at its anterior end, and is considerably constricted at the "canine" notches; it is greatly expanded at the level of the fifth maxillary teeth, and again constricted at the level of the space between the seventh and eighth maxillary teeth. It has a pair of prominent elevations above, internal to, and posterior to the fifth maxillary teeth; these elevations correspond with the very deep alveolar openings which lodge these fifth maxillary teeth. The snout is roughly pitted, but has no median elevation such as that of *C. americanus*; on the whole it is relatively low. Anterior to each orbit, and in line with the inferior border of the orbit, a very shallow groove extends forward and inward; this groove consists largely of an interruption of the pitting.

The cranial table is small, especially in the lateral direction; it is distinctly concave, differing in this respect from *C. americanus*. It is very rugose, and its lateral borders converge slightly; its posterior border is gently concave, with a prominent median process. The amount of vertical festooning, in both upper and lower jaws, is considerable. In general, the form of the skull resembles that of some of the stouter specimens of *C. americanus*, but is somewhat more robust than any of these.

### The Cavities of the Skull

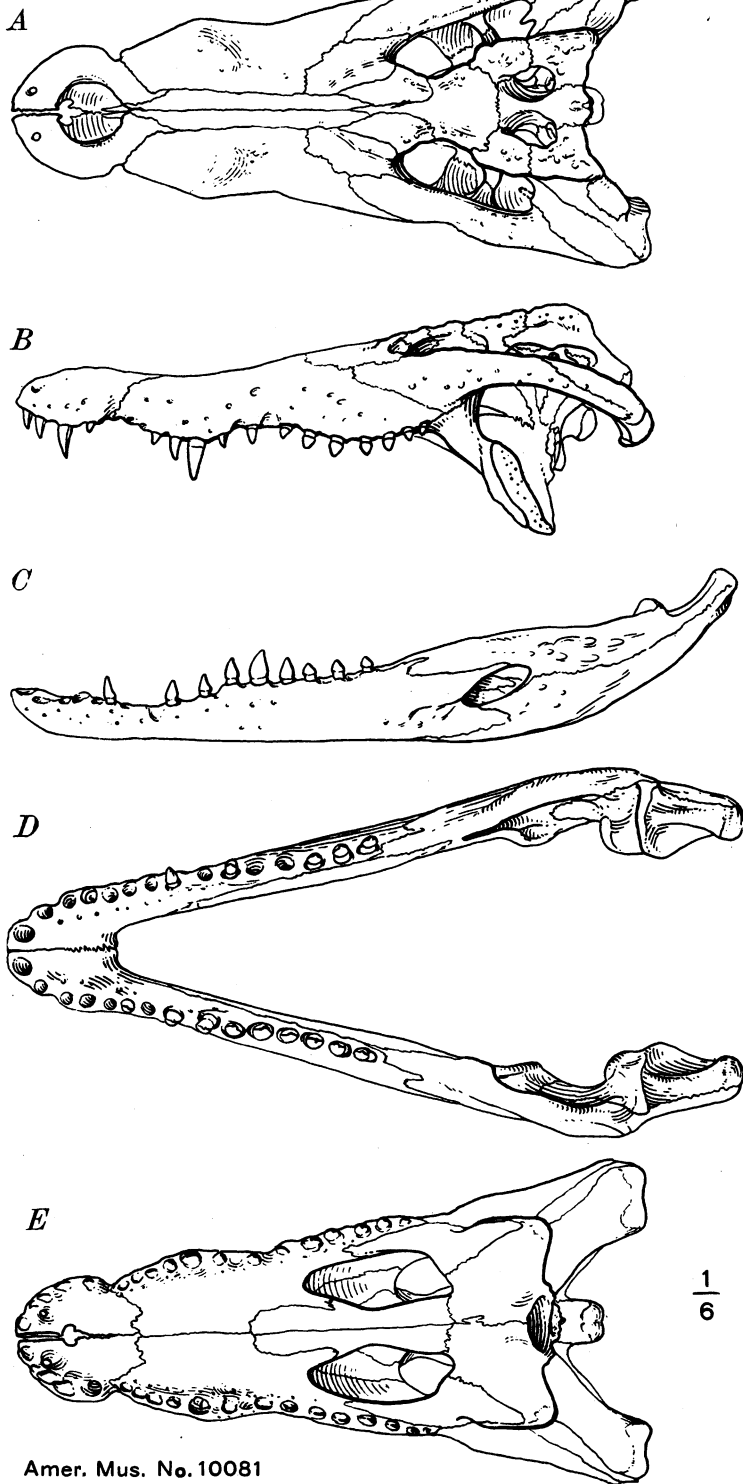
**SUPRATEMPORAL FENESTRÆ.**—These cavities are small, and are very close together. They are irregular in outline, and their longitudinal diameters are greater than their transverse. They extend directly fore and aft and not oblique. The size of the two fenestræ together is somewhat smaller than that of the external narial aperture.

**INFRATEMPORAL FENESTRÆ.**—These cavities are of moderate size, and are more nearly quadrangular than triangular in outline. The posterior processes of the quadrato-jugals which enter them are relatively small.

**ORBITS.**—The orbits are rather large, and their longitudinal dimensions are considerably greater than their transverse. Their longitudinal axes are nearly parallel. They are far apart, and their superior margins are slightly uprolled throughout, and considerably so at their anterior and posterior ends.

**EXTERNAL NARIAL APERTURE.**—This cavity is large; its lateral borders are concave, and it is slightly pointed at its anterior and posterior ends. It is entered posteriorly by the anterior processes of the





Amer. Mus. No. 10081

Fig. 6. Skull and jaws of *Crocodilus niloticus* Laurenti. Amer. Mus. No. 10081, one-sixth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

nasal bones. It is only slightly smaller than either of the orbits. In position it is situated far back on the snout; its anterior end is slightly posterior to the level of the third premaxillary teeth, and its posterior end is posterior to the level of the "canine" notches, and is opposite the level of the first maxillary teeth.

**PREMAXILLARY FORAMEN.**—The premaxillary foramen is small. It is heart-shaped in outline, and its length and breadth are about equal.

**PALATINE FENESTRÆ.**—The fenestræ are very large. They extend forward to the level of the space between the eighth and ninth maxillary teeth. Each of them is slightly pointed at its posterior end, and broadly rounded at its anterior end; its internal border is double in character, the anterior half extending forward, and its posterior half extending backward and outward; its external and postero-external borders are not sharply distinguished from each other.

**INTERNAL NARIAL APERTURE.**—The internal narial aperture is undivided by a median septum. It is large, especially in the lateral direction; it faces downward and backward, but not backward to the extent of *C. americanus*, *C. cataphractus*, or *C. intermedius*.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillary bones are distinctive in form. Their anterior portions, anterior to the nasal orifice, are relatively long, and are pierced by the inferior cavities which lodge the first mandibular teeth. The posterior portions, both of the broad area behind the aperture and the narrow posterior processes, are short. The bones are slightly elevated around the margins of the aperture. The posterior processes extend back very short distances, but reach the level of the space between the third and fourth maxillary teeth, in consequence of the backward position of the whole postnarial region of the bones; these short processes extend slightly outward as well as backward.

On the palate the premaxillaries are slightly broader than they are long. The suture with the maxillaries extends backward and inward, on each side, to a point opposite the center of the second maxillary tooth, then irregularly across the palate to the similar point on the opposite side, then forward and outward again. At the posterior extremity of each premaxillary, about midway between the dental border and the median line, is a sharp, low, irregular, backward pointing process; on one side there is a corresponding elevation of the maxillary. The fourth teeth are the largest in the premaxillaries; the third are somewhat smaller in size; the first and fifth are not preserved in the skull, but from

their alveoli they were evidently only very slightly smaller than the third. the second, while small, are not so small as in most species of *Crocodylus*; The first premaxillary teeth are only moderately separated from the second; the great pit, which receives, on each side, the first mandibular tooth, is not between the first and second premaxillary teeth, but internal to them. The second and third are close together, but are not so close as in most species, and are distinctly separated by short premaxillary borders. The third and fourth are separated about as far as the first and second; partly in line with him, and partly internal to them, is a large pit, on each side, which lodges the second mandibular tooth. Each fourth premaxillary tooth is rather close to the fifth, although the pit which received the third mandibular tooth is directly between these two teeth, and not partly internal to them.

**MAXILLARIES.**—The maxillo-nasal sutures are relatively long, in correlation with the short length of the premaxillo-nasal sutures. The maxillaries are relatively broad, the nasals being narrow. The sutures with the lacrymals are very irregular; they are unsymmetrical on the opposite sides of the snout; these sutures meet the nasals at the level of the spaces between the eighth and ninth maxillary teeth. The maxillo-lacrymal sutures begin at the level of the tenth maxillary teeth, and extend downward, outward, and backward in an irregular manner on each side.

On the palate the principal palatal plate of the maxillaries is short, corresponding with the great elongation of the palatine fenestræ. The maxillaries, or perhaps the maxillo-palatine sutures (maxillaries at the surface and palatines at a greater depth) form about one-fifth of the internal borders of the palatine fenestræ. From a point opposite the tenth maxillary teeth each of these sutures extends inward a short distance across the interfenestral area, then extends forward and slightly outward, finally curving inward toward the median line, meeting its opposite slightly anterior to the level of the seventh maxillary teeth. The maxillo-ectopterygoid sutures extend as far forward as the posterior ends of the tenth maxillary alveoli. There are fourteen teeth in each maxillary. These are all comparatively large and stout. They increase in length very rapidly from the first to the fifth, which is very large; the sixth, seventh, and eighth are somewhat smaller; the ninth is somewhat larger than the eighth, and the tenth is larger than the ninth; posterior to the tenth they decrease steadily in size, until the fourteenth is very small. The first eight maxillary teeth are rather sharp; the ninth to fourteenth, inclusive, are blunt, but not to the extent present in *C. rhombifer*. Posterior to the fifth the crowns of the maxillary teeth be-

come progressively shorter. The "canine" notches are short antero-posteriorly. The first and second, and second and third maxillary teeth, are close together; the third and fourth are slightly farther apart, and the fourth and fifth still farther apart. The fifth and sixth, the sixth and seventh, the seventh and eighth, and the eighth and ninth maxillary teeth are all rather widely spaced from each other. Posterior to the ninth the maxillary teeth are spaced progressively closer and closer together. Between all of the maxillary teeth anterior to the ninth are pits which receive mandibular teeth; between the sixth and seventh, and the seventh and eighth these pits are very deep. From the ninth maxillary teeth back to the end of the dental series the upper and lower teeth evidently bit against each other and not against the jaws themselves. The maxillary teeth might well be divided into two distinct groups; the anterior sharp teeth evidently acted more or less as a unit, while the posterior blunt teeth did the same. The external edges of the maxillaries are deflected downward on a rather large scale, so the bases of the teeth, in the anterior maxillary region, stand above the level of the palatal plate.

**NASALS.**—The anterior processes of the nasals, which are situated between the premaxillaries, broaden very rapidly, and the broadest region of the nasals is at the junction of the premaxillaries, maxillaries, and nasals with each other. From this point, which is slightly anterior to the level of the fourth maxillary teeth, the nasals narrow gradually to their minimum breadth, which is slightly anterior to the anterior ends of the naso-lacrymal sutures. From this point back they expand very slightly, and then converge rapidly in the posterior direction, ending, in this specimen, at the level of the eleventh maxillary teeth. The sutures of the nasals with the lacrymals are slightly shorter than their sutures with the prefrontals. The two nasals are very slightly wedged apart at their posterior ends by a very small anterior projection of the anterior process of the frontal.

**LACRYMALS.**—The lacrymals are large, occupying about twice as much area as the prefrontals. Their anterior extremities lie over the spaces between the eighth and ninth maxillary teeth; their sutures with the maxillaries are very irregular in outline. In shape they are relatively long and narrow, and they converge anteriorly only to a slight degree. Their sutures with the prefrontals are about two and one-half times as long as their sutures with the nasals.

**PREFRONTALS.**—These bones are long and narrow, and their greatest diameters converge very little, if at all, in the anterior direction. Their orbital borders are considerably shorter than their lacrymal borders, and

are altogether different from them in outline. Their sutures with the frontal curve gradually from the internal borders to the orbits, with no sharp angles at the postero-internal portions of the bones.

**FRONTAL.**—The anterior process of the frontal is very narrow; it sends forward a short projection between the posterior ends of the nasals. Its interorbital plate is relatively broad, and is concave in lateral profile. The bone does not extend back for any considerable distance behind the posterior ends of the orbits.

**POSTORBITALS.**—The postorbitals are small, especially in the lateral direction. They comprise about two-fifths of the lateral borders of the cranial table, and only very small portions of the borders of the orbits. The cranial and orbital borders are not sharply separated from each other. Their edges are somewhat elevated.

**SQUAMOSALS.**—The squamosals are considerably elevated along their lateral borders, and are very rough in these regions. Together they occupy about three-fourths of the posterior border of the cranial table.

**PARIETAL.**—This bone appears to be long; this is correlated with the very narrow interfenestral space. Its anterior border almost reaches the level of the posterior ends of the orbits. It occupies about one-fourth of the posterior border of the cranial table, and is extended backward for a short distance as a short process along the median line. The surface of the bone, posterior to the level of the posterior ends of the supra-temporal fenestræ, is rather deeply excavated.

**SUPRAOCCIPITAL.**—This bone has no part in the composition of the surface of the cranial table, but occupies a very small area of the surface of its posterior median projection, between the lateral portions of the posterior projection of the parietal mentioned above, and at a slightly lower level than the surface of the cranial table. On the posterior surface of the skull the supraoccipital extends downward about two-thirds of the distance from the superior border to the foramen magnum. It is very narrow, laterally, on this surface, and occupies scarcely one-fourth of the transverse dimension of the cranial table.

**BASIOCCIPITAL, EXOCCIPITALS, BASISPHENOID, AND QUADRATES.**—These bones are not characteristic of the species in their outlines or proportions.

**QUADRATO-JUGALS.**—The quadrato-jugal bones are short and stout. The anterior projection of the left one is broken off in the specimen, but the right one is preserved; it is rather short and broad. The antero-superior processes of the quadrato-jugals, along the contacts with the

quadrates, are very short; the right process does not extend farther forward than the process which enters the infratemporal fenestra.

**JUGALS.**—The jugals are stout; they extend forward to the level of the tenth maxillary teeth. Their anterior portions are somewhat expanded in the vertical direction.

**PALATINES.**—The suture of the palatines with the maxillaries has been described above. The suture with the pterygoids extends irregularly, but not far from transversely, across the interfenestral plate, slightly anterior to the posterior ends of the fenestræ. The palatines decrease in breadth a short distance posterior to the posterior ends of the maxillo-palatine sutures, the minimum diameter being opposite the eleventh maxillary teeth. From this point back they expand, until at their posterior ends they are broader than at their anterior ends.

**PTERYGOIDS.**—Each pterygoid occupies a very small portion of the posterior border of the corresponding palatine fenestra. The length of the two pterygoids along the median line is great, largely owing to the small antero-posterior diameter of the internal narial aperture.

**ECTOPTERYGOIDS.**—These bones are relatively large. They extend as far forward as the level of the posterior ends of the alveoli of the tenth maxillary teeth. The anterior processes are only moderately broad; the postero-inferior and the superior processes are not especially stout.

### The Mandible

The mandible of *C. niloticus* is very broad, and is composed of individually stout bones. The symphysis extends back as far as the posterior borders of the alveoli of the fifth mandibular teeth. The splenials extend forward as far as the seventh mandibular teeth. The external mandibular foramen is of moderate size in each ramus. The amount of vertical festooning of the jaws is very slight, and the degree of excavation of the sides of the two rami by the superior teeth is only noticeable at one point on each side, i.e., the space which receives the fourth maxillary tooth. The jaws each contain the usual fifteen teeth. There are not enough of these preserved in the specimen to enable one to determine their relative sizes accurately, but judging from their alveoli the first were the largest, the fourth second in size, and the eleventh next. The spacing of the teeth is very irregular. The third and fourth and the fifth and sixth teeth are very close together; the first and second, the fourth and fifth, the sixth and seventh, the ninth and tenth, the tenth and eleventh, and the eleventh and twelfth are moderately far apart; while the second and third, the seventh and eighth, the twelfth and thirteenth,

the thirteenth and fourteenth, and the fourteenth and fifteenth are far apart; the eighth and ninth are very far apart. The first eleven teeth have long crowns, the twelfth has a moderately short crown, and the thirteenth, fourteenth, and fifteenth have short crowns. The first twelve teeth are stout, but sharp-pointed, while the last three are blunt.

#### Measurements Amer. Mus. No. 10081

Length of Skull, Tip of Snout to Supraoccipital	.450M.
Length of Skull, Tip of Snout to Extremities of Quadrates	.503
Breadth of Skull Across Quadrato-jugals	.562
Breadth of Skull Across Anterior Ends of Orbits	.180
Breadth of Snout Across Fifth Maxillary Teeth	.146
Breadth of Snout Across "Canine" Notches	.086
Breadth of Snout Across Premaxillaries	.108
Breadth of Space Between Supratemporal Fenestræ	.010
Breadth of Space Between Orbits	.053
Length of Mandible, Total	.570
Length of Mandible, Left Ramus	.573
Breadth of Mandible	.310

#### Remarks

In many respects the skull of this species very closely resembles that of *Crocodilus americanus*. The proportions in the present species are about the same as those of a short-snouted individual of *C. americanus*. The elevation along the median line of the snout, which especially characterizes the latter species, is often lacking or feebly developed, so that the surface of the snout is often similar in the two species. Upon analyzing the detailed characters of the two species, however, a number of differences may be noted; the position of the external narial aperture in the two species is different; the shape and degree of separation of the supratemporal fenestræ are different; the relative breadth of the cranial table to the total breadth of the skull is different; the outlines of the borders of the cranial table and orbits are different; the shape of the anterior processes of the frontal in the two species is different; the shape of the quadrato-jugal is different; the shape of the premaxillary bones, both on the snout and on the palate, is different; the transverse profile of the cranial table is very different; the character of the interorbital plate is different; the forward extension of the palatine fenestræ is very different; the forward extension of the ectopterygoids is different; the shape and position of the internal narial aperture are different. These differences lead one to suspect that the similarities between the two species

are not due to close relationship between them, but are more likely the result of parallel or convergent evolution, in adaptation to similar surroundings, similar habits, or similar food.

### ***Crocodylus palustris* Lesson**

The skull of this species is here described from one half-grown specimen in the Museum of Comparative Zoology and also from a disarticulated skull in the American Museum.

#### **General Form**

The skull is short and broad; the breadth across the quadrato-jugals, across the base of the snout, and across the premaxillary region is great in proportion to the total length of the skull. The premaxillary region is narrow in comparison with the snout and quadrato-jugal region. On each side is a slight but conspicuous notch at the premaxillo-maxillary suture which receives the fourth mandibular tooth; posterior to this the snout expands considerably to the level of the fifth maxillary teeth, then constricts again at the seventh, posterior to which it expands again. The length of the snout is about one and one-half times its breadth at the base. Its superior surface is flat in general, but it is crossed by three more or less concentric shallow grooves; these are U-shaped, with the concavities facing forward. The anterior one crosses the mid-line at the level of the fourth maxillary teeth, extending forward and outward, on each side, to the "canine" notch, immediately posterior to the premaxillo-maxillary suture. The second, whose lateral portions diverge more widely, crosses the mid-line between the levels of the fifth and sixth maxillary teeth. The third, which is larger than either the first or the second, crosses the mid-line at the level of the seventh maxillary teeth; the lateral arms of this groove are nearly parallel; they cross the lateral arms of the second groove. A fourth groove, which is small and irregular, crosses the mid-line at the level of the spaces between the eighth and ninth maxillary teeth. Above the spaces between the fifth and sixth maxillary teeth is a pair of rounded elevations; these evidently lodge the bases of the large fifth maxillary teeth.

The cranial table is flat. It is nearly rectangular in outline. The superior borders of the orbits are elevated into ridges; these continue in the anterior direction beyond the orbits, and turn inward immediately posterior to the maxillo-lacrymal sutures; they die out near the nasals. The external narial aperture is bounded by an elevation of the surface of the snout.



### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—These cavities are relatively small; they are situated moderately close together. Their boundaries are somewhat upturned, especially near the median line. In outline each is sub-circular, the inner border being more rounded than the outer. The maximum length is nearly fore and aft in direction.

**INFRATEMPORAL FENESTRÆ.**—The infratemporal fenestræ are not sufficiently characteristic to warrant special description.

**ORBITS.**—The orbits are moderately large in size. In outline they are rounded.

**EXTERNAL NARIAL APERTURE.**—This cavity may be described as sharply oval in outline. It is somewhat rounded at its anterior end. Its length is about one and one-half times as great as its breadth. The nasal bones project, as a short process, into its otherwise pointed posterior end.

**PREMAXILLARY FORAMEN.**—This small cavity is broad in proportion to its length, compared with other species of *Crocodilus*. It is pear-shaped in outline, its anterior end being pointed, and its posterior end rounded; its lateral borders are simple curves.

**PALATINE FENESTRÆ.**—The palatine fenestræ are subquadrangular in outline. Their internal borders are nearly straight antero-posteriorly; their antero-internal borders are straight; the external borders are curved; the anterior ends are bluntly pointed; the postero-external borders are straight. The fenestræ extend forward to the level of the spaces between the eighth and ninth maxillary teeth.

**INTERNAL NARIAL APERTURE.**—This cavity is broad in proportion to its length.

### The Bones of the Skull

**PREMAXILLARIES.**—On the superior surface of the snout the premaxillo-maxillary suture extends backward and inward on each side, at an angle of about 45° to the level of the second maxillary teeth, then extends almost directly backward to the level of the fourth maxillary teeth. From this point the premaxillo-nasal suture extends forward and inward to a point slightly posterior to the narial aperture, then directly forward to the aperture itself. On the opposite side the suture follows a reverse path.

On the palate the premaxillo-maxillary suture extends across the skull in an almost transverse direction. It swings slightly backward, however, reaching the level of the first maxillary teeth.

Each premaxillary contains five teeth. Of these the first is small, and is close to the median line. It is separated from the second by a considerable space, in the usual crocodilian manner. The pit which receives the first mandibular tooth lies partly between the first and second premaxillary teeth, and partly internal to them. The second tooth is small and is close to the third, which is approximately equal to the first in size. The third and fourth, and the fourth and fifth are spaced rather far apart, the spaces in the two cases being approximately equal. Partly in these spaces, and partly internal to them are the shallow pits which receive the second and third mandibular teeth. The fourth tooth in each premaxillary is large, and the fifth is of medium size.

**MAXILLARIES.**—On the superior surface of the skull these bones are rather broad and short. The maxillo-nasal suture is practically fore and aft in direction; the maxillo-lacrymal suture is transverse on each side.

The maxillo-palatine suture on the palatal surface of the skull extends, on each side, a considerable distance backward and inward from the anterior end of the palatine fenestra, then turns directly forward, and at the level of the eighth maxillary teeth turns inward toward the median line; it meets this at the level of the anterior ends of the seventh maxillary teeth, or very slightly farther forward. The two opposite sutures meet each other with an acute angle. The maxillo-ectopterygoid suture extends, on each side, from the level of the eleventh maxillary teeth to a point only slightly posterior to the last maxillary tooth.

Each maxillary contains fourteen teeth; the first six of these are short, but sharp, the last eight are short and blunt.

**NASALS.**—The nasal bones are long and slender. Their contacts with the premaxillaries have been noted above. They are broadest immediately anterior to their contacts with the lacrymals. The nasolacrymal sutures are very short; the naso-prefrontal sutures are somewhat longer. Posteriorly the extremities of the nasals are separated by a long slender process of the frontal.

**LACRYMALS.**—These bones are of moderate size. They are approximately equal to the prefrontals in surface area, possibly being slightly smaller. In outline each lacrymal is crescentic, having a convex quarter circle for an anterior border, and a concave quarter circle for a posterior one. The orbital border of each lacrymal is slightly less than the orbital border of each prefrontal.

**PREFRONTALS.**—The prefrontal bones are large and conspicuous. They are irregularly hexagonal in outline.

**FRONTAL.**—The anterior process of the frontal is very long and slender; it wedges apart the posterior ends of the nasal bones for a considerable distance. Its interorbital portion is somewhat concave.

**SQUAMOSALS.**—The squamosals are characterized by their flat postero-external corners.

**PARIETAL.**—The parietal bone has slightly elevated ridges surrounding the supratemporal fenestræ.

**SUPRAOCCIPITAL.**—This bone appears to occupy a small triangular area on the posterior edge of the cranial table. The sutures are not clear, however. On the posterior surface of the skull the supraoccipital occupies but little space. In the vertical direction it extends downward somewhat less than one-half the distance from the superior border to the foramen magnum. In the transverse direction also its extent is slight.

**EXOCCIPITALS, BASIOCCIPITAL, BASISPHENOID, QUADRATES, AND POSTORBITALS.**—These bones are not particularly characteristic.

**QUADRATO-JUGALS.**—The quadrato-jugals are relatively short and broad. Their anterior free processes are low in position, being nearer the quadrato-jugal-jugal sutures than the centers of the posterior borders.

**JUGALS.**—The jugals are not especially characteristic. They appear to be high vertically in proportion to their length.

**PALATINES.**—These bones extend forward in a sharp point at the median line. Their sutures with the maxillaries have been described above. They are relatively short; their anterior extremities extend as far forward as the level of the seventh maxillary teeth. The bones are broadest near the suture with the pterygoids. This suture is W-shaped, with the apex of the W directed forward.

**PTERYGOIDS.**—The pterygoids form only very small portions of the borders of the palatine fenestræ. Their posterior borders consist of two concave lines separated by the median notch.

**ECTOPTERYGOIDS.**—These bones are short and stout. Their anterior processes extend forward to the level of the eleventh maxillary teeth. Their vertical processes are nearly perpendicular to their anterior processes.

### Mandible

The mandible is short and broad. The symphysis extends back to the level of the fourth mandibular teeth; the splenials do not extend forward close to the symphysis.

## Measurements Specimen in Mus. Comp. Zool.

Length of Skull, Tip of Snout to Supraoccipital	.255M.
Length of Snout	.159
Breadth of Skull Across Quadrato-jugals	.147
Breadth of Cranial Table, Posterior End	.079
Breadth of Snout at Base	.112
Breadth of Snout Across Fifth Maxillary Teeth	.087
Length of Mandible	.308(est.)

**Crocodylus porosus** Schneider

The description is based upon a huge specimen in the Warren Collection in the American Museum (Amer. Mus. No. 15179) and two smaller specimens (Amer. Mus. Nos. 7131 and 7115). A number of characters have been verified on specimens in the Museum of Comparative Zoology.

## General Form

The skull of *Crocodylus porosus* is characteristic in form. It is triangular in outline, and relatively short. The species is easily recognized by the very massive proportions of the skull bones, which are unusually thick, also by a pair of ridges which extend forward and very slightly inward from the anterior ends of the orbits. The snout is broad, but is not high; it is moderately sharp in young individuals and rounded in old ones. The lateral constrictions are deep and the vertical festooning pronounced, even in relatively young individuals, and in old ones these characters are developed to an excessive degree. The cranial table and interorbital spaces are more or less concave.

## The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—The supratemporal fenestræ are small and are subtriangular in outline. They are situated relatively close together.

**INFRATEMPORAL FENESTRÆ.**—The infratemporal fenestræ are unusually small, especially in the older individuals.

**ORBITS.**—In the younger individuals the orbits are moderately large, each of them being larger than the narial aperture; in the older specimens the orbits are small, each being considerably smaller than the narial aperture. The orbits are round in outline, and are situated rather far apart.

**EXTERNAL NARIAL APERTURE.**—This cavity is of moderate size, both in young and old individuals. It is rounded in outline, but is broader in its anterior half than in its posterior. The posterior end is

pointed, except for the entrance of the nasal bones into the cavity with a short median process. The premaxillaries extend back from the anterior end as a very short median process.

**PREMAXILLARY FORAMEN.**—The inferior premaxillary foramen is very small, and is rounded triangular in outline.

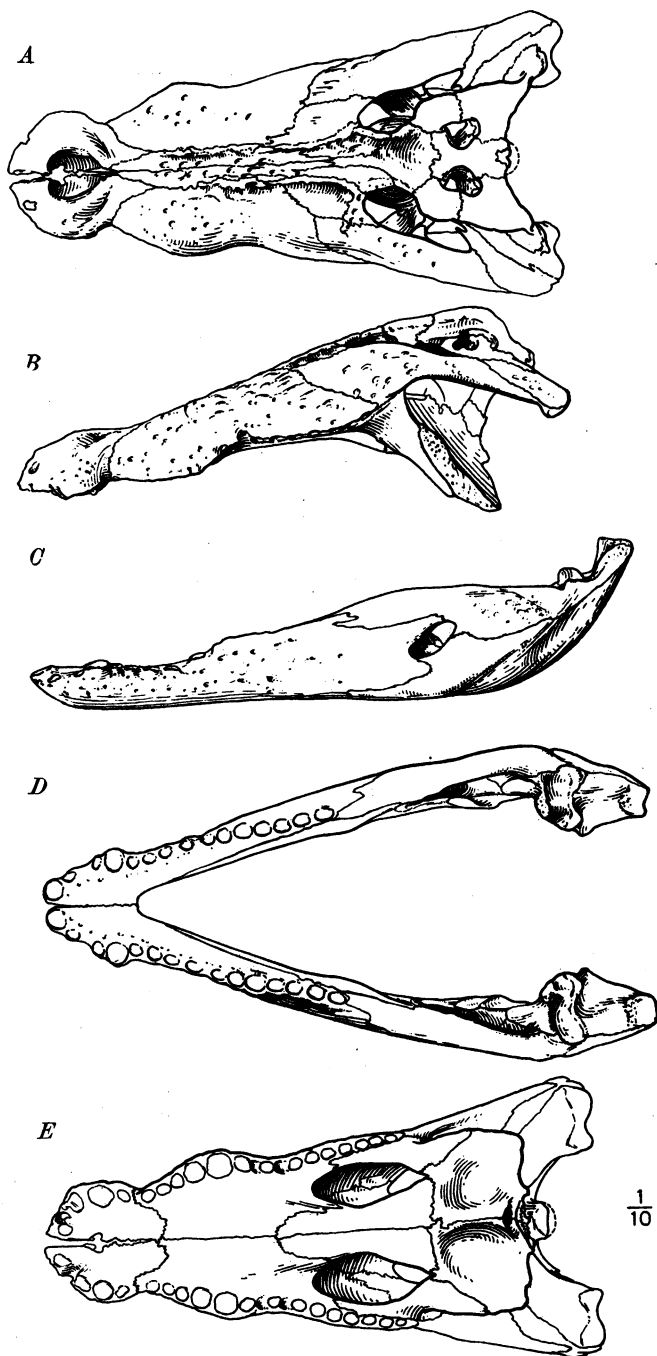
**PALATINE FENESTRÆ.**—The palatine fenestræ are long and narrow in outline. Their external borders are nearly parallel straight lines, but have very gentle concave curvatures; anteriorly the fenestræ are rounded; near their posterior ends is a pair of oblique borders, which are equally external or posterior in direction; near the postero-internal ends of these borders the fenestræ terminate in sharp points; the internal borders are characteristic of the species; from the anterior ends of the fenestræ these borders extend backward and inward in the usual crocodilian manner, then extend outward again toward the posterior ends. This posterior expansion is very marked in the old individuals, and is correlated with the presence of a great expansion of the palatine bones, evidently surrounding an expansion of the nasal passage. The fenestræ extend as far forward as the ninth maxillary teeth.

**INTERNAL NARIAL APERTURE.**—This cavity is relatively very small, and is unusual in its position. It is situated at the posterior end of the palate, as in other crocodiles, but opens obliquely downward and backward, instead of downward in the usual manner.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are comparatively broad in proportion to their length, especially in the older specimens. Their posterior processes extend back as far as the third maxillary teeth in some specimens, and not quite as far as the second in others. On the palate the premaxillo-maxillary suture extends backward as far as the second maxillary teeth; it is W-shaped, with the apex of the W directed forward; this apex does not extend farther forward, however, than the anterior borders of the first maxillary teeth.

There are five teeth in each premaxillary. The fourth is the largest, the third next in size, the first and fourth are about equal to each other and are smaller than the third, and the second is minute. In both young and old individuals the second is situated very close to the third, and in some cases the alveoli of the second and third are confluent. The pits which lodge the mandibular teeth are situated between the premaxillary teeth and not internal to them. The pits for the first mandibular teeth are very large, and in all the specimens studied open upon the superior



Amer. Mus. No. 15179

Fig. 7. Skull and jaws of *Crocodilus porosus* Schneider. Amer. Mus. No. 15179, one-tenth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

surface of the skull as foramina. The pits for the second and third mandibular teeth are situated between the third and fourth, and fourth and fifth premaxillary teeth respectively; they are conspicuous in the young skulls, but are scarcely discernible in the great skull in the Warren Collection.

**MAXILLARIES.**—The maxillaries are relatively long. The maxillo-nasal sutures extend along the preorbital ridges mentioned above. The sutures with the ectopterygoids extend as far forward as the tenth maxillary teeth. The maxillaries comprise practically no part of the internal borders of the palatine fenestræ in the young specimens, in the older ones they occupy small places. The sutures with the palatines extend inward and backward short distances from the anterior ends of the fenestræ, then extend forward in irregular, but roughly parallel lines to a point opposite the seventh maxillary teeth, where they turn sharply inward and meet on the median line. The teeth increase regularly and rapidly from the first to the fifth; posterior to the fifth they decrease in a more or less irregular manner. From the first to the sixth, the teeth of each maxillary are equally close together; the sixth and seventh, and the seventh and eighth are separated by broad spaces which contain pits for reception of mandibular teeth; posterior to the eighth maxillary teeth the teeth are spaced somewhat closer together. In the two medium-sized skulls studied the right maxillaries contain thirteen teeth each and the left ones fourteen; in the large skull each maxillary contains fourteen alveoli.

**NASALS.**—The nasals are very narrow; their posterior extension is somewhat variable, in some cases reaching nearly to the level of the orbits, in others being widely separated from the latter. At their anterior ends they enter the narial aperture as a conspicuous process. The sutures with the lacrymals are very short; those with the prefrontals are considerably longer, and are variable in form. The two nasals are usually very slightly wedged apart by a thin process of the frontal.

**LACRYMALS.**—The lacrymal bones are of medium size, and have nearly parallel internal and external borders; their sutures with the nasals are very short, but those with the prefrontals are long. They occupy the entire anterior ends of the orbits, and they carry the most prominent portions of the great preorbital ridges.

**PREFRONTALS.**—The prefrontals are long and slender. Their contacts with the nasals and with the frontal are about equal in length. They occupy about half of the superior, or internal, borders of the orbits.

**FRONTAL.**—The median frontal bone is very long in proportion to its breadth, especially in the younger individuals. The anterior process is narrow, and in Amer. Mus. No. 7131 it sends forward an exceedingly long and thin process between the nasals. The sutures with the two postorbital bones and the parietal together form a roughly semicircular figure; along the median line the suture with the parietal bends sharply backward on each side, the frontal sending back a small process into the parietal region.

**POSTORBITALS.**—The postorbital bones are small; at the surface they occupy scarcely one-half the space which is occupied by the squamosals; aside from this they are not characteristic.

**SQUAMOSALS.**—These bones are relatively large. As mentioned above, they are about twice the size of the postorbitals, and are relatively large in proportion to the other surrounding bones. Their postero-external processes are long and thick.

**PARIETAL.**—The parietal is of moderate size. Its shape at the surface follows very closely the outline of a cross-section of a T-rail. Its median portion, between the supratemporal fenestræ, is very small.

**SUPRAOCCIPITAL.**—The supraoccipital is relatively small. In the younger specimens it has no place in the cranial table, but in the huge skull in the Warren Collection it occupies a very small place at the posterior end of the table. On the posterior aspect of the skull the bone extends downward from one-half to three-fifths of the distance from the cranial table to the foramen magnum.

**QUADRATES, EXOCCIPITALS, BASIOCCIPITAL, AND BASISPHENOID.**—These bones are not especially characteristic, except for their great thickness and massive construction.

**QUADRATO-JUGALS.**—The quadrato-jugals are broad at their postero-external ends, and they narrow considerably in the direction of their antero-internal ends. The characteristic *Crocodylus* process which extends into each infratemporal fenestra is very sharp.

**JUGALS.**—The jugals are characterized by their very great vertical height, which is unusually great in proportion to their length.

**PALATINES.**—The palatines are characteristic in form, especially in the older individuals. The suture with the maxillaries has been described above. That with the pterygoids is variable in outline; it may be directly transverse, irregularly curved, or a combination of a V and a W, with the long central apex directed forward. The palatines differ from those of other species in being greatly expanded posteriorly and superiorly to assist the pterygoids in enclosing a considerable enlargement of the nasal



passage. They extend forward to the level of the seventh maxillary teeth.

**PTERYGOIDS.**—The pterygoids are more or less characteristic in form. They occupy the posterior ends of the borders of the palatine fenestræ. The posterior portion of the palatine surface, which they occupy, is only slightly concave in the younger specimens, but is much more concave in the older ones. The anterior portions of the pterygoids join the palatines in enclosing the expansion of the nasal passage mentioned above.

**ECTOPTYRYGOIDS.**—These bones extend as far forward as the tenth maxillary teeth. Their inferior processes, which articulate with the pterygoids, are very stout; their superior and posterior processes, however, are relatively slender.

### The Mandible

The mandible of *C. porosus* is characterized by a relatively great spread of the two rami in proportion to the length, and especially by the great vertical diameter and the great thickness and strength of the component bones. This is especially marked in the older individuals. The symphysis extends as far back as the fifth mandibular teeth.

The teeth are rather large in size, and are conspicuously striated. The usual crocodilian number of fifteen is present in each ramus, and the fourth is the largest and the eleventh next in size as is common in the genus *Crocodylus*. The first twelve teeth are subconical in form and are sharply pointed. The last three teeth are flat and blunt. The first and second, the seventh and eighth, the ninth and tenth, and the thirteenth and fourteenth teeth are moderately far apart, the second and third and the eighth and ninth are very far apart; the remainder of the teeth are close together. In the old Warren skull the jaw is distinctly festooned, to correspond with the outline of the maxillary border, but the amount of grooving for the reception of maxillary teeth is slight.

### Measurements

	American Museum		
	No. 7115	No. 7131	No. 15179
Length of Skull, Tip of Snout to Supra-occipital	.305M.	.360M.	.642M.
Length of Skull, Tip of Snout to Ends of Quadrates	.335	.387	.721
Length of Snout	.205	.248	.464
Breadth of Skull, Across Quadrato-jugals	.160	.174	.369

## Measurements (continued)

	American Museum		
	No. 7115	No. 7131	No. 15179
Breadth of Cranial Table, Posterior End	.090	.094	.177
Breadth of Snout at Base	.112	.121	.260
Breadth of Snout Across Fifth Maxillary Teeth	.087	.091	.220
Breadth of Snout Across "Canine" Notches	.048	.052	.131
Breadth of Snout Across Narial Aperture	.056	.065	.158(est.)
Length of Mandible	.370	....	.785
Breadth of Mandible	.147(est.)	.187	.390

***Crocodilus rhombifer* Cuvier**

The material which forms the basis of the present description is one skull, 28.5 cm. long (Mus. Comp. Zool. No. 4042).

## General Form

The shape of the skull in *Crocodilus rhombifer* is characteristic. The snout is short, being about one and one-half times as long as broad at the base. The snout differs from that of any other species of *Crocodilus* in being very high vertically in proportion to its breadth. In transverse profile the snout is triangular, the base of the triangle being the palatal surface, and the apex the median line of the snout. The name *rhombifer* refers to a rhombic plate, whose posterior borders are the internal borders of the orbits and whose anterior borders consist of a pair of oblique ridges converging in front of the orbits. This character is not well-marked in the specimen studied. The snout is broadly rounded anteriorly, and is considerably constricted at the "canine" notches; in spite of this constriction the portion of the snout between the two notches is broad. The constriction posterior to the sixth maxillary teeth is also conspicuous. The vertical festooning is very pronounced.

The cranial table is concave; and its postero-external angles project sharply outward and upward, much as in *C. robustus* Vaillant and Grandidier; these angles are exceedingly rugose, not with the normal crocodilian skull pitting, but with a much finer textured and irregular type of rugosity. The median posterior process of the cranial table is prominent. The lateral borders of the cranial table converge anteriorly to a marked degree, and the antero-external angles are not prominent. The pitting of the entire skull is somewhat finer textured than in most species of crocodiles.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—These cavities are of moderate size, each being slightly smaller than the external narial aperture. They are subcircular in outline, and are close together.

**INFRATEMPORAL FENESTRÆ.**—These fenestræ are about equal in size to the supratemporal fenestræ; they are irregularly triangular in outline, and the quadrato-jugal processes on their postero-superior borders are small.

**ORBITS.**—The orbits are of moderate size, and are slightly longer than broad. They are rather widely separated. A small supraorbital bone, or bony eyelid, is present on the superior border of each orbit.

**EXTERNAL NARIAL APERTURE.**—This cavity is large, being intermediate in size between the orbits and the supratemporal fenestræ. It is subquadrangular in outline, and is somewhat longer than broad. The anterior processes of the nasals enter the orifice as a conspicuous prominence.

**PREMAXILLARY FORAMEN.**—The premaxillary foramen is small. It is heart-shaped, and is somewhat longer than broad.

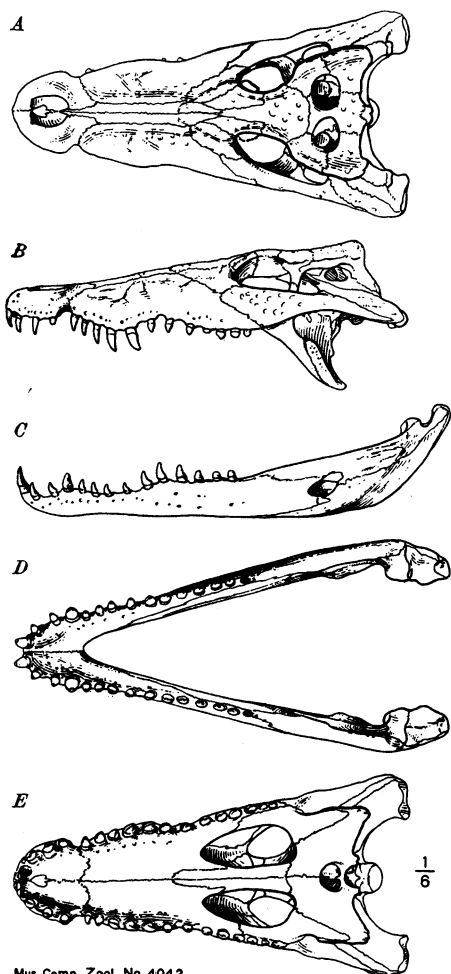
**PALATINE FENESTRÆ.**—The palatine fenestræ are large. They are separated from the teeth by broad plates of the maxillaries and ectopterygoids. They are somewhat irregular in shape; their anterior ends are sharply rounded and their posterior ends broadly rounded. Both the external and the internal borders of these fenestræ are concave. The cavities themselves are relatively broad in proportion to their length. They extend forward to the level of the eighth maxillary teeth.

**INTERNAL NARIAL APERTURE.**—This cavity is relatively large, and occupies a large portion of the pterygoids along their median line. It opens almost directly downward; it is divided by a median septum.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are short and broad. Their posterior processes extend only slightly farther back than the level of the second maxillary teeth; these processes are broad. The premaxillaries narrow considerably at the "canine" notches, but in spite of this the snout is relatively broad at the notches. The anterior ends are broadly rounded.

On the palate the premaxillo-maxillary suture is very irregular in outline. It does not extend back of the level of the first maxillary teeth. It is situated nearer the first maxillary tooth on each side, than the last premaxillary tooth. The premaxillaries, therefore, occupy most of the



Mus. Comp. Zool. No. 4042

Fig. 8. Skull and jaws of *Crocodilus rhombifer* Cuvier. Mus. Comp. Zool. No. 4042, one-sixth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

surfaces of the "canine" notches. Extending inward from the notches is a pair of shallow grooves, evidently used in lodging the fourth mandibular teeth during lateral movement of the jaws. The breadth of the palatal surfaces of the premaxillaries is somewhat greater than their length.

There are five teeth in each premaxillary; the fourth tooth is the largest. The teeth are all considerably stouter than those in other crocodilian skulls of the same size. They are situated on pedicles, with

grooves between, but the pedicles are not readily seen in a lateral view, as a downward projecting flange of the rim of the premaxillary hides the intervening grooves. The first tooth of each premaxillary is separated from the second by a very deep pit, which lodged the first mandibular tooth; this pit has, in each premaxillary, been extended upward to open on the superior surface as a conspicuous foramen; it is partly in line with the teeth themselves, and partly internal to them. The small second tooth is situated very close to the third tooth, the alveoli of the two being almost confluent. The third tooth is separated from the fourth, and the fourth from the fifth, by rather broad spaces. Each space is excavated into a deep pit, which extends inward a slight distance from the line of the teeth themselves.

**MAXILLARIES.**—The maxillary bones are broad, and are especially high in the vertical direction. They expand rapidly posterior to the “canine” notch, as far as the fifth maxillary teeth, then contract as far as the spaces between the sixth and seventh maxillary teeth; posterior to this level they increase in breadth rapidly. The maxillo-nasal sutures are irregular, but are essentially parallel; the maxillo-lacrymal sutures join the nasals with sharp angles slightly posterior to the level of the seventh maxillary teeth; they extend outward, downward, and backward, and are replaced by the maxillo-jugal sutures at the level spaces between the ninth and tenth maxillary teeth. Both of these sutures are irregular on a small scale, and the maxillo-jugal sutures are sharply indented near their inferior extremities.

On their palatal surfaces the maxillaries are relatively short and broad. Their suture with the premaxillaries has been described above. The suture with the palatines is characteristic in outline. On the internal border of each palatine fenestra the suture itself forms the border of the fenestra, from a point about one tooth's diameter from the anterior end, back for about the same distance, then it turns backward and inward to a level slightly posterior to the ninth maxillary teeth, then turns forward and gradually curves inward, meeting its opposite at the level of the spaces between the sixth and seventh maxillary teeth. The opposite portions of the maxillo-palatine suture are nearly parallel and close together for most of their length. The maxillaries, at the level of the seventh maxillary teeth, compose five-sixths of the distance across the palate. The maxillaries form about one-seventh of the internal border of the palatine fenestra on each side, and with the maxillo-palatine suture another seventh. Each maxillary forms about one-third of the external border of the corresponding fenestra; opposite the tenth maxillary tooth

the maxillo-ectopterygoid suture extends sharply inward from the edge of the fenestra to a point near the tooth. The portion of the maxillary which forms the border of the fenestra anterior to this suture, is very broad, separating the teeth from the fenestra by a considerable space. The posterior portion of each maxillary, along the longitudinal portion of the maxillo-ectopterygoid suture, is very narrow, the ectopterygoid being separated from the alveoli of the last three teeth by a very thin layer of the bone only.

There are fifteen teeth in each maxillary. They increase in size rapidly from the first to the fifth; the sixth, seventh, and eighth are somewhat smaller; the ninth is much larger than the eighth, and from it back to end of the series there is a steady decrease in size. All of the teeth are unusually stout for a crocodile skull of the size of the one studied. The anterior six or seven teeth are situated on pedestals, with pits between them; as in the premaxillaries, the pits and pedestals of each maxillary are largely hidden in a lateral view of the skull by vertical a flange of the external edge of the maxillary. The vertical festooning of the skull is considerable, and the descent from the prominence on which the large fifth tooth is situated, to the depression in which the sixth tooth is lodged, is very marked; this is greatly emphasized by the difference in size between the two teeth. The first eight maxillary teeth are relatively long-crowned and sharp-pointed; the ninth to thirteenth, inclusive, are short-crowned, relatively blunt, and elongated in the antero-posterior direction. The first five teeth are moderately and equally far apart from each other; they are separated by short spaces which include deep pits, which, in turn, lodge the mandibular teeth; the fifth and sixth, the sixth and seventh, and the seventh and eighth maxillary teeth are far apart, and the intervening pits are deep; posterior to the eighth the maxillary teeth are about equally spaced at moderate distances, with no intervening pits. The first five maxillary teeth are arranged in a rather unusual manner. They are stout, and are slightly curved; their concave inner surfaces face, not directly inward, but inward and backward; similarly their convex outer surfaces face outward and forward; these teeth therefore, are placed oblique to the longitudinal axis of the skull. They are parallel with each other and appear to have functioned more or less as a unit. The small, but rather sharp, sixth, seventh, and eighth maxillary teeth evidently likewise functioned as a unit. In both of these groups the maxillary and mandibular teeth interlock very closely, the mandibular teeth extending up into the pits of the maxillaries. The same is true of the premaxillaries. The maxillary teeth from the ninth

to the thirteenth, inclusive, must also have acted as a unit; between them the mandibular teeth do not reach the maxillary bones when the jaws are closed, but the maxillary and mandibular teeth bite against each other. This grouping of the maxillary teeth into separate regions, or units, is not confined to this species, but appears to be sufficiently emphasized in it to warrant special emphasis in the description.

**NASALS.**—The nasal bones of this species are distinctive in form. From their prominent anterior processes, which enter the narial orifice, they broaden rapidly in the posterior direction, as far back as the level of the second maxillary teeth, or to the posterior extremities of the premaxillaries; from this point back their lateral borders, the maxillo-nasal sutures, are somewhat irregular in outline on a small scale, but are not far from straight, and are essentially parallel. In the vicinity of the level of the eighth maxillary tooth, their lateral borders, which at that point consist of the naso-lacrymal sutures, converge sharply backward, meeting in an irregular manner at the level of the ninth maxillary teeth. The left nasal, in the skull studied, extends considerably farther back than the right; the two nasals are only very slightly separated by the anterior process of the frontal. The posterior portions of the nasals carry the anterior end of the rhombic elevation which gives the species its name.

**LACRYMALS.**—The lacrymals are rather characteristic in form and position. They carry the antero-lateral borders of the "rhomb." Their sutures with the prefrontals are more oblique than in most crocodiles, possibly in connection with the great height of the snout. The sutures of the lacrymals with the nasals are greater in length than the naso-prefrontal sutures, reversing the usual crocodilian condition. The longest axes of the bones themselves converge sharply in the anterior direction, making angles of nearly  $45^{\circ}$  with the longitudinal axis of the skull.

**PREFRONTALS.**—The sutures of the prefrontals with the nasals are unusually short. Their axes of greatest length converge anteriorly, but not to the extent of the axes of the lacrymals.

**FRONTAL.**—The frontal bone has a broadly concave posterior border; its anterior process is only slightly longer than its posterior plate. Its sutures with the prefrontals extend directly inward for short distances, then turn forward with sharp angles, contrasting somewhat with the gently curved sutures of most crocodiles.

**POSTORBITALS.**—The postorbitals are of medium size. Each of them has a greater extent along the lateral border of the cranial table than along the posterior border of the orbit, and each occupies an unusually

large extent of the anterior border of the corresponding supratemporal fenestra.

**SQUAMOSALS.**—These bones are of moderate size, and are sharply upturned at their postero-external extremities; in fact these extremities extend upward and outward as distinct processes. The posterior borders of the squamosals are greater than their lateral borders.

**PARIETAL.**—The parietal bone is unusually irregular in outline. Along its posterior border it extends outward as the base of a median posterior process, of which the supraoccipital occupies the apex. The parietal occupies somewhat over two-thirds of the portion of the posterior border of the cranial table which is situated between the squamosals. Immediately anterior to the supraoccipital the parietal is elevated into a strong rounded ridge, whose convex border faces forward.

**SUPRAOCCIPITAL.**—The superior, or cranial table, portion of the supraoccipital is small; it is elevated somewhat above the general level of the cranial table, and is confluent with the ridge of the parietal mentioned above.

On the posterior surface of the skull the supraoccipital extends downward about three-fourths of the distance from the superior border to the foramen magnum. Laterally this portion of the bone is not very broad, occupying but two-sevenths of the lateral extent of this surface of the skull.

**QUADRATES, EXOCCIPITALS, BASIOCCIPITAL, AND BASISPHENOID.**—These bones are not especially characteristic of the species, except for the type of stoutness which is characteristic of the skull as a whole.

**QUADRATO-JUGALS.**—These bones narrow very rapidly from the posterior to the anterior end. Their free processes are sharp, but are not large.

**JUGALS.**—The jugals are very slender at their extreme posterior ends, but otherwise are very deep vertically. At the level of the thirteenth maxillary teeth these bones are especially high.

**PALATINES.**—These are long and slender. Their sutures with the maxillaries have been described above. The suture with the pterygoids is only partly preserved, but appears to extend inward and slightly backward from a point near the posterior end of the palatine fenestra, then forward and inward to the median line. The narrowest diameter of the two palatines together is at the level of the spaces between the eleventh and twelfth maxillary teeth. The posterior ends are slightly expanded around an enlargement of the narial passage.



**PTERYGOIDS.**—The pterygoids are broad in proportion to their length. Their anterior borders converge rather sharply forward; the median line is occupied very largely by the unusually large internal narial orifice. The pterygoids occupy considerable portions of the broadly rounded posterior borders of the palatine fenestræ.

**ECTOPTYERYGOIDS.**—The anterior processes of the ectopterygoids, which extend as far forward as the level of the tenth maxillary teeth, are broad laterally. Their postero-inferior processes are short and are relatively stout; their superior processes are rather long.

### The Mandible

The mandible is broad and stout, and is composed of individually stout bones. The lateral borders are slightly festooned. The symphysis extends back to the level of the anterior ends of the fifth maxillary teeth; the splenials extend farther forward than the level of the sixth maxillary teeth.

The teeth are all relatively large and strong. The fourth, on each side, is the largest, with the first a close second in size, followed by the tenth. The number of teeth is fifteen as in other true crocodiles; in form they resemble those of the upper jaw. The spacing of the teeth is very irregular; the wider spaces correspond with large teeth in the upper jaw, and the smaller spaces with smaller teeth. The first ten, on each side, are moderately long and pointed; the eleventh and twelfth are shorter and less sharp; the thirteenth and fourteenth are very short and blunt; the fifteenth is absent on both sides of the jaw, but it undoubtedly resembled the fourteenth.

### Measurements Mus. Comp. Zool. No. 4042

Length of Skull, Tip of Snout to Supraoccipital	.28M.
Length of Skull, Tip of Snout to Ends of Quadrates	.32
Length of Snout	.18
Breadth of Snout at Base	.112
Breadth of Snout at Notch	.054
Breadth of Skull Across Quadrato-jugals	.16
Breadth of Cranial Table, Posterior End	.102
Breadth of Cranial Table, Anterior End	.073

### Remarks

This species bears no close resemblance to any other known living crocodile in the form of its skull. The combination of short snout, very high median portion of the snout, and elevated postero-external angles of the squamosals are not known in any other species. *C. americanus*

has the median portion of the snout somewhat elevated, but its entire snout is much lower than in *C. rhombifer*; also the former species has a much longer snout, and has practically no elevation of the angles of the squamosals; no other species has a high snout. The shortness of the snout is approached or equalled by *C. palustris*, and possibly the late Pleistocene *C. robustus*, but both of these have very low snouts. The last-mentioned species resembles *C. rhombifer* in the elevation of the postero-external angles of the squamosals, but differs in having a lower snout, broader premaxillaries, and a different type of festooning. The only known connecting forms between this species and other crocodiles are the American Museum crocodiles from the Pleistocene of Cuba, collected by Mr. Barnum Brown and Dr. de la Torre, which may be referred to *C. rhombifer*, but which exhibit some characters, evidently more primitive, which may assist in bridging the gap between the skull of the modern *C. rhombifer*, and other crocodiles. These Pleistocene specimens will be described later.

#### ***Crocodylus siamensis* Schneider**

No specimen of the skull of this species was available for study. The following description is quoted from Boulenger. "18 upper and 15 lower teeth on each side. Snout once and three fourths as long as broad at the base, rough but without any distinct ridges; interorbital space broad, with a median longitudinal ridge (which, in the specimen figured by Cuvier, is developed into a strong crest followed by another on the occiput); mandibular symphysis extending to the fourth tooth; præmaxillo-maxillary suture, on the palate, directed backwards; præmaxillaries narrowly separated above by the nasals."

#### **OSTEOBLEPHARON Schmidt**

##### **GENERIC CHARACTERS**

In this genus the cranial table is very flat, and the supratemporal fenestræ are small and widely separated from each other. The nasal bones enter the external narial aperture but do not divide it as in *Osteolemus*. The quadrato-jugals have the anterior processes as in *Crocodylus*. There are four teeth in each premaxillary and thirteen in each maxillary; fifteen teeth are present in each ramus of the mandible. The fifth maxillary teeth are enlarged. The fourth mandibular tooth on each side is received into a notch in the upper jaw. The amount of festooning of the skull is considerable. The maxillo-palatine suture does not extend forward beyond the level of the anterior ends of the palatine fenestræ. The

fronto-parietal suture enters the supratemporal fenestræ at their anterior ends. The symphysis extends to the fourth mandibular teeth, and does not include the splenial bones.

This genus resembles *Osteolæmus* in some respects and *Crocodilus* in others; in general it is intermediate between the two. It is somewhat more primitive than *Osteolæmus tetraspis*, and in some respects resembles some of the Eocene crocodiles.

### ***Osteoblepharon osborni* Schmidt**

The description of this species is based upon the type specimen (Amer. Mus. No. 10082), a skull of a half-grown individual.

#### **General Form**

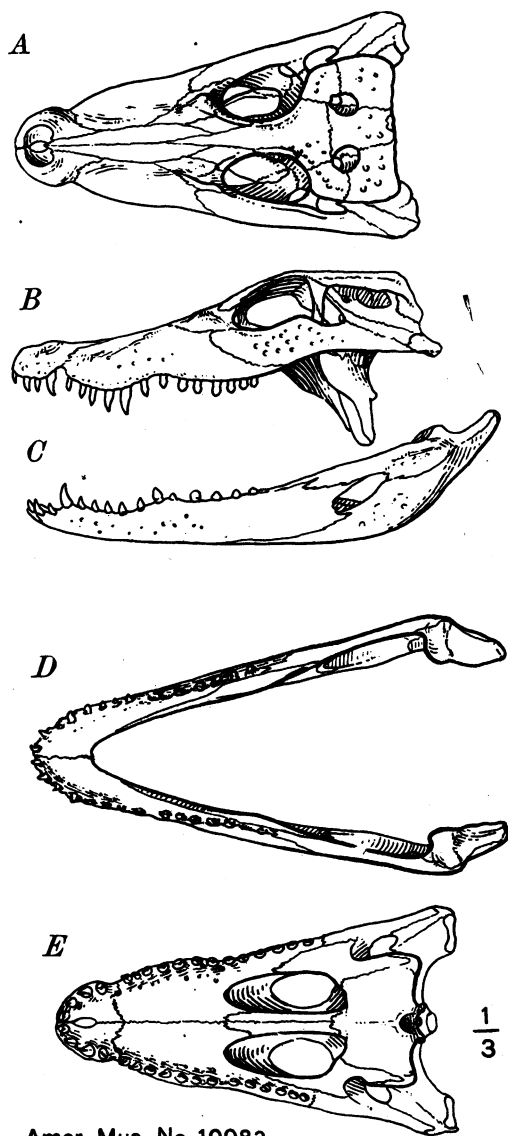
The skull of this species is moderately broad, and is rather high vertically, resembling somewhat in form the skull of *Osteolæmus tetraspis* Cope. A number of differences between the skulls of the two species may be noted, however.

The cranial table is broad and relatively short; its posterior border is a straight line; its external borders are symmetrically curved in slight convexities; the antero-external angles are gently rounded. The surface of the table is flat.

The snout is relatively short and broad, being only one and one-third times as long as broad at the base. The cross profile of the snout at the base consists of three more or less sharply differentiated planes, resembling somewhat those of *Caiman trigonatus*; these planes are not readily distinguishable in the anterior portion of the snout. There are faint suggestions of ridges on the snout, resembling those of some of the caimans, but they are not very prominent. The interorbital plate is rather broad, and is only very slightly rolled up at the edges. The tip of the snout is not turned up as in *Osteolæmus*.

One of the most characteristic features of the skull is a pair of bluntly pointed processes which extend outward from the flat superior surface of the snout immediately anterior to the orbits; they are situated entirely on the lacrymal bones.

The vertical festooning is very prominent, unusually so for so small a skull. The lateral constriction at the "canine" notch is very marked, but the one near the base of the snout is very faint.



Amer. Mus. No. 10082

Fig. 9. Skull and jaws of *Osteoblepharon osborni* Schmidt. Amer. Mus. No. 10082, type, one-third natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—These cavities are small; they are irregularly elongate oval in outline; their longitudinal axes diverge slightly in the anterior direction. They are separated rather widely from each other, and are nearly equidistant from the anterior, external, and posterior borders. The fronto-parietal suture enters the fenestræ at their anterior ends.

**INFRATEMPORAL FENESTRÆ.**—The infratemporal fenestræ are small. Each of them consists of an irregular acute triangle whose apex is superior in position. The anterior border is straight, the base is concave upward, and the posterior border is irregular.

**ORBITS.**—The orbits are large. They are very irregular in outline, the supero-internal borders being strongly concave and the infero-external borders very slightly concave. The anterior ends are bluntly pointed.

**EXTERNAL NARIAL APERTURE.**—This cavity is of moderate size, being much smaller than the orbits, and larger than the supratemporal fenestræ, and it is surrounded by a low, more or less indistinct ridge. It is subquadrangular in outline, and it is not divided by a median bony septum, though there is a prominent process, composed of the anterior tips of the nasal bones, which enters it at its posterior end.

**PREMAXILLARY FORAMEN.**—The premaxillary foramen on the palate is very small. It is irregularly lens-shaped, the anterior end being very sharply pointed, the posterior end more blunt.

**PALATINE FENESTRÆ.**—The palatine fenestræ are long and narrow, the length of each being about two and one-half times its breadth. In form these fenestræ are very irregular. The internal corner of each is a straight line throughout most of its length. The inner third of the posterior border is almost directly transverse in direction; the external two-thirds extends outward and forward obliquely; this latter portion belongs equally to the posterior and external borders. The external border is gently concave for most of its length. The anterior end is rather sharply rounded, the external and internal borders converging into a bluntly rounded point. The fenestræ extend as far forward as the level of the spaces between the seventh and eighth maxillary teeth.

**INTERNAL NARIAL APERTURE.**—This opening is small and is circular in outline. It is situated at the extreme posterior end of the palate, and faces downward and slightly backward. Its anterior border only is elevated; it is not divided by a median septum.

## The Bones of the Skull

**PREMAXILLARIES.**—The premaxillary bones are relatively short and broad. They are separated posterior to the narial aperture by the relatively broad anterior processes of the nasals. They narrow considerably at the “canine” notch. The premaxillo-maxillary suture extends almost transversely inward for a short distance, and then turns almost directly backward. The posterior processes extend back beyond the level of the third maxillary teeth, but not as far back as the level of the fourth.

On the palate the premaxillaries are broader than long. The premaxillo-maxillary suture is irregularly transverse in direction. Its most posterior extension, at the median line, extends scarcely behind the level of the first maxillary teeth. A short distance in from the “canine” notch the suture is interrupted, on each side, by a conspicuous foramen.

There are four teeth in each premaxillary. The second premaxillary teeth of *Crocodylus* appear to have no homologues in *Osteoblepharon*. The first teeth are the smallest and the fourth are next in size. On the left side the third is the largest tooth, and on the right side the second is largest. The third tooth on the right side does not completely fill its alveolus, however, and is evidently very young. The third teeth, therefore, are the largest, and the second teeth next in size in the premaxillaries. The teeth are evenly spaced, and the pits which receive the mandibular teeth are between the teeth themselves, and not internal to them.

**MAXILLARIES.**—The maxillaries are relatively short and broad. The sutures with the nasals are especially short, being little longer than the sutures with the lacrymals and shorter than the sutures with the jugals.

On the palate the maxillaries form about two-fifths of the external borders of the palatine fenestræ, and about one-fifth of the internal borders. These internal borders are actually composed of two bones, the maxillaries forming the borders at the palatal surface, and the palatines at a deeper level; the suture between the maxillaries and the palatines extends horizontally along the borders themselves. The portion of each maxillo-palatine suture at the surface is characteristic in form. It extends inward from the palatine fenestra about opposite the ninth maxillary tooth in a transverse direction, then curves forward and inward to meet its opposite at the median line at the level of the spaces between the seventh and eighth maxillary teeth, only a slight distance anterior to the anterior ends of the palatine fenestræ. This condition contrasts strongly

with that of most crocodilians, in which the suture extends far in front of these fenestræ. It is approached more closely by some of the Eocene crocodiles than by the living ones.

There are fourteen maxillary teeth on each side; these increase regularly in size from the first to the fifth, as in *Crocodilus*. The sixth teeth and the teeth posterior to them are much smaller than the fifth. The anterior six or seven maxillary teeth are slender and sharp, resembling those of the premaxillaries; those farther back have short blunt crowns. The alveoli of the last two teeth are continuous with each other. The internal wall of the posterior half of the compound alveolus is composed of a portion of the ectopterygoid bone and not of the maxillary. The sixth and seventh, and seventh and eighth maxillary teeth are rather widely spaced from each other; all the other maxillary teeth are closely and evenly spaced. A pair of deep foramina is situated immediately internal to the sixth maxillary teeth. There is a very slight lateral constriction of the snout at the level of the seventh maxillary teeth. Vertically, the lateral, or external, border of each maxillary descends rapidly from the "canine" notch to the fourth and fifth maxillary teeth, then rises to the space between the seventh and eighth teeth, posterior to which it descends gradually. The only conspicuous pits for reception of mandibular teeth are between the sixth and seventh, and the seventh and eighth maxillary teeth; these pits are slightly internal to the line of the teeth.

**NASALS.**—The nasal bones are broad. Their external borders are characteristic, being simple, gently convex curves from end to end. The anterior portion, which wedges in between the premaxillaries, is broad, and forms a conspicuous projection into the nasal aperture. The sutures with the maxillaries are very short; these with the lacrymals are relatively long, while those with the prefrontals are very short. At their posterior ends the nasals are wedged apart by a long anterior process of the frontal, which separates them for a considerable distance.

**LACRYMALS.**—The lacrymals are very large compared with those of other crocodile skulls of similar size. Each of them forms a large part of the anterior border of the orbit, both above and below the anterior point of the latter. A conspicuous projection extends outward from each lacrymal.

**PREFRONTALS.**—The prefrontal bones are small and are very irregular in shape. They are much longer than they are broad; their sutures with the frontal and lacrymals are moderately long, but their sutures with the nasals and also their portions of the superior borders of the orbits are very short.

**FRONTAL.**—The frontal bone is very long in proportion to its breadth. Its broader posterior portion extends as far back as the level of the anterior ends of the supratemporal fenestræ; in fact the bone occupies a very small portion of the anterior wall of each of these fenestræ. The interorbital portion is comparatively broad. The long anterior portion is a simple V in outline, the prefronto-frontal and nasofrontal sutures forming straight lines continuous with each other. The anterior process extends as far forward as the level of the eighth maxillary teeth.

**POSTORBITALS.**—These bones are relatively small. They are subquadrangular in outline, and occupy only small portions of the posterior boundaries of the orbits, the external borders of the cranial table, and the external borders of the supratemporal fenestræ.

**SQUAMOSALS.**—The squamosal bones are large; they are subquadrangular in outline, and occupy about twice as much space on the surface of the cranial table as do the postorbitals.

**PARIETAL.**—The parietal is considerably longer than it is broad. It is slightly broader at the anterior end than at the posterior. It occupies about half of the space along the posterior border of the cranial table between the two squamosals, the supraoccipital occupying the other half.

**SUPRAOCCIPITAL.**—The supraoccipital occupies about half of the space between the squamosals on the posterior border of the cranial table, its antero-posterior diameter on the cranial table is less than one-half its lateral diameter. On the posterior surface of the skull it extends downward about three-fifths of the distance from the superior border to the foramen magnum.

**QUADRATES, EXOCCIPITALS, BASIOCCIPITAL, AND BASISPHENOID.**—These bones are not sufficiently characteristic to warrant description at the present time.

**QUADRATO-JUGALS.**—These bones are long and slender in two dimensions, and thick in the other at the posterior ends, where they cover the quadrates. They have processes extending into the infra-temporal fenestræ as in *Crocodylus* and *Tomistoma*; but the processes are not so sharply pointed as in the latter genera.

**JUGALS.**—The jugals are deep vertically in their anterior portions, and shallow near their posterior ends; each of them has a superior process at the posterior end of the orbit.

**PALATINES.**—The palatines are long and slender; their sutures with the maxillaries have been described above. They do not extend



as far in the posterior direction as the palatine fenestræ, the sutures with the pterygoids consequently extending only across the narrow bar separating the two fenestræ. This short suture is irregular in outline.

**PTERYGIDS.**—The pterygoids appear to have fused into a single bone. They occupy considerable portions of the borders of the palatine fenestræ; they are somewhat broader than long, and curve downward at their external borders, making the pterygoid surface of the palate concave. A faint ridge is situated anterior to the internal nasal aperture and partly surrounding it. Two small processes extend backward beyond the palate.

**ECTOPTYERYGIDS.**—The ectopterygoids occupy portions of the posterior borders of the palatine fenestræ as well as the external borders, and they form the internal wall of the alveolus of each of the last maxillary teeth. They extend as far forward as the level of the spaces between the tenth and eleventh maxillary teeth.

### The Mandible

In general form each ramus of the mandible is slender, though the two rami together make a rather broad jaw. The symphysis extends as far back as the level of the anterior ends of the fifth mandibular teeth. The external mandibular foramina are small, and are situated far back in the normal crocodilian position.

The dentaries are long and slender. Each contains fifteen teeth only, as in *Crocodylus*. The bones are peculiar in that they do not constitute the internal wall of the compound alveolus of the last three mandibular teeth. The first three teeth are of small or medium size, and are spaced regularly at moderate distances from each other. The fourth teeth are the largest in the jaw. Posterior to the fourth the teeth are small and are spaced close together as far back as the eighth; between the eighth and ninth teeth are considerable spaces; posterior to the eighth the teeth are all close together. The tenth and eleventh teeth are larger than those immediately anterior to them. The twelfth, thirteenth, fourteenth, and fifteenth teeth are small. As far back as the eleventh the teeth are slender and sharply pointed; posterior to the eleventh they are small and blunt. The superior borders of the mandible, as shown on the dentaries, are festooned in the reverse order from the maxillaries.

The splenials extend as far forward as the sixth mandibular teeth. They form the internal walls of the compound alveoli of the fourteenth and fifteenth mandibular teeth; in the region of these teeth each splenial sends a small shelf-like process inward toward the median line.

The angular, surangular, and coronoid bones are not sufficiently characteristic to warrant special description.

The articular surfaces of the articular bones are rather long antero-posteriorly. They are characterized especially by the oblique, inturned positions of the posterior processes.

#### Measurements Amer. Mus. No. 10082

Length of Skull, Tip of Snout to Supraoccipital	16.65cm.
Length of Skull, Tip of Snout to Ends of Quadrates	16.4
Length of Snout, Anterior End of Orbit to Tip	8.5
Breadth of Skull, Across Quadrato-jugals	9.25
Breadth of Cranial Table	5.9
Breadth of Snout at Base	6.4
Breadth of Snout Opposite Fifth Maxillary Teeth	5.2
Breadth of Snout at "Canine" Notch	3.2
Breadth of Snout Opposite External Narial Aperture	3.55

#### Remarks

In its general form, its large flat cranial table, and in some of the details of its bones the skull of this species resembles that of *Osteolæmus tetraspis* rather closely. In other characters it differs appreciably from the latter crocodile. In many characters *Osteoblepharon osborni* resembles *Crocodylus* as closely as it does *Osteolæmus*. In certain characters *Osteoblepharon* is more primitive than *Osteolæmus* or *Crocodylus*, and stands intermediate between the two genera. It appears to be only distantly related to *Tomistoma*, *Caiman*, and *Jacare*, and still more distantly to *Gavialis* and *Alligator*. The present interpretation is that *Osteoblepharon* has descended from some primitive species of *Crocodylus* or a form very closely related to that genus, and has retained a few primitive characters which the Recent species of *Crocodylus* have lost, and at the same time has developed some new characters which are not known in *Crocodylus*. *Osteolæmus* is evidently a more specialized form, and may perhaps be a derivative of *Osteoblepharon*.

#### **OSTEOLÆMUS** Cope

##### GENERIC CHARACTERS

This genus resembles *Osteoblepharon* in many of its characters. In it the cranial table is large and flat, and the supratemporal fenestræ are small, and are far apart; the fronto-parietal suture does not enter the fenestræ. The nasal bones extend forward into the external narial aperture, and divide it into two lateral portions as in *Alligator*. The snout

is short and is considerably indented. The tip of the snout is turned upward, giving the superior profile of the snout a concave curve. The upper eyelids are bony.

The premaxillaries contain four teeth each, and the maxillaries thirteen each typically; the mandible contains fourteen or fifteen teeth in each ramus. The fourth mandibular teeth bite into notches in the snout, as in *Crocodilus*. The symphysis extends to the fourth or fifth mandibular teeth, and does not contain the splenials, and the quadrato-jugals possess sharp anterior processes.

The fifth maxillary tooth on each side is somewhat enlarged. The maxillo-palatine suture does not extend forward beyond the anterior ends of the palatine fenestræ; these fenestræ are very irregular in outline.

This genus is evidently closely related to *Osteoblepharon*, and less closely to *Crocodilus*. It is more specialized in several respects than either of these genera.

#### ***Osteolæmus tetraspis* Cope**

This description of *Osteolæmus tetraspis* is based chiefly upon a small skull in the American Museum Collection (Amer. Mus. No. 7743), also upon published descriptions and figures. Judging from a number of characters, not including its small size, the skull is that of a young individual. Among these characters may be mentioned the large size of the orbits, the number of teeth (four or five) beneath the orbits, the small size of the interorbital plate, the amount of cranial overhang when the skull is viewed from below, the weakness of the various rugosities, and the incomplete appearance of the mandibular dental series. The size is small, but the maximum size listed by Boulenger for the species is not great; this skull evidently belonged to an individual much smaller than the maximum size.

#### **General Form**

The skull is short and broad, and moderately high. The snout is about one and one-fifth times as long as broad at the base; the length of the snout is approximately one-half of the total length of the skull from the tip of the snout to the ends of the quadrates. The superior longitudinal profile of the snout is decidedly concave, and the rim of the external narial aperture is elevated. In general the snout is smooth, but anterior to each orbit is a small prominence, and on each maxillary bone, near its anterior end, is a shallow depression. The lateral constrictions of the snout are deep, and the amount of vertical festooning is considerable.

The cranial table is moderately large, and is flat. It is approximately quadrangular in outline; its lateral borders are substantially parallel, and its posterior border is very gently concave. The antero-external angles of the table are neither rounded nor sharp. The interorbital plate is deeply concave.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—The supratemporal fenestræ are very small; they are very irregular in outline, and are far apart from each other. Their axes of greatest length converge very sharply in the posterior direction.

**INFRATEMPORAL FENESTRÆ.**—These cavities are very much larger than the supratemporal fenestræ, and are irregularly subtriangular in outline. They differ from the corresponding fenestræ of most crocodilians in having their vertical diameters very much greater than their antero-posterior.

**ORBITS.**—The orbits are very large. They are subcircular in outline, but their superior, or internal, borders are more concave than their inferior, or external, borders; they consequently appear to be very slightly pointed at their anterior ends. Their superior borders are conspicuously rolled upward.

**EXTERNAL NARIAL APERTURE.**—The external narial aperture is very large. It is divided longitudinally, at the surface, by the anterior processes of the nasal bones, which extend forward and join shorter processes of the premaxillaries extending backward from the anterior margin of the aperture, similar to the condition in *Alligator*. The anterior end of the aperture is very near the anterior margin of the snout; the posterior margin is slightly posterior to the level of the last premaxillary teeth.

**PREMAXILLARY FORAMEN.**—The premaxillary foramen on the palate is very small. It is sharply pointed at its anterior and posterior ends, and its two lateral borders are simple concave curves.

**PALATINE FENESTRÆ.**—The palatine fenestræ are large and very irregular in outline. They extend forward to the level of the spaces between the seventh and eighth maxillary teeth. Between one-fourth and one-fifth of the internal border of each fenestra is composed of the maxillary bone, and this portion is not in direct line with the palatine portion immediately posterior to it. The maxillary portion is oblique, and the anterior part of the palatine portion is nearly antero-posterior. This palatine portion quickly turns inward, however, and sweeps around,

in a deep concavity, to an point near the posterior end of the fenestra. The posterior portion of the internal border, about one-tenth or one-twelfth, is composed of a portion of the pterygoid bone.

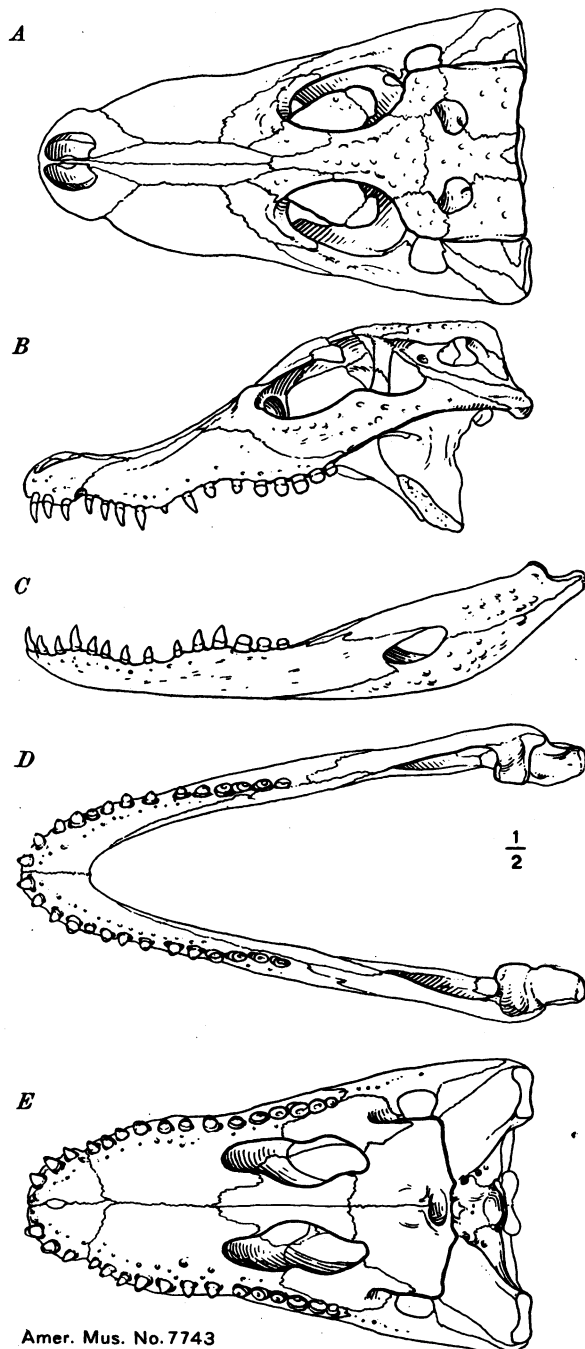
The external border, on each side, is likewise very irregular. The anterior two-fifths is composed of the maxillary bone; this portion is slightly concave; immediately posterior to it is the ectopterygoid portion, which extends abruptly into the fenestra, and then follows a very concave path of its own to a point very near the posterior end of the fenestra. A very small portion of the external border, perhaps one-fifteenth, is composed of the pterygoid. Both anterior and posterior ends of the fenestræ are rounded.

INTERNAL NARIAL APERTURE.—The internal narial aperture is rather small; its breadth is considerably greater than its length. It is not divided by a median septum, and it faces almost directly downward.

### The Bones of the Skull

PREMAXILLARIES.—The premaxillary bones are very short and broad. The greatest constriction at the "canine" notches is on the premaxillaries, but between these notches they are much broader than they are long. Their posterior processes are very broad, and are not sharply separated from the posterior region of the bone in general; they extend as far back as the level of the third maxillary teeth. A slender process extends back from the anterior margin of the external narial aperture to join the anterior processes of the nasals.

On the palate the premaxillaries are very much broader than long. The premaxillo-maxillary suture extends inward and backward from each side and meets its opposite on the median line at the level of the second maxillary teeth. The two lateral components of the suture together form an irregular V. In the specimen studied only three teeth are present in each premaxillary; the anterior portions of the palatal surfaces of the premaxillaries are not complete, however, and there are indications of a pair of small alveoli. In the figure of the palate of *Osteolexemus* in Schmidt's article on the Congo Reptilia (after Gray), a pair of small alveoli are represented near the median line. The species therefore undoubtedly has four teeth in each premaxillary. There is no trace of the very small second tooth of the more primitive crocodilians. The teeth are about equally spaced apart, and are separated by deep pits which lodge mandibular teeth; these pits are slightly internal to the lines of the teeth themselves.



Amer. Mus. No. 7743

Fig. 10. Skull and jaws of *Osteolemus tetraspis* Cope. Amer. Mus. No. 7743, two-thirds natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

**MAXILLARIES.**—The superior portions of the maxillaries are exceedingly short and the inferior portions are moderately so. The maxillo-nasal sutures are less than one-third as long as the total length of the maxillary bones. Their sutures with the lacrymals are very irregular; their sutures with the jugals are very short in the antero-posterior direction. As noted above, the maxillaries, in the antero-internal portions of their superior surfaces, lodge a pair of shallow depressions.

On their palatal surfaces the maxillaries are unusually short and broad. The length of the two maxillaries along the median line is very much less than their transverse diameter at any point. The maxillaries comprise portions of the internal borders of the palatine fenestræ, as noted above. From a point opposite the ninth maxillary tooth, each maxillo-palatine suture extends inward and backward a very slight distance, then turns forward, and extends in a direction only very slightly inward and almost antero-posterior, to a point opposite the seventh maxillary tooth, and then extends irregularly inward to meet its opposite at the median line. In its forward extent and its outline, the maxillo-palatine suture of this specimen differs slightly from the one figured by Gray and Schmidt.

The maxillary portions of the external borders of the palatine fenestræ are broad laterally, extending inward from the dental borders. From the anterior ends of the maxillo-ectopterygoid sutures (which extend forward to the level of the tenth maxillary teeth) backward, the borders of the maxillaries are very narrow; opposite the last and next to the last maxillary teeth the internal walls of the alveoli are at least very thin, and may possibly be absent altogether, so far as the maxillaries are concerned, the ectopterygoids taking their places. The maxillaries do not extend back for any considerable distances posterior to the dental series.

The right maxillary contains thirteen teeth and the left twelve. The specimen figured by Gray and Schmidt has twelve in each maxillary. There is a progressive increase in the size of the teeth from the first to the fifth (on the right side of the skull studied the fifth tooth is small, but its alveolus is large). The sixth, seventh, eighth, and ninth teeth are smaller; the tenth is slightly larger, the eleventh larger still, while the twelfth is small, and thirteenth is exceedingly small.

The first seven teeth in each maxillary are long-crowned, sharp-pointed, and blade-like in form, and their external surfaces are curved more than their internal surfaces; the eighth is short-crowned, but is sharp; posterior to the eighth the teeth are all very short-crowned and

are very blunt. The demarkation of the maxillary teeth into distinct tearing and chewing groups is very marked. The anterior seven teeth in each maxillary are all moderately far apart from each other; they are separated by pits which receive the mandibular teeth. The seventh and eighth are likewise separated by pits, but are farther from each other than are the teeth farther forward. All of the pits are in line with the teeth themselves. The eighth and ninth teeth are moderately far apart, but are not separated by pits. Posterior to the ninth the maxillary teeth are all very close together.

**NASALS.**—The nasal bones are short, occupying less than one-half the length of the skull, in spite of the fact that they extend farther forward than do most crocodilian nasals. Their anterior processes, which separate the superior level of the narial aperture into two separate cavities, are very slender; immediately posterior to the narial aperture, however, the nasals expand in breadth very rapidly, and reach their maximum breadth at the points where the premaxillaries, maxillaries, and nasals come together. From these points, which are at the level of the third maxillary teeth, backward, the nasals remain constant in breadth, their lateral boundaries (the maxillo-nasal sutures) being parallel. Posterior to the ends of the maxillo-nasal sutures, at the level of the seventh maxillary teeth, the nasals decrease in breadth, and end rather abruptly at the level of the ninth maxillary teeth. Their posterior borders are nearly transverse. The sutures of the nasals with the lacrymals are slightly longer than their sutures with the prefrontals.

**LACRYMALS.**—The lacrymals are large. They contain the tuberosities anterior to the orbits which were noted above. Each of them occupies about twice as much area as the corresponding prefrontal; their sutures with the prefrontals, and their axes of greatest length are very oblique in position.

**PREFRONTALS.**—The prefrontals are of moderate size. Their postero-external borders (the orbits) and their antero-external borders (the lacrymo-prefrontal sutures) are symmetrical with each other; their internal borders (the naso-prefrontal sutures and prefronto-frontal sutures) form symmetrical, gently concave lines. Their sutures with the nasals are very short.

**FRONTAL.**—The median frontal bone is relatively large. Its anterior process is unusually short in proportion to the size of the large posterior plate. The anterior process is relatively broad, and it ends rather abruptly at its anterior end, not wedging the two nasals apart as in most crocodilians. The orbital borders of the frontal are sharply uprolled;



the interorbital space is relatively narrow. The posterior portion of the frontal, posterior to the level of the posterior ends of the orbits, is relatively long antero-posteriorly, and is flat.

**POSTORBITALS.**—These bones are small. Each of them occupies about two-fifths as much area on the cranial table as the corresponding squamosal. Each occupies about three-tenths of the lateral border of the cranial table; the lateral border, and anterior, or orbital border, of each are approximately equal in length.

**SQUAMOSALS.**—The squamosal bones are large. Each squamosal occupies about two and one-half times as much surface area as the prefrontal of the same side, and about seven-tenths of the lateral border of the cranial table; its surface area is about equal to that of the parietal. The length of external border of each squamosal is only slightly greater than the length of its posterior border; each squamosal comprises a larger portion of the posterior border of the cranial table than the parietal and supraoccipital together. The squamosals are not elevated at their postero-external angles, nor are they characterized by unusual pitting, except that some of their pits are somewhat deeper than those of other parts of the cranial table.

**SUPRAORBITALS.**—The supraorbital bones, or bony eyelids, are unusually large, and are considerably curved. The one on the right side appears to be composed of several separate elements which are united to each other by suture. This may be partly accidental, however, although at least one of the cracks appears to be a true suture.

**PARIETAL.**—The parietal is very flat and is very regularly pitted, except immediately around the supratemporal fenestræ, where it is smooth. Its central portion is very broad, in connection with the wide spacing of the fenestræ. It occupies about two-thirds of that portion of the posterior border of the cranial table which is situated between the internal boundaries of the squamosals. The supraoccipital occupies the median third, while the parietal embraces it on either side, and forms the two external thirds.

**SUPRAOCCIPITAL.**—The supraoccipital occupies a very small portion of the surface of the cranial table, and occupies a small portion of its posterior border, as noted above. On the posterior surface of the skull it occupies over one-third of the breadth of the cranial box, at its broadest point, and it extends downward about two-thirds of the distance from the superior border to the foramen magnum; this last character may be correlated with the young age of the individual.

EXOCCIPITALS, BASIOCCIPITAL, BASISPHENOID, AND QUADRATES.—These bones are not sufficiently characteristic to deserve special attention.

QUADRATO-JUGALS.—These bones are broad at their posterior ends, and are slender farther forward. The right quadrato-jugal of the specimen studied extends into the infratemporal fenestra as a sharp process, comparable to those of the various species of *Crocodylus*, and of *Tomistoma*, but somewhat smaller. The left side has no such process, but it may have been present and broken off. The Gray-Schmidt figures indicate no such processes on the specimen figured.

JUGALS.—The jugal bones are characterized by their relatively great vertical, and short antero-posterior diameters. Their posterior processes are especially short.

PALATINES.—The sutures of the palatines with the maxillaries have been described above. Posterior to these sutures the palatines decrease in breadth very rapidly, until at the level of the eleventh maxillary teeth, or perhaps the level of the borders of the tenth and eleventh maxillary teeth, they are about one-half their breadth at the level where the maxillo-palatine sutures enter the fenestral borders. From the constricted portion backward the palatines broaden very rapidly, until at their sutures with the pterygoids they are broader than at their anterior ends. They are also somewhat expanded vertically at their posterior ends, assisting the pterygoids in enclosing an enlargement of the nasal passage. The transverse suture of the palatines with the pterygoids is situated altogether anterior to the posterior ends of the palatine fenestræ. This suture extends across the interfenestral plate in an irregular, though almost directly transverse, direction. Near the fenestra, however, on the left side of skull, the suture makes a sharp turn forward, and then turns sharply backward again. The irregularities are all on a very small scale, however, and the suture is nearly transverse.

PTERYGOIDS.—The pterygoids are relatively long in proportion to their breadth, as compared with other crocodiles. The small internal narial aperture occupies only a small portion (about one-fifth) of the antero-posterior diameter on the median line. The two pterygoids are united by suture ventrally, but are united without suture superiorly. The pterygoids extend forward beyond the posterior ends of the palatine fenestræ, and compose a portion of the interfenestral plate.

ECTOPTERYGOIDS.—These bones extend as far forward as the posterior margins of the tenth maxillary teeth; as noted above, they extend into the palatine fenestræ as short processes. Their posterior

processes, therefore, are very broad, and are not pointed anteriorly. Their inferior processes are very broad at their bases; their superior processes are small.

### The Mandible

The mandible is broad, and is composed of stout bones. Each ramus has fourteen teeth, but also has a depression in the alveolar border posterior to the teeth, which might be occupied by a pair of teeth in an older individual. The posterior processes extend backward parallel to each other, instead of converging posteriorly, as in many other crocodiles. The external mandibular foramina are relatively large. The large posterior internal mandibular foramina are very large; anterior to these are two pairs of small foramina, one very small, along the contacts of the dentaries and the coronoids, the other, at a lower level, and somewhat larger, along the contacts of the dentaries and angulars. The mandibular borders are slightly festooned. The symphysis extends back as far as the level of the fifth mandibular teeth. The splenial bones extend almost to the symphysis, reaching beyond the level of the sixth mandibular teeth. The internal walls of the alveoli of the thirteenth and fourteenth mandibular teeth appear to be composed of the splenial bones instead of the dentaries.

The spaces between the mandibular teeth are all approximately equal, except for the spaces between the eighth and ninth, on each side, which are greater than those between the other teeth. The fourth is the largest tooth on each side, and the eleventh is second in size. The first ten teeth on each side are sharp, while the last four are blunt; the transition from relatively long-crowned to relatively short-crowned teeth is more gradual.

### Measurements Amer. Mus. No. 7743

Length of Skull, Tip of Snout to Supraoccipital	.1265M.
Length of Skull, Tip of Snout to Ends of Quadrates	.1315
Length of Snout	.0670
Breadth of Snout at Base	.0560
Breadth of Snout at Fifth Maxillary Teeth	.0475
Breadth of Snout at Notches	.0280
Breadth of Snout Across Premaxillaries	.0290
Breadth of Skull Across Quadrato-jugals	.0778
Breadth of Cranial Table	.0454
Breadth of Interorbital Plate	.0122
Length of Right Orbit	.0300
Length of Left Orbit	.0290
Length of Mandible	.1485
Breadth of Mandible	.0780

## Remarks

This form is in some respects more highly specialized than *Osteoblepharon osborni*, especially in connection with the nasal septum, the irregularities of the palatine fenestræ, and the very small size of the supratemporal fenestræ. In other respects it is rather primitive, and resembles the Eocene crocodiles of the Bridger Epoch. It may be considered as a side line, which has diverged from the central crocodile stem in Tertiary time; *Osteoblepharon* is intermediate between this form and the true crocodiles; the species has no direct relation to *Alligator* or *Gavialis*.

**JACARE** Gray

## GENERIC CHARACTERS

The species listed under this genus are sometimes included under *Caiman*, as in the catalogue by Boulenger. Certain writers, especially Huxley, have considered that the South American caimanoid species belong naturally in two genera instead of one. Three of the five species referred by Boulenger to *Caiman* are here referred to *Jacare* (*J. sclerops*, *J. latirostris*, and *J. niger*); the two remaining species (*C. trigonatus* and *C. palpebrosus*) are referred to *Caiman*.

The skull of this genus is broad, and is rounded at the anterior end; the fourth mandibular teeth typically bite into pits in the upper jaw as in *Alligator*. The prefrontal borders of the orbits are elevated into prominent ridges; these extend forward and slightly outward, over the lacrymal and maxillary bones; their strength and extent vary among the species. Near the anterior ends of the orbits the two ridges are connected by a transverse ridge, which in some cases is lower and narrower than the antero-posterior ridges; the transverse ridge is usually interrupted at the median line by a slight depression; it separates the lower surface of the snout from the upper surface of the interorbital plate; the anterior portions of the longitudinal ridges and the transverse ridge together frequently form a letter U in general outline. The supratemporal fenestræ are small, and in very old individuals are occasionally obliterated; they are situated far apart from each other. There may or may not be a constriction at the lateral border of the snout along the line of the premaxillo-maxillary suture. There is usually a slight constriction farther back. The cranial table is flat.

The orbits are large and close together. The narial aperture is also large, and is especially broad in proportion to its length. It is not divided by a median bony septum as in *Alligator*. The premaxillary foramen is large; it is very long in proportion to its breadth; it is

sharply pointed anteriorly, and may be pointed or rounded posteriorly. The palatine fenestræ are large. The internal narial aperture is very broad in proportion to its length; it is, usually at least, divided by a median septum.

One of the most characteristic and constant characters of the genus is the relation of the squamosal, parietal, and supraoccipital bones to each other. The supraoccipital occupies a considerable area on the surface of the cranial table; it occupies the entire portion of the posterior border of the table which is situated between the two lateral portions which consist of the squamosals; the PARIETAL IS THEREFORE EXCLUDED FROM THE POSTERIOR BORDER ALTOGETHER; this is a decided contrast with the condition in all other known crocodiles.

The lacrymal bones are large, and irregular in outline, especially along their anterior borders; they have extensive contacts with the nasals. The maxillo-palatine suture is characteristic and constant in outline. On each side it curves outward anterior to the palatine fenestra, then inward again to the median line. The anterior end of the two palatines together, is therefore rounded externally. The posterior ends are not distinctive.

Huxley includes in his diagnosis of the characters of this genus this statement: "The vomers [prevomers], separated by a longitudinal suture, appear in the palate between the premaxillaries and the palatine plates of the maxillaries." This statement will hardly hold for the entire genus, as in none of the specimens of *J. sclerops* and *J. latirostris* examined do the prevomers appear at the surface of the palate. They do so appear in *J. niger*, however, and their presence may be considered as a specific and not a generic character.

The teeth are stout, and the lower series bites entirely inside of the upper series. The fourth maxillary teeth are enlarged. The number of superior teeth on each side varies from eighteen to twenty; the number of inferior teeth also ranges from eighteen to twenty.

#### **Jacare niger** (Spix)

The following description of the skull of *Jacare niger* is based primarily upon a somewhat more than half-grown specimen in the Harvard Museum (Mus. Comp. Zool. No. 4043). Many of the characters were verified upon a full-grown specimen in the American Museum (Amer. Mus. No. 15171); this specimen is not complete.

### General Form

In the general form of the skull *Jacare niger* resembles *J. sclerops* and *J. latirostris*; it differs somewhat from the other two species, however, and in some respects is intermediate between them.

The skull is relatively broad and short, as in the other two species of *Jacare*. The anterior end of the snout is slightly more pointed than in these species, especially *J. latirostris*. The outline of the snout suggests a triangular form, although it is not distinctly triangular.

The ridges of the snout are unusually prominent. They comprise two distinct groups, as in the two related species; they are far more prominent than in *J. sclerops*. The posterior group consists of the pre-orbital U-shaped elevations and the anterior group of a pair of oblique elevations which extend inward and backward, at angles of about 45° from the antero-posterior direction, from the position of the premaxillo-maxillary suture on the lateral borders of the skull, to points near the junctions of the premaxillo-maxillary, premaxillo-nasal, and maxillo-nasal sutures, and then directly backward, or backward and then slightly outward, and join the posterior U-shaped ridges immediately anterior to the junctions of the maxillo-nasal, maxillo-lacrymal, and naso-lacrymal sutures.

The posterior ridges rise on the superior borders of the orbits about midway between the anterior and posterior ends of the latter. They extend forward in almost straight lines to the areas above the fourth maxillary teeth, where they merge into the rounded elevations of the snout above these large teeth. The anterior half of the interorbital region, between the two ridges, is concave. The ridges themselves are very prominent; they diverge anteriorly and, not counting the transverse connecting ridge, resemble a V rather than a U. The connecting ridge is low; it is only very slightly elevated above the level of the interorbital region, but is distinctly elevated above the surface of the snout. At the median line the passage from the interorbital plate to the snout is gradual, the ridge being low, practically absent at this point. Either side of the median line the descent is very sudden, the snout being depressed immediately anterior to the transverse ridge. The two strong diverging ridges and the weaker transverse ridge together make a U-shaped structure, whose arms diverge much more than do those of *J. sclerops* or *J. latirostris*.

There is no prominent elevation around the external narial aperture, but there is a low ridge-like structure bordering the postero-external corner on either side.

The cranial table is rather small, and its surface is very flat. Its external borders are nearly parallel, though they converge very slightly in the anterior direction. The external borders are not sharply set off from the anterior borders, but merge into them through short antero-external borders at the antero-external angles of the cranial table. The posterior border of the table is strongly concave.

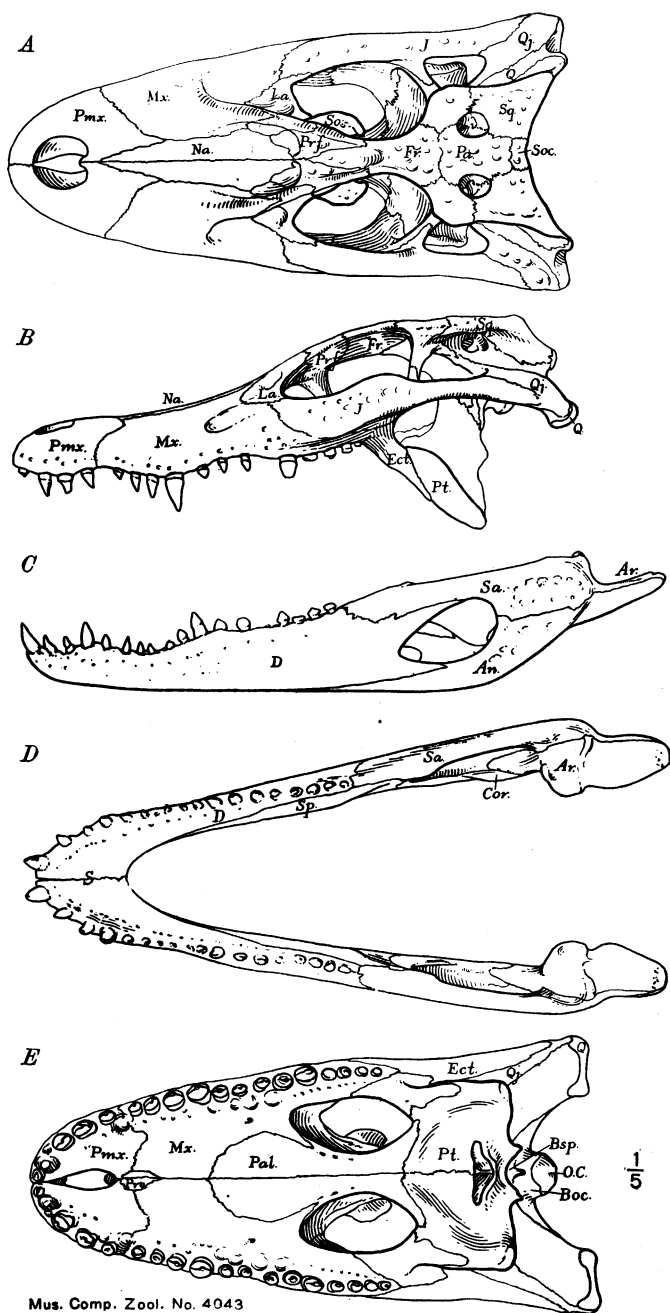
### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—These cavities are small and are irregularly elongate in form, their greatest diameters being antero-posterior in direction. They are situated rather far forward on the cranial table, being nearer the orbits than the posterior border; they are also rather widely separated, the interfenestral space being considerably greater than the space between either fenestra and the external border. The two fenestræ together would be much smaller than the external narial aperture.

**INFRATEMPORAL FENESTRÆ.**—These fenestræ are small in size, though they are considerably larger than the supratemporal fenestræ. Each of them is distinctly triangular in form, with the three sides of the triangle approximately equal in length. The apex of each triangle lies under the anterior end of the corresponding supratemporal fenestra. The postorbital bar, which forms the anterior boundary of each infra-temporal fenestra, is considerably more inclined than in most crocodilians including *J. sclerops*.

**ORBITS.**—The orbits are enormous in size, occupying one-fourth of the total length of the skull, from the extremities of the quadrates to the tip of the snout. They are also broad laterally, the interorbital space being narrow, especially in its posterior half. In form the superior, or internal, half of each orbit is regularly curved; the inferior, or external border is composed of two nearly straight lines of equal length, which meet below the center of the orbit. The huge size of the orbits is a striking characteristic of the species. Each orbit contains a small bony eyelid.

**EXTERNAL NARIAL APERTURE.**—This cavity is large, and is well separated from the tip of the snout. It is rounded anteriorly, with a slight notch at the median line; its broadest point is nearer the anterior than the posterior end. The anterior portions of the lateral borders are rounded, and are not separable from the anterior border; the posterior portions are straight and converge slightly backward. The posterior border is straight and transverse, except at the median line, where there is a pair of processes from the premaxillaries projecting into the cavity itself.



Mus. Comp. Zool. No. 4043

Fig. 11. Skull and jaws of *Jacare niger* (Spix). Mus. Comp. Zool. No. 4043, one-fifth natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.



**PREMAXILLARY FORAMEN.**—This cavity is very large; it is elongate in form, and is pointed at each end, more acutely so at the anterior end than at the posterior. The lateral borders are straight converging lines in the anterior portions, but are more rounded near their posterior ends. The foramen extends from very near the first premaxillary teeth to the premaxillo-prevomer suture.

**PALATINE FENESTRÆ.**—The palatine fenestræ are large, but not unusually so; they are rather broadly rounded anteriorly and broadly pointed posteriorly. They are regular in outline, the external and internal borders being symmetrical with each other. They extend as far forward as the spaces between the eighth and ninth maxillary teeth.

**INTERNAL NARIAL APERTURE.**—This cavity is very broad in proportion to its length. Its anterior border is straight and transverse in direction; its posterior border is irregular, and is elevated into a pair of flanges which slightly overhang the cavity itself. The median bony septum is strong. The cavity faces forward as well as downward.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillary bones are broad in proportion to their length. In the smaller specimen examined they are pierced by the first and fourth mandibular teeth; in the larger specimen they are not pierced at all.

The premaxillo-maxillary sutures, on the superior surface, extend inward and backward, somewhat irregularly, but in a general direction about 45° from antero-posterior. The posterior ends of the bones lie over the third maxillary teeth. In the smaller specimen the premaxillaries meet behind the narial aperture, excluding the nasals from the latter; in the larger specimen they do not come in contact with each other superiorly, the nasals entering the aperture. The premaxillo-nasal sutures diverge rapidly in the posterior direction.

On the palatal surface each premaxillo-maxillary suture extends from the center of the space between the fifth premaxillary tooth and the first maxillary tooth, inward and slightly backward across the deep pit which receives the fourth mandibular tooth, across a small foramen internal to this pit, then backward and slightly inward to a point slightly posterior to the level of the first maxillary teeth, then obliquely inward and forward to the contact of the premaxillary, maxillary, and prevomer, from which point the suture extends obliquely, but not far from antero-posteriorly, forward to the median line as a premaxillo-prevomer suture.

The first premaxillary teeth are very small; the second are not preserved in either skull studied, but from their alveoli appear to have been small, but not much smaller than the first; the third are large and strong; the fourth are also large and stout, next to the fourth and ninth maxillary teeth being the largest in the upper jaw; the fifth are of medium size, being larger than the first and smaller than the third.

These teeth are spaced in the usual manner; the first are situated close together; they are separated from the second by the unusually large pits for the first mandibular teeth; the second are rather close to the third, but their alveoli are separated from those of the latter by stout walls of bone; the third and fourth, and the fourth and fifth, are separated by considerable, though not great, spaces of equal size.

**MAXILLARIES.**—Like the premaxillaries, the maxillaries are relatively broad. They contain most of the large preorbital ridges mentioned above, also the larger portions of the anterior oblique ridges.

The maxillo-nasal sutures diverge in the posterior direction, but not as conspicuously as the premaxillo-nasal sutures, throughout their entire lengths. The maxillo-lacrymal sutures are complex in form. Each of them extends forward and outward a short distance from its origin at the maxillo-naso-lacrymal contact over the space between the seventh and eighth maxillary teeth, then backward and slightly outward up on the preorbital ridge, to a point over the large ninth maxillary tooth, then outward and forward, down over the external margin of the preorbital ridge to a point opposite its origin, then backward and outward to a point near the anterior end of the orbit, over the ninth maxillary tooth, where the maxillary, lacrymal, and jugal bones come in contact with each other.

The maxillo-jugal suture extends almost directly downward, on each side, from the point just mentioned, for a distance about half of that between this point and the inferior border of the skull, then curves backward to the posterior end of the maxillary bone.

On the palate the maxillaries occupy a comparatively small space, because of the large size of the anterior processes of the palatines, and the presence of the prevomers at the surface. Neglecting the prevomers the distance along the median line from the premaxillaries to the palatines is not great, the anterior end of maxillo-palatine suture extending slightly farther forward than the level of the fifth maxillary teeth. As nearly one-half of this distance is occupied by the prevomers, the median longitudinal extension of the maxillaries is very small. The maxillo-palatine suture extends, on each side, inward and backward from near the anterior

end of the palatine fenestra in the usual crocodilian manner, then forward and outward to a point slightly posterior to the level of the seventh maxillary teeth, then curves forward and inward to the median line. At the level of the greatest lateral expansion of the palatines the maxillaries occupy but seven-twelfths of the total breadth of the skull.

**NASALS.**—The nasals are relatively short and broad bones. They are excluded from the external narial aperture in the smaller skull studied, but enter it in the larger one; in the smaller specimen the left nasal is longer than the right. The nasals broaden rapidly from their anterior extremities to the level of the anterior ends of the naso-lacrymal sutures, over the seventh maxillary teeth; from this point back they narrow gradually to the posterior ends of the naso-lacrymal sutures, then narrow rapidly to a point between the anterior ends of the orbits, immediately anterior to the transverse ridge. The sutures with the premaxillary and maxillary bones have been described above. The contacts with the lacrymals are very short, each being but one and one-half centimeters long in the smaller skull. The naso-prefrontal sutures are somewhat longer, but are still rather short; the nasals have no contact with the frontal in the smaller skull, but they are slightly wedged apart at their posterior ends by the anterior process of the frontal in the larger one. The total length of the nasals is about one-third of the total length of the skull.

**LACRYMALS.**—The lacrymals are moderate in size and complex in form. The maxillo-lacrymal and naso-lacrymal sutures have been described above. The lacrymo-prefrontal sutures are long, the lacrymal bones extending relatively far back on the superior borders of the orbits. The sutures with the jugals are short, being less than three centimeters long in the younger skull; these sutures rise from the inferior borders of the orbits slightly posterior to their anterior pointed extremities.

**PREFRONTALS.**—The prefrontal bones are long and slender. They occupy very short spaces along the centers of the superior borders of the orbits; in the smaller skull they meet each other along the median line posterior to the nasals. The prominent cross-ridge between the anterior ends of the orbits is borne entirely by the prefrontals.

**FRONTAL.**—The frontal is relatively long. As noted above, it has no contact with the nasals. It is narrow in its central portion, in connection with the huge size of the orbits. The posterior, or cranial, portion is also narrow; the bone does not extend far back of the posterior ends of the orbits.

The frontal is rather widely separated from the supratemporal fenestra. The sutures with the postorbitals are short, and are inclined about

45° with the longitudinal axis of the skull. The suture with the parietal is also short, and is nearly transverse in direction.

POSTORBITALS.—These bones are small. Their sutures with the frontal have been described above. The sutures with the parietal are short, and they make angles of about 45° with the longitudinal axis of the skull; they are nearly, if not quite, perpendicular with the longitudinal axis of the skull.

SQUAMOSALS.—The squamosal bones are very large, the surface area of each being about three times as great as that of the corresponding postorbital. They have extensive sutures with the supraoccipital, completely excluding the parietal from the posterior border of the cranial table. In this *J. niger* resembles *J. sclerops* more than *J. latirostris*. The sutures with the parietal and supraoccipital are nearly antero-posterior in direction, except near the posterior ends of the supratemporal fenestræ, where the squamoso-parietal sutures bend outward in the anterior direction.

PARIETAL.—The parietal bone is relatively large, in correlation with the small size of the supratemporal fenestræ. As noted above, the bone is excluded from the posterior border of the skull by the large superior plate of the supraoccipital.

SUPRAOCCIPITAL.—The supraoccipital bone is large. Along the posterior border of the cranial table it occupies the entire space between the two squamosals. The sutures with the squamosals are rather extensive, contrasting somewhat with those of *J. latirostris*. The supraoccipital portion of the posterior surface of the skull is also large; it extends vertically about two-thirds of the distance downward from the superior border to the foramen magnum.

EXOCCIPITALS, BASIOCCIPITAL, BASISPHENOID, AND QUADRATES.—These bones are not especially characteristic in outline or relations.

QUADRATO-JUGALS.—These bones are rather short and broad, and their borders are nearly parallel. Their antero-superior processes are relatively broad; they have smoother outlines than in *J. sclerops*.

JUGALS.—The posterior bars of the jugal bones are unusually slender and their anterior plates are high. The transition from slender to broad portion, in each, is sharp.

PREVOMERS.—*Jacare niger* is unique among the existing crocodilians in having the prevomers as part of the surface of the palate between the premaxillary and maxillary bones. They may sometimes be seen on the palate of *Tomistoma schlegelii*, but between the maxillaries and palatines. In *J. niger* the prevomers on the palatine surface appear as a small irregu-

larly rhomboid figure. In the smaller specimen studied they are unequal in size; this may vary among different individuals. These bones are not preserved in the larger skull. They extend from the posterior end of the large inferior premaxillary foramen, slightly posterior to the level of the fifth premaxillary teeth, back to the level of the second maxillary teeth.

**PALATINES.**—These bones are not preserved in the larger skull. In the smaller one they form nearly the entire internal borders of the palatine fenestræ. The sutures with the maxillaries have been described above. The anterior processes together occupy a large rounded area on the surface of the palate, as in *J. sclerops* and *J. latirostris*. The palatines extend back beyond the posterior ends of the palatine fenestræ. The suture with the pterygoids is shaped like a letter V, with the apex directed forward.

**PTERYGOIDS.**—The pterygoids are not preserved in the larger skull. In the smaller one they are very concave in form, both in the antero-posterior and the transverse directions. They form very small portions of the external borders of the palatine fenestræ. Posterior to the internal narial aperture they are elevated into a pair of ridge-like processes.

**ECTOPTYRGOIDS.**—The anterior processes of the ectopterygoids are short, extending forward only to the level of the posterior borders of the eleventh maxillary teeth. Their superior processes are very short, and their postero-inferior processes are both long and stout.

### Mandible

The mandible is stout. The symphysis is of moderate length; in the smaller specimen it extends back to the level of the spaces between the fourth and fifth mandibular teeth; in the larger one it extends back to the level of the fifth mandibular teeth. In the larger specimen the splenials extend forward to the symphyseal suture, but do not form any extensive portion of the symphysis; in the smaller specimen the left splenial extends forward to the symphysis, but the right one falls short of it. The external mandibular foramina are very large; the internal ones are moderately large. The articular surfaces of the articular bones are crossed by small but distinct transverse ridges, dividing them into anterior and posterior portions. The posterior processes of the surangular and articular bones extend directly backward, and do not converge inward as in many crocodilians.

Each ramus of the mandible contains eighteen teeth. These vary considerably in size and form. The fourth, in each ramus, is the largest; the first is only slightly smaller. The eleventh and twelfth are also large.

From the fifth to the tenth, inclusive, the teeth are very small. The second and third are of median size, also those posterior to the twelfth. The anterior twelve or thirteen teeth are stout, but they are more or less sharp pointed, especially in the anterior region of the jaw. The posterior teeth are very blunt.

### Measurements

	Mus. Comp. Zool. No.	Amer. Mus. No. 15171
	4043	
Length of Skull, Tip of Snout to Supraoccipital	.340M.	.455M.
Length of Skull, Tip of Snout to Ends of Quadrates	.374	.500
Length of Snout	.190	.270
Breadth of Skull Across Quadrato-jugals	.181	.268
Breadth of Snout at Base	.150	.197
Breadth of Cranial Table	.095	.145
Length of Left Orbit	.092	.110
Length of Mandible, Total	.417	....
Breadth of Mandible, Maximum	.200	.270

### *Jacare latirostris* (Daudin)

The description of the skull of this species is based upon a single specimen (Mus. Comp. Zool. No. 4981).

### General Form

The skull is exceedingly short and broad; the snout is especially so, its length and its breadth at the base being approximately equal. The anterior end of the snout is rounded, much as in *Alligator mississippiensis*. A very slight constriction marks the lateral portion of the pre-maxillo-maxillary suture. The cranial table is large, and is considerably broader than long; it is rather coarsely pitted, and it is convex in lateral profile; this last character may be due to the relatively young age of the specimen; it is approximately rectangular in outline.

The interorbital region is concave, the posterior portion of it only slightly so, the anterior portion deeply so. A conspicuous ridge constitutes each supraorbital boundary. Anterior to the orbit this ridge becomes very prominent; it extends forward and outward to a point over the fourth maxillary tooth, where it ends in a slight expansion. The two opposite ridges are connected near the orbits by a complex transverse bridge. This rises a short distance anterior to each orbit, branches off from the rostral ridge and extends inward and somewhat backward to a point slightly external to the mid-line, about on a level with the anterior

ends of the orbits. There it dies out as a prominent cross-ridge, and across the mid-line constitutes an inclined path, connecting the lower level of the snout with the upper level of the interorbital region. On the opposite side it continues symmetrically to its termination in front of the orbit. The posterior edge of this ridge is merely a very slight elevation of the interorbital region (except near the mid-line); the anterior edge is deeply overhung.

The U-shaped ridge is therefore somewhat more irregular than in *J. sclerops*. The snout is very irregular in shape. Two low flat ridges extend forward, with a shallow depression between them; these ridges and depression are situated on the nasal bones exclusively. They die out near the external narial aperture. At the level of the fourth maxillary teeth is a pair of depressions between the prominent preorbital ridges and the low nasal ridges. In the vicinity of these depressions the snout is deeply pitted; between this pitted area and the orbits it is relatively smooth. A pair of shallow irregular ridges extends outward and forward from a point near each premaxillo-maxillary-nasal juncture, along the premaxillo-maxillary suture. The posterior half of each lateral border of the external narial aperture is elevated and rugose.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—The supratemporal fenestræ are small, and are irregular in outline. They are situated rather far apart from each other, and their boundaries are not elevated into ridges. They are angular in outline rather than rounded, and the two are unlike each other.

**INFRATEMPORAL FENESTRÆ.**—These cavities are small, and are distinctly triangular in outline. They are overhung by the edges of the broad cranial table.

**ORBITS.**—The orbits are large; their inferior borders are straight and are nearly antero-posterior in direction. Their posterior borders are nearly straight, and their antero-internal borders are distinctly rounded.

**EXTERNAL NARIAL APERTURE.**—This cavity is broader than long. The nasals enter it at its posterior end, and form a conspicuous projection into it. The premaxillary portions of the posterior border curve forward somewhat toward this median posterior process. The small foramina caused by the piercing of the snout by the first mandibular teeth enter the aperture at the level of the anterior end of the premaxillary foramen. At the anterior end of the aperture four very small foramina pierce the floor near the median line.

**PREMAXILLARY FORAMEN.**—This cavity is shaped much as in *J. sclerops*. Its lateral borders are slightly concave curves; these meet anteriorly, giving the cavity a rather acute anterior termination. The posterior border is directly transverse except for a slight notch at the median line.

**PALATINE FENESTRÆ.**—The palatine fenestræ are broad themselves, and the space between them is also broad, especially at its anterior end.

**INTERNAL NARIAL APERTURE.**—This cavity is short antero-posteriorly, and is broad in proportion to its length.

### The Bones of the Skull

**PREMAXILLARIES.**—These bones are considerably broader than they are long. The premaxillo-maxillary suture on each side, on the superior surface, extends inward on each side, about two-thirds of its length in a direction more nearly transverse than longitudinal, then turns backward in a direction more nearly longitudinal than transverse. The extreme posterior extensions of these sutures, on the superior surface, terminate at the level of the spaces between the second and third maxillary teeth. On the palatal surface the premaxillo-maxillary suture is very nearly transverse in direction.

Each premaxillary contains five teeth, which are rather widely spaced from each other; the fourth of these teeth is the largest.

**MAXILLARIES.**—The maxillaries are short in proportion to their length. They carry the larger portions of the prominent preorbital ridges. The posterior border of each maxillary, on the superior surface, is more nearly transverse than antero-posterior in its inner portion; its outer portion, over half the vertical distance down from the orbit to the dental border, is more nearly antero-posterior than transverse. At its extreme posterior end this border again curves upward.

Each maxillary contains fourteen teeth, of which the fourth is the largest. All of the teeth are weak and short; posterior to the fifth they are very short. The spaces between the teeth are approximately equal, except that between the fifth premaxillary and the first maxillary on each side; the latter space is greater than the rest. The sutures of the maxillaries with the nasals are short.

**NASALS.**—These bones are short and broad. Their broadest portions are immediately anterior to the anterior ends of the naso-lacrymal sutures. The naso-lacrymal and naso-prefrontal sutures are approximately equal in length. The lateral borders of the nasals converge anteriorly, from the anterior ends of the naso-lacrymal sutures, in a



gradual manner to the posterior ends of the premaxillo-nasal sutures. The anterior ends of the lateral borders of the nasals, between the premaxillaries, converge sharply. Posteriorly the two nasals are wedged apart by the broad blunt process of the frontal.

**LACRYMALS.**—The lacrymals are large, and their breadth is greater than their length. The lacrymo-prefrontal sutures extend across the transverse ridge near the anterior ends of the orbits. Half of each nasolacrymal contact is along an anterior process of the lacrymal, and not the main mass of the bone. The sutures with the jugals are in the position of being anterior prolongations of the inferior borders of the orbits.

**PREFRONTALS.**—These bones are smaller than the lacrymals. Their sutures with the nasals are approximately equal in length to the nasolacrymal sutures. The transverse ridge crosses the prefrontals, and is interrupted medially at the contact of the prefrontals and frontal.

**FRONTAL.**—The frontal is short antero-posteriorly. It comprises, in its anterior process, the bridge from the interorbital region to the snout. The anterior end of the process is in the form of a wedge, which separates the posterior ends of the nasal bones. The suture with the parietal is in the form of a broadly open V; it is situated a considerable distance anterior to the supratemporal fenestræ.

**POSTORBITALS.**—These bones are small and subrectangular in outline.

**SQUAMOSALS.**—These bones are large. Each occupies two-thirds of the external border of the cranial table. The squamosals appear to come in contact with the supraoccipital at or near the posterior border of the cranial table. The contacts are not clear in the specimen studied.

**PARIETAL.**—The parietal forms a considerable portion of the anterior as well as the internal border of each supratemporal fenestra. The bone is relatively narrow. It forms no portion of the posterior border of the cranial table, but is separated from it by the broad supraoccipital. The bone is deeply pitted.

**SUPRAOCCIPITAL.**—This bone occupies a small triangular area on the surface of the cranial table as in other species of *Jacare*. On the posterior surface it extends downward from the superior border three-fourths of the distance from this border to the foramen magnum.

**QUADRATES.**—These bones have rather broad articular surfaces, which are not lower in position than the foramen magnum.

**EXOCCIPITALS, BASIOCCIPITAL, AND BASISPHENOID.**—These bones are not sufficiently distinctive in form to require special description.

**QUADRATO-JUGALS.**—The quadrato-jugals are small; they lack the sharp processes which characterize the quadrato-jugals of some crocodilians, but they have irregular borders, with projections which faintly suggest these processes. In this respect *J. latirostris* resembles *J. sclerops* rather than *J. niger*; in the latter species there are no suggestions of projecting processes on the quadrato-jugals.

**JUGALS.**—The contacts of the jugals with the lacrymals are very short; those with the quadrato-jugals are very irregular.

**PALATINES.**—The palatines of this species are very short and broad.

**PTERYGOIDS.**—The pterygoids form but very small portions of the borders of the palatine fenestræ.

**ECTOPTERYGOIDS.**—These bones are very short and stout. Their sutures with the maxillaries extend as far forward as the level of the spaces between the tenth and eleventh maxillary teeth.

### Mandible

The mandible is very short and broad. The symphysis is short, extending only slightly farther back than the level of the third mandibular teeth. The splenial bones extend almost to the symphysis. The dentaries are very shallow vertically in their anterior portions. The articular bones are very broad and stout.

The right ramus of the mandible contains eighteen teeth and the left one nineteen, in the specimen studied. None of the teeth are very large. Except that the fourth are somewhat larger than the rest the teeth are nearly equal in size.

### Measurements Mus. Comp. Zool. No. 4981

Length of Skull, Tip of Snout to Supraoccipital	.128M.
Length of Snout	.067
Breadth of Skull, Across Quadrato-jugals	.079
Breadth of Snout at Base	.062
Breadth of Snout Across Fourth Maxillary Teeth	.055
Breadth of Cranial Table, at Posterior End	.051(est.)
Length of Mandible	.156

### Remarks

This species is the most brachycephalic of the modern crocodilians. The breadth of the snout is approximately equal to its length, and the length of the snout is only very slightly greater than the distance from the anterior end of the orbit to the supraoccipital. The prominence of the preorbital ridges resembles that of *J. niger*. In some other respects, however, the species is nearer *J. sclerops* in form.

**Jacare sclerops** (Schneider)

The following description of the skull of *Jacare sclerops* is based upon a series of specimens of varying ages. They include the following: Mus. Comp. Zool. No. 5082, Amer. Mus. No. 5239, Mus. Univ. Mich. No. 53113, Mus. Univ. Mich. No. 53112, Mus. Comp. Zool. No. 5031, Amer. Mus. No. 15184, Amer. Mus. No. 15183. In addition to these a disarticulated skull, Amer. Mus. No. 15185, was used to verify some characters.

## General Form

The skull of *Jacare sclerops* is broad in proportion to its length. It does not reach the excessive breadth which characterizes *J. latirostris*, however. The snout varies from one and one-sixth to one and two-fifths as long as broad at the base. The anterior ends of the orbits are situated nearer the posterior than the anterior end of the skull in old individuals; in young individuals they are about equally distant from the two ends of the skull. The length of the skull from the extremities of the quadrates to the anterior ends of the orbits is from four-fifths to five-sixths the length of the snout in large individuals. The snout is moderately broad at the end and lateral to the external narial aperture; in most specimens it retains this breadth to the level of the first maxillary teeth; in a few it broadens gradually from its anterior end. From the level of the first maxillary teeth to that of the fourth the snout broadens rapidly; posterior to this is a slight constriction, which is most noticeable at the level of the spaces between the fifth and sixth maxillary teeth; from this point back the skull broadens steadily. The amount of vertical festooning of the inferior borders of the skull is slight compared with that in the true crocodiles. On each side a vertical notch extends from the fourth premaxillary to the third maxillary tooth; this notch is deepest between the fifth premaxillary and the first maxillary teeth, opposite the pit which receives the fourth mandibular tooth. The third and fourth maxillary teeth of each side are situated on a convexity of the jaw; back of this is a shallow excavation which reaches its maximum depth between the sixth and seventh maxillary teeth. Posterior to this excavation is a slight convexity, which extends back beyond the dental series. Immediately below each infratemporal fenestra is another slight excavation, posterior to which the inferior border of the skull descends slightly to the distal extremity of the quadrate. None of the above-mentioned irregularities in the vertical contour of the inferior borders of the skull are very pronounced.

The snout, and in fact the whole skull, is relatively low in proportion to its breadth, contrasting strongly with *Caiman trigonatus*. The superior surface of the snout is distinctly concave antero-posteriorly, and nearly flat, with rounded lateral margins, forming a sharp contrast with the angular margins of the snout of *Caiman trigonatus*.

The external narial aperture is almost surrounded, except at the anterior end, by a conspicuous ridge of bone; this character accentuates the upturned appearance of the snout.

In most of the skulls the first mandibular teeth pierce the premaxillaries, and in some the excavations are confluent with the narial aperture. The superior surface of the skull is slightly elevated above the pits which receive the fourth mandibular teeth; in a few cases the skull is completely pierced at this point, the foramen being either in the premaxillary or on the premaxillo-maxillary suture. Over each of the fourth maxillary teeth is a swelling; this is sometimes rather inconspicuous in young individuals, but is prominent in old ones.

Anterior to the orbits, and slightly internal to the median lines of the separate orbits, is a pair of slightly elevated ridges which extend a short distance forward on the snout. Posteriorly each ridge curves inward and meets the other, forming an inverted U. At the juncture of the two sides of the U a low, more or less indistinct ridge extends forward. The snout is distinctly separated from the interorbital region by the base of the U. The snout is distinctly lower in level than the interorbital region, the latter merging into the U so far as level is concerned. The interorbital region is deeply concave, the inner borders of the orbits being elevated into ridges which unite with the base of the U, and are continuous with the arms of the U.

The cranial table is relatively large, and is subquadrangular in outline; it is broader than long, and is relatively flat, although in some individuals it is very slightly convex laterally. It is relatively low in position, contrasting in this respect with *Caiman trigonatus*. The space between the two supratemporal fenestræ is relatively broad, being considerably broader than the space between the orbits.

#### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—The supratemporal fenestræ are relatively small in most of the individuals studied, and in one old one they are absent altogether at the surface, having been roofed over by the surrounding bones. In general they are larger in the younger individuals and smaller in the older ones, but there are slight variations from this

general rule. In form these fenestræ are irregularly oval, and their axes of greatest length diverge anteriorly away from the median line of the skull.

The very small size, and in one case the complete obliteration, at the surface, of these cavities suggests that the species is undergoing the process of their elimination. In this particular character *J. sclerops* appears to be more progressive than *J. niger*. The process of elimination of the fenestræ has not been accelerated to the same extent as in *Caiman trignonatus*, however.

**INFRATEMPORAL FENESTRÆ.**—These openings are small; in form each of them resembles a trianguloid figure with nearly equal straight sides and a curved base.

**ORBITS.**—The orbits are notably large in size, but not to the extreme degree of *J. niger*. In length each orbit varies from about one-fourth of the total length of the skull in very young individuals to about one-sixth in older ones, the average being about one-fifth. The superior boundary of each orbit is nearly semicircular; the inferior border is a gentle curve. There is a suggestion of an anterior point in each orbit, but it is not very pronounced.

**EXTERNAL NARIAL APERTURE.**—This opening is relatively large; it has no suggestion of a median partition, although the nasal bones enter it at its posterior end in a short process. It is rather characteristic in outline. Its straight lateral boundaries converge slightly toward each other in the posterior direction. Anteriorly the cavity is bounded by a curved border, which in old individuals is sometimes irregularly transverse. Posteriorly it is bounded by the small triangular extension of the nasals, and a small notch on either side of that process. The anterior wall is pierced, in some specimens, by the first mandibular teeth. In young skulls the aperture is slightly longer than broad; in old ones it is broader than long.

**PREMAXILLARY FORAMEN.**—This cavity is relatively large in young individuals and small in old ones. It is very narrow in proportion to its length; it is acutely pointed anteriorly, and broadly rounded posteriorly. In some individuals, especially old ones, there is a slight median projection extending forward into the cavity at the posterior end.

**PALATINE FENESTRÆ.**—The palatine fenestræ are simple in form and relatively large in size; they are one-fifth as long as the whole skull, from the tip of the snout to the extremity of the condyle. Their internal borders are rather gentle and symmetrical curves, mostly on the edges of the palatine bones, but partly on the maxillaries as well. The anterior

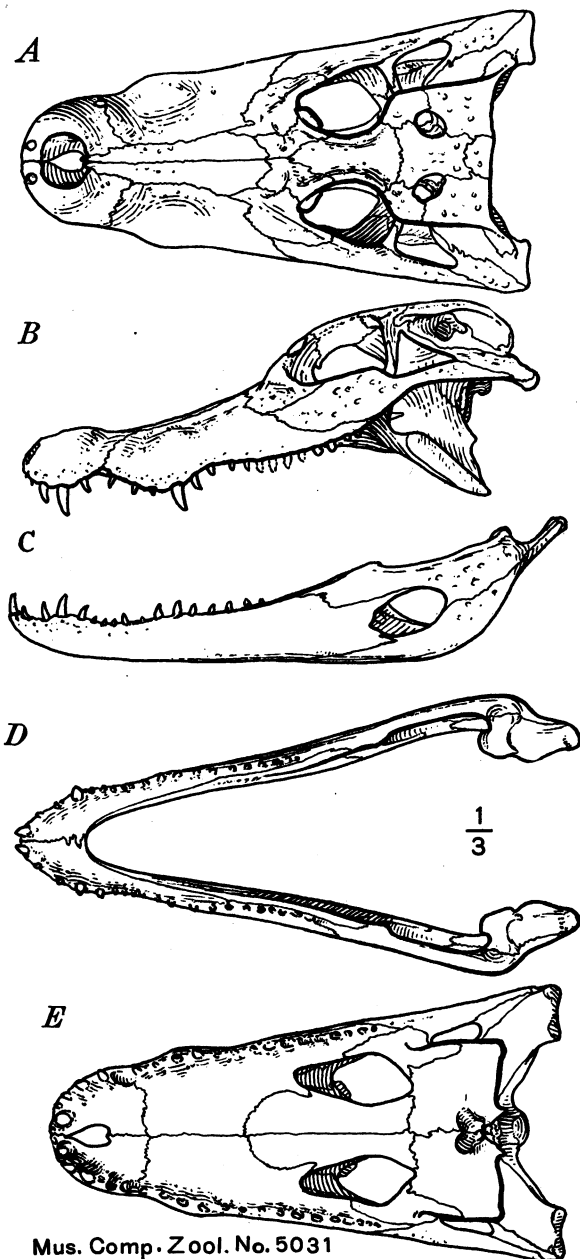
ends are more or less symmetrically rounded; the posterior ends are usually pointed, but not sharply so; the posterior terminations are internal to the median lines of the fenestræ. A small portion of the posterior border of each fenestra is bounded by the pterygoid bone; in some individuals, especially old ones, the pterygoid border of the fenestra is exceedingly small. The external border is sharply bent; the anterior portion of it, which is composed of edges of the maxillary and ectopterygoid bones, comprises from two-thirds to four-fifths of the length of each fenestra; this anterior portion lies parallel to the external wall of the skull. The posterior portion of the external wall of each fenestra is composed of an edge of the ectopterygoid. This border is oblique in position, sometimes being more strictly posterior than external.

**INTERNAL NARIAL APERTURE.**—The internal narial opening, situated near the posterior ends of the pterygoids at their median line, is broader than long. It is divided by a median partition, which usually does not reach the surface of the palate. A pair of projections of the pterygoids form the posterior boundary of the cavity, and in some cases partially roof it over.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are broader than long in both young and old individuals. In some skulls the two premaxillaries are separated behind the narial aperture by the nasal bones; in other skulls, especially the older ones, the premaxillaries roof over the anterior ends of the nasals, and exclude them from the aperture. Anterior to the aperture the premaxillaries are pierced by the first mandibular teeth in some cases, and in others they are not. There is no apparent system to this piercing; it is present or absent in old individuals and young, large and small, narrow and broad, in about equal numbers.

The premaxillo-maxillary suture is more nearly transverse than longitudinal on the superior aspect of the skull. The posterior processes of the premaxillaries are broad; they do not extend back as long wedges between the nasals and the maxillaries as in some crocodiles. The posterior extremities of these processes is never farther back than the level of the third maxillary teeth. In most cases they are only slightly posterior to the level of the second maxillary teeth, and in one specimen Mus. Comp. Zool. No. 5031) they are anterior to the level of the second maxillary teeth.



Mus. Comp. Zool. No. 5031

Fig. 12. Skull and jaws of *Jacare sclerops* (Schneider). Mus. Comp. Zool. No. 5031, one-third natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

On the palatal surface of the skull the suture between the premaxillaries and the maxillaries usually curves outward and backward on each side from the median line, and then curves forward and outward to the center of the pit which receives the fourth mandibular tooth. In some cases the loops formed by the backward curves are very slight, the suture being nearly transverse; in most of the skulls studied they extend back as far as the middle of the spaces between the first and second maxillary teeth; in one old skull they extend back as far as the level of the centers of the second maxillary teeth.

The first premaxillary teeth are small and are very close together. The second teeth are rather widely spaced from the first; they are small in size; one skull (Amer. Mus. No. 15184) has a distinct right second premaxillary tooth, but no left one or alveolus for one. The large pits which receive the first mandibular teeth are situated between the first and second premaxillary teeth, but internal to them rather than in line with them. The second and third teeth are close together. The third and fourth, and the fourth and fifth are about equally spaced, being closer together than the first and second, and farther apart than the second and third. The fourth tooth is the largest in each premaxillary, and the third is second in size; the fifth is slightly larger than the first. This order of size is not always apparent, as the size of the particular teeth is determined partly by their individual age; the size of the alveoli, however, is a true guide to the maximum sizes. All of the premaxillary teeth are sharp-pointed and relatively slender; they are slightly curved, and are somewhat flattened. The crowns are faintly striated.

**MAXILLARIES.**—The maxillaries are relatively broad on the superior surface of the skull, occupying about three-fourths of the total width of this surface. In this character *J. sclerops* contrasts rather sharply with *Caiman trigonatus*. Their length is about one-half the total length of the skull. The premaxillo-maxillary suture has been described above. The maxillo-nasal suture is very short in proportion to the total length of the maxillary bones. The maxillo-lacrymal suture, on each side, is irregular in form, but its form is uniform among all of the skulls examined. It extends a short distance backward and very slightly outward from the posterior end of the maxillo-nasal suture, then extends obliquely outward, downward, and backward to the point of contact of the maxillary, lacrymal, and jugal bones; this point lies over the tenth maxillary tooth.

The suture of each maxillary with the corresponding jugal varies somewhat in form. In some cases its upper portion is more nearly transverse than the postero-external portion of the maxillo-lacrymal suture,



and in others it is in a direct line with the latter. Its lower portion terminates on the inferior border of the skull, only very slightly anterior to the posterior end of the palatine fenestra on the palate.

The longitudinal extent of the maxillaries along the median line, between the premaxillary and palatine bones, is very slight. Nearly one-half of the external border, and in some specimens a considerable portion of the internal border of each palatine fenestra is composed of the maxillary bone. The maxillo-palatine suture is slightly variable in form, but never departs far from the typical *Jacare* outline. It usually extends backward and inward from a point near the anterior end of the internal border of the palatine fenestra, then extends forward, and usually outward to a point opposite or slightly anterior to the end of the fenestra, then curves gradually inward and meets the median line nearly at a right angle; from this point it extends in a symmetrical direction on the opposite side. The union with the opposite suture lies opposite the seventh maxillary teeth, or very slightly anterior to this level. The suture will be discussed further in the description of the palatine bones.

The maxillo-ectopterygoid suture, on each side, extends as far forward as the eleventh or twelfth maxillary tooth.

The maxillary teeth increase regularly in size from the first, which are very small, to the fourth, which are the largest teeth in the superior series. Posterior to the fourth the maxillary teeth are all small. In form the first six or possibly seven maxillary teeth resemble the premaxillary teeth. The eighth, and in some cases the seventh, maxillary teeth are less acutely pointed. Posterior to the eighth all of the maxillary teeth have small, blunt, and more or less elongate crowns, which are better adapted for chewing than for holding or piercing prey. All of the maxillary teeth except the sixth and seventh, and the seventh and eighth, are close together; between these teeth are relatively broad spaces.

**NASALS.**—The nasal bones are characteristic, yet variable, in form. They usually enter the external narial aperture, but are excluded from it by the premaxillaries in some cases. They expand rapidly in breadth from their anterior ends back to the points where they are met by the premaxillo-maxillary sutures; from these points they expand gradually as far back as the points at which the maxillo-lacrymal sutures join the maxillo-nasal sutures. From there back they contract rapidly, and have a very narrow contact with the frontal; the latter does not enter between the two nasal bones in a long wedge, as in many crocodiles. The contacts with the lacrymals are relatively long; in some skulls they are longer than the naso-prefrontal sutures, and in others they are shorter.

**LACRYMALS.**—The lacrymal bones are relatively large in size, being considerably larger than the prefrontals. Each lacrymal forms the entire anterior boundary of the orbit, and a considerable portion of the inferior boundary as well. The contacts with the maxillaries and nasals have been described above. The suture of each lacrymal with the prefrontal extends directly, or slightly obliquely, backward from the nasal as far as the rounded junction of the base and side of the U-shaped ridge described above, then it usually curves almost directly outward to the superior border of the orbit. In one young skull (Amer. Mus. No. 5239) the lacrymo-prefrontal sutures are nearly antero-posterior throughout their entire lengths. The sutures with the jugals are long and rather symmetrically curved, the convexity of the curves facing downward. The lacrymals carry the lateral arms of the U-shaped ridge.

**PREFRONTALS.**—These bones are relatively small. Their most conspicuous feature is their common possession of the base of the U-shaped ridge. Their contacts with the nasals and lacrymals have been described above. The sutures with the frontal are short; they are also somewhat variable in form.

**SUPRAORBITALS.**—The supraorbital bones, or bony supports of the eyelids, are small, occupying only small portions of the orbits or of their borders.

**FRONTAL.**—The single frontal bone is not especially characteristic in form. Its suture with the parietal is situated considerably anterior to the supratemporal fenestræ; in some skulls it is almost transverse, and in others it is V-shaped. The supraorbital edges of the frontal are prominently uprolled.

**POSTORBITALS.**—These bones are not especially characteristic in the typical skulls. In the large skull in which the supratemporal fenestræ are closed the postorbital bones are nearly rectangular in outline.

**SQUAMOSALS.**—The squamosal bones are rectangular in form like the postorbitals. They are characteristic in that each has a considerable contact with the supraoccipital, excluding the parietal from the posterior border of the skull; the squamoso-supraoccipital sutures are long, as in *J. niger*; in this they differ slightly from those of *J. latirostris*.

**PARIETAL.**—The parietal is relatively large, owing to the small size of the supratemporal fenestræ. Its suture with the supraoccipital is as long as either of its sutures with the squamosals. This parieto-supraoccipital suture is V-shaped in young individuals and transverse in old ones.

**SUPRAOCCIPITAL.**—This bone is large. It occupies about one-fourth of the posterior border of the cranial table, also a considerable area of the surface of the table. Its posterior surface extends down nearly three-fourths of the distance from the superior border to the foramen magnum. This posterior surface is distinctly triangular in outline.

**QUADRATES.**—The quadrates are distinctive only because of the irregularities of their borders.

**EXOCCIPITALS, BASIOCCIPITAL, AND BASISPHENOID.**—These bones are not sufficiently characteristic to require special description.

**QUADRATO-JUGALS.**—The quadrato-jugals have very irregular contacts with the quadrates. Their posterior portions are short and broad. Their anterior processes have suggestions of the sharp processes which are well developed in the true crocodiles.

**JUGALS.**—The anterior processes of the jugals are very much greater in their vertical diameters than the posterior bars. The extent of this difference is their only noteworthy characteristic.

**PALATINES.**—The palatine bones are characteristic in outline. Their broad anterior portions, which extend forward as far as the sixth or seventh maxillary teeth, usually expand in breadth anterior to the level of the anterior ends of the palatine fenestræ. The lateral expansion of the posterior ends of the palatines is slight in young individuals, but is much greater in old ones.

The suture between the palatines and the pterygoids is situated anterior to the posterior ends of the palatine fenestræ in young skulls, and farther back, often behind the fenestræ, in older ones. This suture is usually transverse in direction, with short antero-posterior external ends; in one old skull (Amer. Mus. No. 15183) the suture is more complex in outline. In this skull it extends a very short distance directly back from the posterior end of each fenestra, then a short distance inward toward the median line, then turns and extends obliquely forward and inward a considerably greater distance to the median line. The two palatine bones together, in this skull, are shaped like a Y, with the very broad base directed forward, and the short arms directed backward.

**PTERYGOIDS.**—The pterygoid bones are relatively broad in proportion to their length. In young individuals they occupy appreciable portions of the posterior borders of the palatine fenestræ, but in old ones they are almost excluded from the borders of these openings. The postero-external corners do not project far behind the level of the posterior end of the median line, and the posterior portions make a broad open angle with each other vertically.

ECTOPTERYGOIDS.—These bones are rather short antero-posteriorly; they extend as far forward as the eleventh maxillary teeth.

### The Mandible

The mandible is short and stout in appearance. The symphysis extends back only to the level of the fourth mandibular teeth, or very slightly farther back in a few cases. In some specimens the splenial bones extend forward to the symphysis, but do not take part in the median symphyseal suture; in other specimens the splenials end a considerable distance back of the symphysis. The splenial bones themselves are stout; they comprise the inner alveolar walls of the last six mandibular teeth on each side. The articular surfaces of the articular bones are separated into anterior portions by oblique ridges; the posterior processes extend directly backward. The external mandibular foramina are large; the internal ones are of moderate size. The very small foramina which are present on the surfaces of the mandibles, between the splenial and coronoid bones, in most crocodilians, are absent in this species. The jaw is considerably festooned, especially in the older individuals.

Each ramus contains from eighteen to twenty teeth. Of these the fourth is the largest, as usual, and the first next in size. The eleventh and twelfth are only slightly smaller than the first. The fifth to tenth mandibular teeth, inclusive, are very small. The second and third are of medium size. All of the teeth posterior to the twelfth are small. The anterior teeth are sharp, and the posterior ones are blunt; the division line between blunt and sharp teeth is not sharply marked, but it is in the vicinity of the twelfth or thirteenth teeth. The spacing of the teeth varies considerably among the various specimens studied. The anterior three or four are usually far apart, and the posterior ones are close together. The teeth in the middle of the series are sometimes close together and sometimes widely spaced. This spacing also varies on opposite sides of the same specimen. Two of the specimens show a remarkable grouping of several of the teeth. In these specimens the seventh and eighth teeth are situated very close together, and are also inclined toward each other; they therefore act as a single tooth; the same is true of the ninth and tenth. This condition is more pronounced in the larger of the two specimens (Mus. Univ. Mich. No. 53112) than in the smaller one (Mus. Univ. Mich. No. 53113). This curious character is present only in the two specimens noted. Both of these specimens came from the same locality, and it is very probable that this grouping of the teeth is to be interpreted as a form of geographic variation.

# Measurements

	Mus. Comp. Zool.	Amer. Mus.	Mus. Univ. Mich.		Mus. Comp. Zool.	Amer. Mus.	
			No. 53113	No. 53112		No. 15184	No. 15183
	No. 5082	No. 5239			No. 5031		
Length of Skull, Tip of Snout to Supra-occipital	12.55cm.	13.35cm.	14.9cm.	18.7cm.	18.75cm.	19.6cm.	24.8cm.
Length of Skull, Tip of Snout to Ends of Quadrates	13.5	14.4	15.8	18.8	19.9	21.0	27.3
Length of Snout	6.8(est.)	7.6	8.7	10.6	11.1	11.6	15.0
Breadth of Skull, Across Quadrato-jugals	7.4	8.2	8.5	10.0	10.95	12.4	16.2
Breadth of Skull, Across Cranial Table	4.35	4.61	5.20	5.8	6.05	7.28	8.95
Breadth of Snout at Base	5.30	6.10	5.7	7.1	8.0	9.2	11.5
Length of Left Orbit	3.00	3.20	3.3	3.6	3.9	3.8	4.8
Length of Mandible, Total	15.60	16.20	17.2	20.9	22.45	24.2	31.1
Breadth of Mandible, Maximum	.....	8.2	8.4	10.4	11.2	11.8	16.9

**CAIMAN Spix**

## GENERIC CHARACTERS

The skull of this genus is without transverse ridges; it is moderately long, and is subacuminate in outline. The skull is sharply angulated anterior to each orbit; the snout thus consists of three more or less distinct planes. The supratemporal fenestræ are obliterated, even in young individuals. The external narial aperture is undivided. The premaxillary foramen is approximately equal in length and breadth in *C. trigonatus*, differing from all the species of *Jacare*; probably *C. palpebrosus* resembles *C. trigonatus* in this respect. The fourth mandibular teeth bite into pits in the upper jaw, and all of the mandibular teeth bite inside the line of the upper teeth. Each premaxillary contains four teeth, and each maxillary fifteen or sixteen; the third and fourth maxillary teeth are the largest. Each ramus of the mandible contains from twenty to twenty-two teeth. The upper eye-lids are entirely bony. A number of characters through which *C. trigonatus* differs considerably from the species of *Jacare*, but which have not been verified on *C. palpebrosus*, include the following: parietal bones forming considerable portions of the posterior border of the cranial table, the supraoccipital being very narrow on its superior surface; vertical height of the cranial region considerable; anterior processes of the palatines considered together as one process rectangular in outline; very large external mandibular foramen; probably these will apply to *C. palpebrosus*, but they need verification in that species. The quadrato-jugals lack the anterior processes which are characteristic of *Gavialis*, *Tomistoma*, and *Crocodylus*.

**Caiman trigonatus** (Schneider)

The description of the skull of *Caiman trigonatus* is based upon a single young specimen (Mus. Univ. Mich. No. 46113).

## General Form

The general form of the skull is in close accordance with the specific name *trigonatus*. The whole skull, from the ends of the quadrates to the tip of the snout, when viewed from above, is seen to be triangular in outline. The snout is long, being about one and nine-elevenths times as long as broad at the base, and is rather acute at its anterior end. The lateral borders are very nearly straight when viewed from above, there being little in the way of lateral constriction; the amount of vertical festooning is also slight.

The cranial table is broad and flat; it is considerably elevated vertically; the height of the skull from the extremities of the pterygoids to the cranial table is about two-thirds of the breadth across the quadratojugs. The cranial table itself is large, measuring about five centimeters laterally, and three and six-tenths centimeters longitudinally along the external border. In shape it is nearly rectangular. Anterior to the orbits the superior longitudinal profile of the snout is concave; the base of the snout is elevated. The transverse profile of the snout is unusual in the modern Crocodilia. The central half of the snout is flat, except for a slight median depression. In front of each orbit is a pronounced ridge, which separates the central flat portion from a very highly inclined lateral portion. Immediately below the ridge this lateral slope is nearly vertical, but at a lower level it becomes less highly inclined; near the inferior border it again becomes nearly vertical. The profile of the side of the snout, below the ridge which separates the side from the superior surface, is therefore concave above and convex below. These distinct planes on the sides of the snout become less pronounced farther forward. A prominent elevation is situated above each fourth maxillary tooth. Slightly posterior to the premaxillo-maxillary sutures, but more oblique in position than these, is a pair of short low ridges. The sides of the narial aperture are elevated, but the anterior and posterior ends are low.

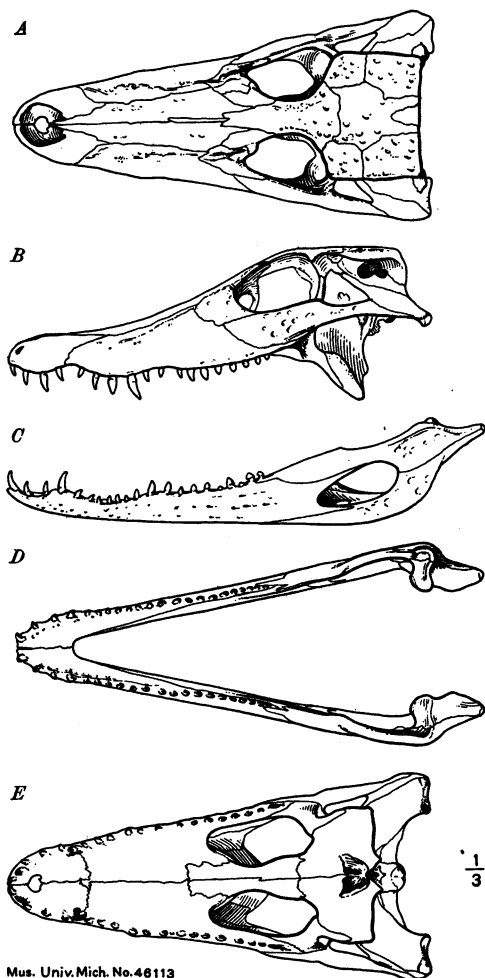
#### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—The supratemporal fenestræ are absent on the surface of the cranial table, having become secondarily closed. They are present in a vestigial condition in the form of a pair of tubular excavations extending back from the orbits over the external auditory meati.

**INFRATEMPORAL FENESTRÆ.**—These cavities are moderate in size. They are triangular in outline, with the anterior borders nearly vertical, the inferior borders horizontal, and the postero-superior borders oblique in position.

**ORBITS.**—The orbits are large, and are not bordered superiorly by upturned edges. The length of each orbit is about one-fifth of the total length of the skull. The superior border of each orbit is semicircular in outline, and the inferior border is nearly straight. The anterior end is not acuminate as in many crocodilians.

**EXTERNAL NARIAL APERTURE.**—This cavity is large. The posterior two-thirds of the lateral borders converge in the posterior direction; the anterior thirds converge more sharply in the anterior direction,



Mus. Univ. Mich. No. 46113

Fig. 13. Skull and jaws of *Caiman trigonatus* (Schneider). Mus. Univ. Mich. No. 46113, one-third natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

joining the nearly transverse anterior border not far from the median line. The small foramina which receive the first mandibular teeth enter the narial aperture.

**PREMAXILLARY FORAMEN.**—This opening is small; it contrasts with the corresponding foramen in *Jacare*, in having its breadth as great as its length. It is pointed anteriorly, but not sharply so. Laterally it is



rounded; its greatest breadth is nearer the posterior than the anterior end. The posterior border is largely occupied by a broad shallow notch.

**PALATINE FENESTRÆ.**—The palatine fenestræ are large. They are about one and one-third times as long as in a skull of *Jacare sclerops* of the same size. In outline the fenestræ are somewhat irregular; the inter-fenestral plate is relatively narrow. The anterior ends are broadly rounded, and the posterior ends are slightly pointed.

**INTERNAL NARIAL APERTURE.**—This cavity is triangular in outline, with the base of the triangle at the anterior end. The lateral borders, which converge backward, are elevated into distinct ridges, which extend back over the posterior surface of the skull. The aperture is divided by a median vertical septum into right and left portions.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillary bones are relatively long and narrow, and are irregular in outline. On the superior surface of the skull the premaxillo-maxillary suture on each side extends obliquely upward and backward from the inferior border to a point a little anterior to the level of the second maxillary tooth, then extends directly backward and joins the premaxillo-nasal suture at the level of the center of the space between the second and third maxillary teeth. The two premaxillaries are rather widely separated by the nasals, posterior to the narial aperture. The premaxillo-nasal sutures diverge sharply in the posterior direction.

On the palatal surface of the skull the premaxillo-maxillary suture is nearly transverse, but it sags slightly backward in a gentle curve, which reaches the level of the first maxillary teeth.

There are but four teeth in each premaxillary. The first of these is small, and is situated close to the median line. The first tooth, on each side, is separated from the second by a considerable space; the length of this space is equal to the height of the second tooth. The space is largely occupied by the deep pit which receives the large first mandibular tooth; this pit is almost directly in line with the premaxillary teeth, and not internal to them. The second premaxillary tooth is considerably larger than the first; it is rather widely spaced from the third, but is not as far from the third as from the first. The small pit which receives the second mandibular tooth is situated in the space between the second and third premaxillary teeth. The third tooth is the largest in the premaxillary; it is homologous with the fourth premaxillary tooth of those species which have five teeth in each premaxillary bone. The third is separated

by a considerable space from the small fourth premaxillary tooth; this space is occupied by a pit which receives the third mandibular tooth. The fourth premaxillary tooth, on each side, is about equal to the first in size. Internal to the deep pits along the premaxillo-maxillary suture, which lodge the fourth mandibular teeth, is a pair of small, but very distinct and deep foramina. In the fact that the pits in the premaxillaries which receive the mandibular teeth are practically in line with the teeth themselves, this species differs considerably from the various species of *Jacare*, *Crocodilus*, and *Alligator*.

**MAXILLARIES.**—Each maxillary bone exhibits a greater height than breadth. In this *Caiman trigonatus* differs from all other species except perhaps *C. palpebrosus*. The prominent ridge in front of each orbit is carried largely on the maxillary bone. The sutural connection with the premaxillary has been described in the discussion of that bone. The maxillo-nasal sutures are practically straight; they extend back from the posterior ends of the premaxillo-nasal sutures, and diverge slightly as far as the junctions of the maxillary, nasal, and lacrymal bones. The suture of each maxillary with the lacrymal on the same side of the skull extends downward and forward a very short distance from its origin at the posterior end of the maxillo-nasal suture, then turns abruptly downward and backward to the point where it is joined by the lacrymo-jugal suture; from this point the maxillo-jugal suture extends downward to a point very near the inferior border of the skull, over the thirteenth maxillary tooth, then extends almost directly backward and joins the inferior border a short distance posterior to the last maxillary tooth.

On the palatal surface of the skull the maxillaries occupy a considerable area. The maxillo-palatine suture is very irregular; it differs decidedly from the same suture in the species of *Jacare*. From a point very near the anterior end of the palatine fenestra, opposite the posterior border of the ninth maxillary tooth, each maxillo-palatine suture extends backward and inward to a point opposite the eleventh maxillary tooth, then turns forward and extends directly, but irregularly, to the level of the anterior edges of the eighth maxillary teeth, then turns at a right angle and extends directly, but irregularly in the transverse direction to the median line, meeting the similar suture from the opposite side. The suture of each maxillary with the corresponding ectopterygoid extends from the space between the twelfth and thirteenth maxillary teeth to the level of the palato-pterygoid suture.

Each maxillary in the specimen studied contains fourteen teeth and an alveolar space for one more. Boulenger states that there ar

nineteen or twenty superior teeth in this species, consequently some individuals must have sixteen in each maxillary. The maxillary teeth increase in size from the first to the fourth; the fourth maxillary teeth are the largest of the superior series. Posterior to the fourth the maxillary teeth are all small. The anterior maxillary teeth are long and slender, and the posterior ones are short-crowned; none of the teeth are blunt, however. The anterior six or seven teeth in each maxillary are spaced rather widely, and not far from equally apart. Posterior to the eighth they are close together. Between the fifth and sixth and the sixth and seventh, but somewhat internal to them, are pits which receive mandibular teeth; they are not deep. Along the inner margins of the bony supports of the first four maxillary teeth are faint suggestions of pits to receive mandibular teeth.

**NASALS.**—The nasals are broad in proportion to the total breadth of the snout. At their maximum breadth, which is at the junctions of nasals, lacrymals, and jugals, the nasals occupy about half the total breadth of the snout. The nasals widen rapidly from their anterior projections into the narial aperture as far back as the posterior ends of the premaxillaries. Posterior to the contacts with the premaxillaries the nasals broaden gradually as far back as the junctions of the nasals with the lacrymals; this is at the level of the ninth maxillary teeth. Posterior to the level of the ninth maxillary teeth the nasals decrease in breadth to their posterior terminations, which are situated a considerable distance posterior to the anterior ends of the orbits. In this character *Caiman trigonatus* differs from most, if not all other Recent crocodilians. The posterior ends of the nasals are not in contact with each other, but are widely separated by the broad anterior process of the frontal. The posterior portions of the nasals in fact consist of two backward projecting processes, which wedge between the frontal on the one hand, and the prefrontals on the other. The contact of each nasal with the lacrymal is considerably shorter than its contact with the prefrontal. Along the median line, in the specimen studied, is a narrow sliver of bone between the two nasals. This is not regarded as possessing any particular significance, merely being the result of accessory ossification.

**LACRYMALS.**—The lacrymal bones are relatively large, and are nearly vertical in position. Their contacts with the nasals and maxillaries have been described above. The sutures with the prefrontals are obscure in the specimen examined. Each of them extends from the posterior end of the naso-lacrymal suture directly backward to a point near the anterior border of the orbit. It then turns almost directly outward toward the

antero-internal border of the orbit. The suture with the jugal extends directly back from the lower extremity of the maxillo-lacrymal suture to the antero-inferior border of the orbit. The lacrymals carry the knob-like processes anterior to the orbits, also a pair of ridges, which extend downward and forward from the anterior ends of the orbits to the inferior extremities of the maxillo-lacrymal sutures; they are perpendicular to the latter sutures in position.

**PREFRONTALS.**—The prefrontal bones are small and irregular. Each prefrontal has no separate anterior border, but an irregularly curved internal border. This internal border is composed partly of the suture with the nasal, and partly of that with the frontal. Each suture with the frontal is unusually short, in correlation with the great length of the corresponding posterior process of the nasal. On the external border of each prefrontal, about midway between the anterior and posterior ends of the bone, a short process projects outward; the anterior boundary of this process is part of the lacrymo-prefrontal suture, and the external and posterior boundaries are the orbit itself.

**FRONTAL.**—The frontal is relatively large, especially in its anterior portion. The anterior process is both long and broad. It wedges apart the two posterior processes of the nasals; the contact with the nasals consists of an irregular transverse suture, and two straight almost antero-posterior sutures. Each of these straight sutures is continued backward as the prefronto-frontal suture to the center of the superior border of the orbit. Each naso-frontal suture is considerably longer than the prefronto-frontal suture. The interorbital plate is moderately broad, and is not concave. The posterior boundary of the frontal is a suture which extends inward and backward from the posterior border of the orbit at an angle of about  $45^{\circ}$  with the longitudinal axis of the skull, then directly across in a transverse direction, and on the opposite side, forward and outward to the orbital border. The transverse portion of this suture is somewhat longer than either of the oblique portions. The contact with the parietal occupies the transverse portion of the suture, and about two-fifths of each oblique portion, the remaining three-fifths being occupied by the fronto-postorbital contacts.

**POSTORBITALS.**—The postorbitals are of moderate size; they are flat on their external surfaces, and are irregularly quadrangular in outline. The fronto-postorbital sutures have been described above. The post-orbito-parietal sutures extend backward and slightly outward from the contacts with the frontal. The postorbito-squamosal sutures are directly transverse in direction, and are approximately equal in length to the postorbito-parietal sutures.

**SQUAMOSALS.**—The squamosal bones are large and flat. In outline they are five-sided, but are almost rectangular. The external border is the longest; the posterior border, which is perpendicular to the external one, is next in size; the internal border, which is parallel to the external one, is slightly shorter than the posterior; the transverse anterior, and oblique antero-internal borders are small and equal in size.

**PARIETAL.**—The parietal bone is large in size, occupying the central portion of the flat cranial table; the large size is correlated with the absence of supratemporal fenestræ. The lateral borders are slightly irregular. The anterior border has been described above as the posterior border of the frontal. The bone occupies two short portions of the posterior border of the cranial table, these portions being separated by the supraoccipital. The latter bone is long, separating two rather long slender processes of the parietal from each other.

**SUPRAOCCIPITAL.**—On the surface of the cranial table this bone is long antero-posteriorly, and narrow laterally. It occupies the median portion of the posterior border of the cranial table. On the posterior surface of the skull the supraoccipital occupies somewhat more than one-third of the total breadth, and extends down from the superior border about three-fifths of the total distance from this border to the foramen magnum.

**EXOCCIPITALS.**—The exoccipital bones are characterized by a somewhat greater vertical height than those of most Recent crocodilians.

**BASIOCCIPITAL, BASISPHENOID, AND QUADRATES.**—These bones are not sufficiently characteristic to require special description.

**QUADRATO-JUGALS.**—The quadrato-jugals are very broad in their posterior portions, but very slender in their anterior portions. They have no suggestions of free anterior processes.

**JUGALS.**—The broad anterior portions of the jugals are nearly vertical in position, otherwise are not especially characteristic.

**PALATINES.**—The form of the palatine bones is characteristic. The maxillo-palatine sutures have been described above. The anterior processes of the palatines are nearly rectangular in outline. The inter-fenestral portions are slightly narrower than the anterior processes opposite the twelfth maxillary teeth; posterior to this level they expand slightly. The palato-pterygoid suture is situated a considerable distance anterior to the posterior ends of the palatine fenestræ. It extends across the interorbital plate in a series of loops. The forward position of this suture may be due partly to the young age of the specimen studied, and may not have specific value.

**PTERYGOIDS.**—These bones occupy considerable portions of the postero-internal borders of the palatine fenestræ. They are flat along the median line, and bend downward at the borders only slightly. They are somewhat elevated around the internal narial aperture. Posterior to the aperture a pair of short processes extend backward from the posterior border.

**ECTOPTERYGOIDS.**—The anterior processes of these bones are very small, extending only as far forward as the level of the fourteenth maxillary teeth. The postero-superior processes are also small; the inferior processes are large.

### The Mandible

The mandible of this species is slender. The symphysis is short, extending back only to the level of the fourth mandibular teeth. The splenial bones extend about as far forward as the fifth mandibular teeth. The articular surfaces of the articular bones are not divided by transverse ridges as in some of the species of *Jacare*. The anterior end of the two rami forms a sharp point. The external mandibular foramina are large.

The right ramus contains twenty-two teeth and the left twenty-one. Boulenger states that there are from twenty to twenty-two mandibular teeth on each side. From the first to the fifth the mandibular teeth are far apart, especially the second and third. From the fifth teeth back to the posterior end of the dental series the teeth are only moderately, and nearly equally far apart. The first and the fourth mandibular teeth are approximately equal in length, but the fourth are stouter than the first. The second and third are of medium size, also the twelfth and thirteenth. The fifth to the eleventh teeth and those posterior to the thirteenth, are small. The crowns of the anterior teeth are considerably longer than those of the posterior ones, but the latter are not especially blunt.

### Measurements Mus. Univ. Mich. No. 46113

Length of Skull, Tip of Snout to Supraoccipital	.1595M.
Length of Skull, Tip of Snout to Ends of Quadrates	.1660
Breadth of Skull Across Quadrato-jugals	.084
Breadth of Cranial Table	.049
Breadth of Snout at Base	.057
Breadth of Snout at Fourth Maxillary Teeth	.044
Breadth of Snout at Third Premaxillary Teeth	.029
Length of Mandible	.184
Breadth of Mandible, Maximum	.084

**Caiman palpebrosus** (Cuvier)

No skull of this species was available for study. The following description is from Boulenger. "19 or 20 upper and 20 lower teeth on each side; third and fourth maxillary teeth largest. Head once and three-fifths to once and two-thirds as long as broad; snout subacuminate, its basal width contained about once and a half in its length; no cross-ridge in front of the interorbital region, which is but slightly concave; upper eyelid flat and smooth, entirely bony, the bony plate consisting of four distinct pieces; lores very steep and high; canthus rostralis angular; supratemporal fossæ obliterated."

**ALLIGATOR** Cuvier

## GENERIC CHARACTERS

In *Alligator* the snout is short and rounded anteriorly. The supratemporal fenestræ are small; the external narial aperture is divided medially by a pair of long anterior processes of the nasal bones and a corresponding pair of short processes from the premaxillary bones. There are seventeen to twenty upper teeth on each side, and eighteen to twenty lower teeth. There is no sharp anterior process to each quadratojugal. The fourth mandibular teeth bite into pits in the upper jaws; the mandibular teeth in general bite inside the line of the superior teeth. In one character *Alligator mississippiensis* differs from all the other crocodilians studied; it is not known at present whether it is true of *A. sinensis* or not; if not that form is not closely allied with *A. mississippiensis*. This character, which was called to the writer's attention by Prof. W. K. Gregory, is related to the contact of the lacrymals with the surrounding bones. In all the other crocodilians studied the lacrymals form contacts with the nasals. In this species the lacrymals are separated from the nasals by the greatly elongated anterior processes of the prefrontals. The lacrymals therefore come in contact with the jugals, maxillaries, and prefrontals only. The maxillaries, in consequence of this separation of the lacrymals and jugals, are in contact with the prefrontals.

**Alligator mississippiensis** Daudin

The description of the skull of *Alligator mississippiensis* is based upon a series of skulls of greatly varying ages. They are, in order of increasing size, the following specimens: two very small skulls in the collections of the Museum of Comparative Zoology (Nos. 13101 and 13102), neither of which is over 40 mm. long; Amer. Mus. Nos. 2321 and 2320;

another skull in the collections of the Museum of Comparative Zoology (No. 13103), about 100 mm. long; Amer. Mus. No. 12572, about 200 mm. long; Amer. Mus. No. 15180 about 340 mm. long; another skull of practically the same size (Amer. Mus. No. 15178); and Amer. Mus. No. 15181, about 490 mm. long.

### General Form

The skull of the American alligator is broad and flat; the region of the snout is especially so. The snout varies from about equal length and breadth at the base in the very young skulls to a length about one and two-thirds as long as the breadth at the base in the oldest skull. The lateral margins of the snout are unusually smooth; in the very young individuals they converge rather sharply in the anterior direction, the anterior end of the snout being rather acute; in the older specimens the margins of the snout are almost parallel, and the end of the snout is very broadly rounded. The fourth mandibular teeth bite into pits in the upper jaw, instead of into grooves as in *Crocodylus*, consequently there is no sharp constriction of the snout at the premaxillo-maxillary suture; the snout is very slightly expanded at the level of the fourth maxillary teeth, and very slightly constricted a short distance posterior to that level. These slight constrictions and expansions are very much less marked than in *Crocodylus*, and are in different positions. There is an elevation above each fourth maxillary tooth, and in Amer. Mus. No. 15180 the left of these has been pierced by the root of the tooth (evidently after the preparation of the skull) showing the extremely thin character of the bone. The snout varies greatly in its degree of pitting; the older skulls are of course much more deeply pitted than the younger ones. In some skulls the median posterior portion of the snout is relatively smooth, while the borders of the snout are deeply pitted, and there is a sharp transition from the smooth to the rough areas. In other skulls the degree of pitting is more nearly equal; in still others the posterior median area of the snout is smooth, but grades into the rougher borders. The meaning of this type of variation is not known, but it may possibly be geographic in nature. The external narial aperture is divided into two portions by a median septum.

The interorbital region is relatively narrow, and is strongly uprolled. The cranial table is of moderate size; it varies considerably in outline. In the younger specimens there is a tendency toward convexity in the external borders of the table; in the older skulls the lateral borders converge slightly in the anterior direction. This is not invariably the case,



as in the largest skull studied (Amer. Mus. No. 15181) the borders converge less than in two smaller skulls. The height of the skull, especially in the region of the snout, but also in the cranial region, is not great.

### The Cavities of the Skull

**SUPRATEMPORAL FENESTRÆ.**—In the older specimens these fenestræ are of moderate size, and are close together. They are very irregular in outline, and their greatest diameters converge anteriorly. In the young skulls they exhibit the characteristic juvenile crocodilian features of great length in proportion to their breadth, and wide separation from each other. In the older skulls they are very much smaller than the lateral halves of the external narial aperture.

**INFRATEMPORAL FENESTRÆ.**—The infratemporal fenestræ are moderately large, and are subtriangular in outline. The postorbital bars which form their anterior boundaries slope more obliquely downward than in the true crocodiles. The fenestræ are not penetrated by sharp processes of the quadrato-jugals, as in the species of *Crocodilus* and *Tomistoma*.

**ORBITS.**—In the young skulls the orbits are excessively large; in the older ones they are relatively small, with intermediate conditions in the intervening stages. The orbits of the older skulls are considerably longer than they are broad; this is true to a slight extent in the young skulls. In the older specimens the orbits are rather sharply pointed at their anterior ends; their internal borders are very deeply concave, and these borders, especially at their anterior ends, are conspicuously elevated; the inferior, or external borders are slightly concave inward in the younger stages, but in the older ones they are more nearly straight, and in the oldest of all (Amer. Mus. No. 15181) they are very slightly convex inward. This makes the outline of each orbit exceedingly irregular.

**EXTERNAL NARIAL APERTURE.**—The external narial aperture is large. Its anterior breadth is greater than its posterior. Its total breadth is considerably greater than its length. It is completely divided into right and left portions at the surface of the snout by the enlarged anterior processes of the nasal bones, and shorter processes of the premaxillaries which extend backward to meet the nasal processes. There is no bony separation of the aperture at a lower level, however.

**PREMAXILLARY FORAMEN.**—This cavity is comparatively large. It is rounded at its posterior end and sharply pointed at its anterior end; its lateral boundaries are curves which are deeply concave in their posterior halves, and gently convex in their anterior halves.

**PALATINE FENESTRÆ.**—The palatine fenestræ are rather small and far apart, especially in the older specimens. In the younger skulls they are relatively somewhat larger, especially in the transverse direction. In the youngest specimen they are about twice as long as broad. In all of the young specimens they are relatively close together. In all of the skulls up to and including the 10 cm. skull of the Museum of Comparative Zoology Collection, the space between the two fenestræ is not greater than the breadth of either fenestra. In the oldest specimen (Amer. Mus. No. 15178) the minimum transverse diameter of the interfenestral plate is nearly twice as great as the maximum transverse diameter of each of the fenestræ. The younger individuals have rather symmetrically shaped fenestræ; the older ones have them very irregular in outline. In all of the older skulls the fenestræ are long and narrow, and their anterior ends are rounded. Their external borders are irregularly concave; their internal borders are nearly straight lines which converge sharply in the posterior direction, but near their posterior ends they curve inward around an expansion of the nasal passage, and in the oldest specimen curve outward, and finally inward again. The posterior ends of the fenestræ are sharp; their greatest transverse diameters are near their posterior ends. In the youngest skulls they extend forward to the level of the tenth maxillary teeth; in the older ones they extend as far forward as the anterior borders of the eleventh.

**INTERNAL NARIAL APERTURE.**—This cavity faces downward and slightly forward. It is large, occupying about half the median length of the pterygoids. It is completely divided by a median bony septum, and it extends far up into the basicranial region of the skull; its median septum is supported laterally, inside the cavity, by a series of lateral bars, or braces. Externally it is shielded posteriorly by a ridge of the pterygoids.

### The Bones of the Skull

**PREMAXILLARIES.**—The premaxillaries are very broad and short. Their very small posterior processes extend only as far back as the level of the second maxillary teeth; the narial aperture extends back to the level of the first maxillary teeth, so the post-narial portion of each premaxillary is very small. From the anterior border of the aperture a pair of closely appressed processes of the premaxillaries extend backward to meet the long anterior processes of the nasals.

On the palate the premaxillo-maxillary suture is rather irregular in outline. From the lateral border it extends inward and backward a short distance to a point slightly posterior to the level of the first maxil-

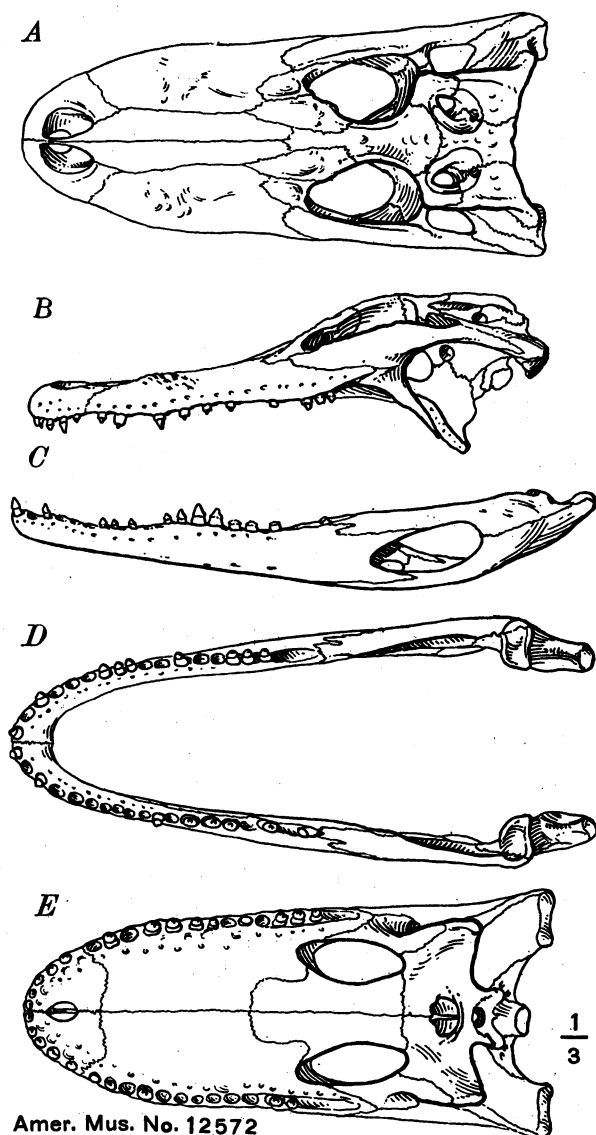


Fig. 14. Skull and jaws of *Alligator mississippiensis* Daudin. Amer. Mus. No. 12572, one-third natural size. A, superior view of skull; B, lateral view of skull, left side; C, lateral view of mandible, left side; D, superior view of mandible; E, inferior view of skull.

lary teeth, and anterior to the second, or in line with their anterior borders, and about one-third the distance inward from the margin of the jaw to the median line. Then it turns inward and very slightly forward, meeting its opposite on the median line opposite the first maxillary teeth. The maximum length of the premaxillaries on their palatal surface is about three-fifths their total breadth; on the superior surface the length is about four-fifths the breadth.

There are normally five teeth in each premaxillary; in one specimen, however, one of the first pair was not developed. The teeth increase regularly in size from the first to the fourth; the fifth is approximately equal in size to the third. The teeth are all spaced moderate distances from each other. The pits which lodged the mandibular teeth are all situated internal to the line of the premaxillary teeth, the lower teeth biting entirely within the upper ones. The first of these pits, on each side, internal to the second tooth and the space between the first and second, is deep, but does not pierce the surface of the skull. The second pit, opposite the space between the third and fourth teeth, is small; the third pit, internal to the space between the fourth and fifth teeth, is also small. The pit which lodges the fourth mandibular tooth is deep; it is internal to the line of both premaxillary and maxillary teeth, and is situated on the suture between the two bones; its deepest point lies in the premaxillary and not the maxillary.

**MAXILLARIES.**—The maxillary bones are very short in the younger skulls, but are relatively longer in the older ones. In all of the skulls they are relatively broad in proportion to their length. Their sutures with the nasals are convex (in the direction of the maxillaries) in the young individuals, and straight or slightly concave in the older ones. Their sutures with the prefrontals, lacrymals, and jugals are very irregular, together forming a series of loops across the posterior portion of the snout. In having contacts with the prefrontals the maxillaries of the alligator differ from those of all other crocodilians, in which the maxillaries are excluded from contact with the prefrontals by the lacrymals, which usually form contacts with the nasals.

On the palate the maxillaries occupy a considerable area. Their suture with the premaxillaries has been described above. The maxillo-palatine suture differs somewhat from that of most crocodilians. It extends backward and inward from the anterior end of the palatine fenestra, on each side, for a short distance only, then turns and extends almost directly forward to the level of the ninth maxillary teeth in the

older specimens, and the eighth in most of the younger ones, then extends almost directly inward to the median line, and in a symmetrical direction to the opposite border. In the two youngest specimens the suture differs somewhat from this outline. In the very smallest one the suture extends almost directly forward and inward from the anterior end of the fenestra, to meet its opposite on the median line opposite the seventh maxillary teeth, the two lateral portions together forming a letter V, with the apex directed forward. In the second smallest skull the suture extends obliquely inward and forward to a point opposite the seventh maxillary teeth, as in the one just described, but then turns directly inward and meets its opposite on the median line at that level. The maxillaries are excluded from the internal borders of the fenestræ, and form only small portions of their external walls. The maxillo-ectopterygoid sutures extend forward to the level of the twelfth or the thirteenth maxillary teeth, varying somewhat among the skulls studied. The maxillaries do not extend far back of their alveolar borders.

There are fifteen teeth in each maxillary. These are directly in line with the premaxillary teeth. They increase regularly in size from the first to the fourth, which is the largest in each maxillary. From the fifth to the seventh, inclusive, the maxillary teeth decrease in size. From the eighth to the eleventh, inclusive, they increase; the eleventh is second in size to the fourth. From the twelfth to the fifteenth, inclusive, they decrease regularly.

The maxillary teeth, from the first to the sixth, are close together, likewise the eighth and ninth; the sixth and seventh, and the seventh and eighth are considerably farther apart than the others; from the tenth to the fifteenth they are very close together, in fact from the eleventh to the fifteenth their alveoli are continuous with each other. The crowns of the anterior maxillary teeth are moderately long, like those of the premaxillary teeth, but they do not have the relatively great length of those of most typical crocodiles; the crowns of the posterior maxillary teeth are very short. All of the teeth are rather short and stout. The anterior teeth are more or less pointed, but not sharply so; the posterior teeth are very blunt. Conspicuous pits for reception of the mandibular teeth are situated internal to the spaces between the sixth and seventh, and the seventh and eighth teeth in each maxillary. Anterior to this level there are very slight indentations of the maxillaries which lodge mandibular teeth; all of them are entirely internal to the line of teeth themselves. The transition from sharp to blunt teeth is more gradual than in most true crocodiles.

**NASALS.**—The nasal bones are broad in comparison with those of other crocodilians, but not in proportion to the breadth of the snout. Their anterior processes extend forward into the nasal aperture, and joining with a pair of short processes of the premaxillaries, completely divide the aperture into right and left portions at the surface. At the posterior ends of the two lateral halves of the aperture they are broad, and occupy considerable portions of the postnasal borders. Their breadth at the posterior end of the aperture is much greater than in any other crocodilian skull studied. Posterior to the aperture they expand rapidly to the level of the fourth maxillary teeth, where they reach their maximum breadth. Posterior to the level of the fourth maxillary teeth they vary somewhat in the various individuals; in some their external borders remain almost parallel; in others they converge slightly in the posterior direction, and then diverge again; the positions of the minimum breadth of the anterior portions of the nasals, and of the expansion back of this, vary considerably. In all the specimens examined the nasals decrease in breadth rapidly posterior to the anterior end of the naso-prefrontal sutures. The nasals have no contacts with the lacrymals. The posterior ends of the nasals, between, or in some cases slightly anterior to the anterior ends of the orbits, are irregular; in some specimens the two nasals are very slightly wedged apart by a minute extension of the anterior process of the frontal; in others they are irregularly transverse.

**LACRYMALS.**—The lacrymal bones of the alligator are unusual. They have no contacts with the nasals; they are much shorter than the prefrontals, and do not extend as far forward or as far backward as these bones; they are slightly broader than the prefrontals; their longitudinal axes are nearly parallel with the longitudinal axis of the skull.

**PREFRONTALS.**—The prefrontals are unusually long. Their external and internal borders converge anteriorly, forming sharp points at the anterior ends of the bones; their contacts with the maxillaries are about one-half as long as their contacts with the nasals. Their posterior ends, along the borders of the orbits, are very rugose.

**FRONTAL.**—The anterior process of the frontal is comparatively short, being considerably shorter than the posterior plate; it is of moderate breadth. The interorbital plate is relatively narrow, and its edges are sharply uprolled. The posterior expansion, posterior to the orbits, is slight.

**POSTORBITALS.**—These bones are of medium size. Each occupies about one-third of the lateral border of the cranial table, and its orbital border is slightly shorter than its lateral border. Each forms a part of

the antero-internal as well as the external border of the supratemporal fenestra.

**SQUAMOSALS.**—The squamosals are moderately large. Together they occupy about five-sevenths of the posterior border of the cranial table. Their sutures with the parietal are concave, but tend to converge in the anterior direction.

**PARIETAL.**—In most of the specimens the parietal occupies much of the entire posterior border of the cranial table. In the very young specimens the supraoccipital wedges in as a process on the median line. In the oldest one there is a very minute process of the supraoccipital visible on the cranial table, preventing the parietal from occupying the entire central portion of the posterior border.

**SUPRAOCCIPITAL.**—As noted above the supraoccipital has little or no representation on the surface of the cranial table. The smaller skulls, including the 10 cm. skull of the Museum of Comparative Zoology Collection, exhibit an appreciable surface of this bone on the cranial table. The three skulls which are somewhat larger (Amer. Mus. Nos. 12542, 15180, and 15178) show no traces of it whatever. The largest skull (Amer. Mus. No. 15181) exhibits the bone as a minute area on the posterior border, as mentioned above.

The smallest skull in the collection studied (Mus. Comp. Zool. No. 13101) possesses not only a supraoccipital but a dermo-supraoccipital, which is separated from the true supraoccipital and from the parietal by sutures. In the next to the smallest skull (Mus. Comp. Zool. No. 13102) this dermo-supraoccipital is distinguishable, but it appears to be almost united with the parietal.

On the posterior surface of the skull the supraoccipital extends downward from the superior border to a point about two-thirds the distance from this border to the foramen magnum. Its breadth is about two-fifths as great as the breadth of the posterior border of the cranial table.

**EXOCCIPITALS, BASIOCCIPITAL, BASISPHENOID, AND QUADRATES.**—These bones are not especially characteristic, and need no special description.

**QUADRATO-JUGALS.**—These bones differ considerably from those of the true crocodiles. Their superior, or quadrate, borders are irregularly curved; they lack altogether the sharp processes extending into the infratemporal fenestræ, which are conspicuous in the species of *Crocodylus* and *Tomistoma*. The antero-superior processes are large, both in length and thickness; they extend upward and forward, and articulate with the postorbitals as well as the squamosals and quadrates.

**JUGALS.**—The jugal bones are relatively short and broad. Their posterior processes are thin, but their entire anterior halves are deep vertically; in their anterior regions they differ in this character from the jugals of the true crocodiles, in which the anterior halves are considerably lower, or narrower, than the central portions.

**PALATINES.**—The palatine bones are very distinctive in outline. Their sutures with the maxillaries have been described above. They extend forward to the level of the eighth, ninth, or tenth maxillary teeth. Their anterior processes are considerably broader than they are long, and they are terminated by nearly straight transverse borders. The palatines form all of the internal borders of the palatine fenestræ in some skulls, and all except exceedingly short distances near the posterior ends in others. They form about one-fourth of the external borders of these fenestræ.

The sutures of the palatines with the pterygoids are distinctive in outline. They vary considerably among themselves, but their paths may be described as follows: each palato-ptyergoid suture extends backward and inward from a point at or near the posterior end of the palatine fenestra, for a short distance, then turns inward and slightly forward for an equal distance, then turns inward and backward again, and meets its opposite on the median line. The variation concerns the obliquity of the external portion, the degree of irregularity, the level of the juncture with the median line, and other characters of the same general description.

The palatines are relatively short in proportion to their breadth. Their minimum diameter is transverse in direction, at the level of the juncture of the maxillary, jugal, and ectopterygoid bones. Posterior to this point they broaden slightly, and anterior to it they broaden considerably, making the anterior ends of the palatine fenestræ very narrow. The anterior processes, which are much narrower than the maximum breadth of the bones, are considerably broader than the posterior ends of the bones. At the ends of the anterior processes the palatines occupy at least one-third of the total breadth of the palatal surface.

**PTERYGOIDS.**—The pterygoids are very short antero-posteriorly. The large internal narial aperture occupies about one-half of their length along the median line. They occupy small portions of the posterior, or postero-external, surfaces of the palatine fenestræ, the actual extent varying considerably among the different specimens. They appear to be fused together at their posterior ends; posterior to the internal narial aperture they are elevated into a curved ridge, which protects the aperture on its posterior border; they also send forward a median partition in the aperture and farther up in the nasal passage.



ECTOPTERYGOIDS.—The bones are somewhat characteristic. Their anterior processes extend forward to the twelfth or the thirteenth maxillary teeth; these anterior processes are sharply pointed. Their superior processes are large, and their postero-inferior processes are relatively slender.

### The Mandible

The mandible is relatively broad, especially near its anterior end. This is true in spite of the fact that its teeth bite entirely inside the premaxillary and maxillary teeth. The symphysis is short, extending as far back as the fourth mandibular teeth in some specimens, and in others not behind the third. The splenials extend to the posterior ends of the fourth mandibular teeth.

There are nineteen or twenty teeth in each ramus. These resemble the teeth of the upper jaws in general form, although some of them are more sharply pointed. The fourth tooth is the longest in each ramus, but the twelfth is considerably thicker. The teeth between the fourth and the twelfth (or thirteenth) are small; those posterior to the twelfth (or thirteenth) are somewhat larger, but decrease progressively from the thirteenth to the twentieth. The first twelve (or thirteen) teeth are relatively sharp-pointed, but from that point back to the end of the series the teeth are all blunt.

There is a great variation in the spacing of the mandibular teeth; the third and fourth (Amer. Mus. No. 15178, in which there are nineteen mandibular teeth on each side), the seventh and eighth, and the tenth and eleventh teeth are close together, also all the teeth posterior to the twelfth; the first and second, the second and third, the fourth and fifth, the fifth and sixth, the sixth and seventh, and the ninth and tenth are moderately far apart; the eighth and ninth are very far apart. The extra tooth in the jaws which have twenty appears to be in the region immediately posterior to the large fourth tooth; the jaw with nineteen therefore has seven small teeth between the fourth and the next large tooth, while the jaws with twenty have eight.

### Remarks

This species appears to be very widely separated in the structure of the skull from all of the other species studied. From the descriptions the small Chinese relative (*Alligator sinensis*) may partially bridge over the gap between the species described and the true crocodiles, but this is uncertain. The American alligator appears to be as distantly related to

# Measurements

	Mus. Comp. Zool.		Amer. Mus.		Mus. Comp. Zool.	Amer. Mus.			
	No. 13101	No. 13102	No. 2321	No. 2320		No. 12572	No. 15178	No. 15180	No. 15181
Length of Skull, Tip of Snout to Supraoccipital	.036M.	.039M.	.052M.	.057M.	.096M.	.197M.	.335M.	.325M.	.490M.
Length of Skull, Tip of Snout to Extremities of Quadrates	.035	.039	.053	.058	.098	.210	.370	.368	.549
Length of Snout	.014	.016	.025	.027	.049	.116	.217	.215	.337
Breadth of Skull Across Quadrato-jugals	.019	.021	.027	.030	.046	.098	.182(est.)	.182	.252
Breadth of Snout, Base	.015	.017	.024	.028	.042	.083	.148	.148	.215
Breadth of Snout Across Fourth Maxillary Teeth	.....	.....	.....	.....	.038	.073	.132	.134	.203
Length of Mandible	.036	.....	.056	.063	.....	.237	.407	.....	.....
Breadth of Mandible	.018	.....	.....	.035	.....	.099	.192	.....	.....

the caimans as to the true crocodiles. The similarities with the skulls of the various species of caimans appear to be superficial in character, and not necessarily indicative of close relationship. The American alligator, and presumably its Chinese relative as well, has evidently descended from a different Mesozoic ancestor from the remainder of the Crocodilia.

#### **Alligator sinensis** Fauvel

No skull of this species was available for study. The following description is quoted from Boulenger. "17 or 18 upper and 18 or 19 lower teeth on each side. Head nearly once and a half as long as broad; lateral outlines of snout converging towards the end, which is obtusely rounded; upper eyelid entirely bony."

#### SPECIES NOT RECOGNIZED AS VALID

No attempt has been made, in the present study, to verify or correct the synonymy of the Recent crocodilian species as given by Boulenger. However, several species which are recognized by Boulenger are not recognized as valid in the present study, . .

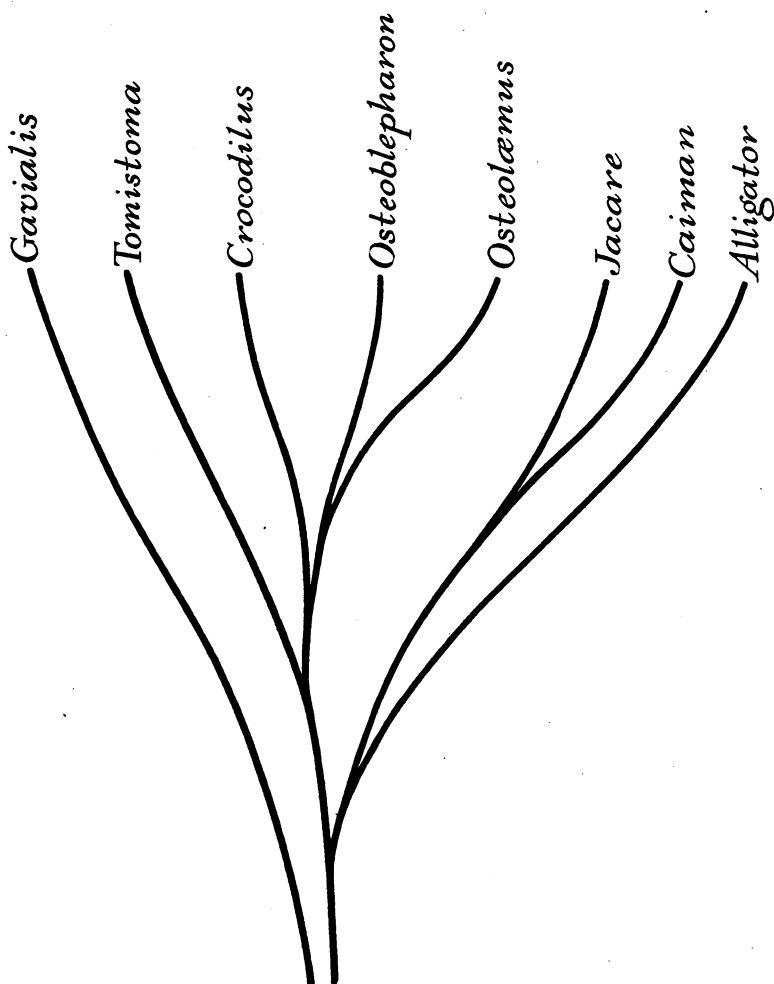
Barbour has discussed the synonymy of *Crocodilus rhombifer* Cuvier, and *C. moreletii* Duméril, and given reasons why the latter species should be considered synonymous with the former. The same writer has discussed *C. robustus* Vaillant and Grandidier, and has found that it is valid as a fossil species, but not as a Recent one. Barbour also considers *Alligator helois* Cope, to be based upon insufficient grounds. Fowler has discussed *Perosuchus fuscus* Cope, and considered it, upon good grounds, to be a synonym of *Caiman (Jacare) sclerops*.

#### DISCUSSION OF THE AFFINITIES OF THE VARIOUS GENERA OF RECENT CROCODILIA

From the characters described above it will be seen that *Gavialis* is more or less remote from a central crocodilian stem on the one hand, and *Alligator* is remote from this stem on the other. *Crocodilus* may be considered as intermediate between *Gavialis* and *Alligator*. *Tomistoma* is then intermediate between *Gavialis* and *Crocodilus*, but resembles the latter much more closely than the former. *Os'eoblepharon* is evidently very closely related to *Crocodilus*, and in many respects is intermediate between this genus and *Osteolæmus*. In certain superficial characters *Osteolæmus* resembles *Alligator*; it is unlikely, however, that there is any close degree of relationship between these two genera. *Jacare*, *Caiman*,

and *Alligator* have a number of rather important characters in common. Of the three *Jacare* is the most primitive, and bears the greatest resemblance to *Crocodilus* and *Osteoblepharon*. In the character of its supra-occipital this genus differs from all other Recent genera of crocodilians, however. In most of its characters, especially those of importance *Alligator* is very remote from *Crocodilus*. ■

The relations of the genera of Recent crocodiles, as indicated from a study of Recent species only, are probably somewhat as indicated in the accompanying diagram. A study of the fossil species may necessitate a revision of this outline.



# SYNOPSIS OF THE CRANIAL CHARACTERS OF THE GENERA OF RECENT CROCODILIA

This synopsis is based upon that of Boulenger, and differs but little from it. A few modifications have been introduced, however, chiefly in connection with the recognition of *Jacare* Gray and *Osteoblepharon* Schmidt as valid genera.

- I. Nasal bones widely separated from the nasal aperture; splenial elements entering the mandibular symphysis, which extends at least to the fifteenth tooth.
  - A. 27-29 superior, 25-26 inferior teeth on each side, none of the mandibular teeth received into pits; nasal bones widely separated from premaxillaries.....*Gavialis*.
  - B. 20-21 superior, 18-19 inferior teeth on each side, the lateral mandibular received into pits between the maxillary teeth; nasal bones in contact with the premaxillaries. . .*Tomistoma*.
- II. Nasals entering the nasal aperture; splenial elements not entering the mandibular symphysis; the latter does not extend back of the eighth tooth.
  - A. Fourth mandibular tooth usually fitting into a notch in the jaw; 16-19 superior, and 14-15 inferior teeth on each side.
    - i. No bony nasal septum.
      1. Fronto-parietal suture does not enter supratemporal fenestræ, maxillo-palatine sutures extend considerably anterior to ends of palatine fenestræ.  
*Crocodylus*.
      2. Fronto-parietal suture enters supratemporal fenestræ; maxillo-palatine sutures do not extend far beyond the ends of the palatine fenestræ.  
*Osteoblepharon*.
    - ii. Nasal bones dividing the nasal aperture.....*Osteolæmus*.
  - B. Fourth mandibular tooth usually fitting into a pit in the upper jaw; 17-20 superior and 17-22 inferior teeth on each side.
    - i. No bony nasal septum.
      1. Supratemporal fenestræ not closed except in very old individuals; premaxillary foramen elongate; parietal bone forms no part of posterior border of cranial table; 5 premaxillary teeth, 17-20 mandibular teeth on each side.....*Jacare*.

2. Supratemporal fenestræ closed; premaxillary foramen broad; parietal bone forms part of posterior border of cranial table; 4 premaxillary teeth; 20–22 mandibular teeth on each side . . . . . *Caiman*.
- ii. Bony septum divides external narial aperture . . . *Alligator*.