

ART. XXXVI.—*Studies of Eocene Mammalia in the Marsh Collection, Peabody Museum*; by J. L. WORTMAN. (With Plates VII and VIII.)

[Continued from p. 206.]

Family *Hyænodontidæ*.

STILL another group of the Creodonta is the family Hyænodontidæ, which, like so many representatives of the Carnivora already noticed, appears suddenly in the lower stages of the Middle Eocene or Wasatch deposits, without any previous announcement in the way of ancestors in the underlying Torreon. The present association of the genera in this family is very different from that adopted by Cope, Scott, and Schlosser. For example, Cope placed *Hyænodon* by itself in a separate and distinct family; *Pterodon* was arranged in the Oxyænidæ; while *Sinopa* (*Stypolophus*), *Proviverra*, *Quercytherium*, and *Didelphodus* were classified in the family Leptictidæ. Both Scott and Schlosser arranged *Oxyæna*, *Protopsalis*, *Hemiposalodon*, *Pterodon*, *Dasyurodon*, *Thereutherium*, and *Hyænodon*, in the family Hyænodontidæ, at the same time placing *Patriofelis* in the Palæonictidæ. The genera *Sinopa*, *Proviverra*, *Quercytherium*, and *Didelphodus* were placed by them in a distinct family, Proviverridæ. The first important advance over this arrangement of the genera into family groups was made in 1894,* when I pointed out that *Oxyæna* and *Patriofelis* are nearly related types, and should be classified in the same family; that *Protopsalis* is probably the same as *Patriofelis*; that neither of these genera is closely related to *Hyænodon*; but that *Hyænodon* and *Sinopa* (*Stypolophus*) are closely related to each other. In the same year, Osborn and myself added *Pterodon* to the two last-mentioned genera, from a consideration of the teeth.† The close relationship of *Proviverra*, *Cynohyænodon*, and *Quercytherium*, to *Sinopa*, was then well known, and the inference was clear that these forms follow *Sinopa* wherever placed in the classification. In further elaboration of these views, I published in 1899‡ a brief classification of the three families Hyænodontidæ, Oxyænidæ, and Palæonictidæ, which, I may add, forms the basis of our present understanding of the arrangement of these three important groups of the Carnivora.

As regards the definition of the Hyænodontidæ, if we leave out of consideration *Palæosinopa* and *Didelphodus*, which more probably are members of the Insectivora rather than of the Creo-

* Bull. Amer. Mus. Nat. Hist., 1894, pp. 152, 156. † Ibid., 1894, p. 237.

‡ Ibid., 1899, pp. 139, 140.

donta, we shall have little difficulty in distinguishing it from the Oxyclænidæ on the one hand, and the Oxyænidæ on the other. In the former of these families, none of the superior molars are of a pronounced shearing type, but seem (according to Matthew) to have been tending more in the direction of a tubercular than of a sectorial structure.* From the Oxyænidæ the family under discussion may be distinguished by the circumstance that it is the *second molar* above and the *third molar* below that were becoming the most specialized carnassials; whereas, in the Oxyænidæ, it was the *first molar* above and the *second molar* below that were thus specialized. In the Carnassidentia, as I have pointed out on a former page (337), the axis of sectorial development has shifted still further forward, and involves the *fourth premolar* above and the *first molar* below. Another important dental character of this family is the comparatively small size and weak development of the first molar below and frequently of the corresponding tooth above as well. This is a conspicuous feature of all the later species, particularly those of *Hyænodon* and *Pterodon*, and is also seen in nearly all species of *Sinopa*, although less strongly marked.

The progressive characters of the teeth consist in the gradual loss of the internal cusps of the superior molars, the complete fusion of their primary external cusps, and the loss of the third molar. In the inferior molars, the heels or talons decrease in size and disappear, and the internal cusp of the trigon becomes rudimental or wanting.

Sinopa Leidy.

Sinopa Leidy, Proc. Acad. Nat. Sci., Phila., 1871, p. 115;
Stypolophus Cope, Pal. Bull., No. 2, Proc. Amer. Philos. Soc., 1872, p. 446;
Prototomus Cope, Report on Fossil Vert. N. M., Ann. Rept. U. S. G. S. W. of 100th Mer., 1874;
Linnocyon Marsh, in part, this Journal, 1872, p. 122.

The only genus of the family thus far known to be represented in the Bridger fauna is *Sinopa*, described by Leidy from the lower part of the horizon in 1871. It first appears in the beginning of the Middle Eocene or Wasatch, and is represented by at least six fairly distinct specific modifications in these beds. One very well known species comes from the Wind River beds, while at least four are now known from the Bridger. The definition of the genus is as follows:

A group of small or medium-sized Creodonts, with a complete dentition, having the superior molars with well-developed internal

* There is as yet no evidence sufficient to determine the position of this group satisfactorily. They have always been assumed to be Placentals, and have been placed among the Creodonts. They may quite as well be Implacentals, as far as any very good evidence to the contrary is concerned, or they may prove to be Insectivores, with numerous transitional or Implacental Metatherian characters.

cusps, more or less fused or well-separated external cusps, and with anterior and posterior external angles produced into shearing blades; with first premolar above, and first and frequently second below, spaced; with first lower molar more or less reduced, and becoming progressively smaller and weaker than the others; and with pentadactyle limbs, in which the unguis phalanges are compressed, curved, and sharp-pointed.

Sinopa rapax Leidy.

Sinopa rapax Leidy, Proc. Acad. Nat. Sci. Phila., 1871, p. 115;
Stypolophus pungens Cope, Proc. Amer. Philos. Soc., 1872, p. 446.

The type species of this genus was described from a lower jaw fragment, carrying the fourth premolar and first molar in good condition, together with the heel of the second and the roots of the third. The specimen, although fragmentary, was well described and figured by Leidy, and it is possible to refer other material to it from the same horizon. Cope in speaking of his genus *Stypolophus* says: * “Dr. Leidy has applied the name *Sinopa* to some flesh-eaters of the Bridger epoch without distinctive generic description. An examination of the typical specimen of the *S. vorax* [*rapax*], which Dr. Leidy kindly

83

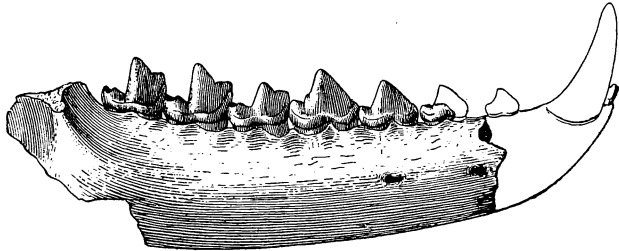


FIGURE 83.—Lower jaw of *Sinopa rapax* Leidy; side view; natural size.

permitted me, shows that it differs from *Stypolophus* in the rudimental character of the heel of the last molar, if the specimen is not deceptive. It is otherwise identical in the last four inferior molars.” Now Leidy’s specimen is deficient in the matter of the last molar, and it is not possible, according to his figure, to make out anything concerning the crown more than what is stated in the description, which is as follows: † “The last molar is a two-fanged tooth like those in advance, but is not quite so wide, and a small portion of the back of the crown indicates it to have been of less thickness.”

There are two specimens in the Marsh collection, consisting of considerable portions of the mandibular rami. One is a

* Tertiary Vertebrata, 1884, p. 289.

† Extinct Vertebrate Fauna of the Territories, 1873, p. 116.

right lower jaw of a young adult, figures 83, 84, containing all the molars and the three posterior premolars, in an almost perfect condition. The second specimen is more fragmentary,

84



FIGURE 84.—*Sinopa rapax* Leidy; crown view of three lower molars; natural size.

but the anterior portion of the ramus is sufficiently preserved to show the roots of the anterior premolars and the canine. The teeth agree so perfectly, both in measurements and structure, with Leidy's type of *S. rapax*, that I do not hesitate to refer them to this species. Containing, as they do, almost the entire lower dentition, including the last two molars, it is possible to compare them with Cope's type of *Stypolophus pungens*, which is also a jaw fragment carrying the second and third molars. The Marsh specimens agree quite as well with the Cope specimen as with that of Leidy, from which it is evident that all refer to one and the same species. I therefore unite them under Leidy's name *Sinopa rapax*.

The characters of the species, as revealed by these specimens, are as follows: The first lower premolar is single-rooted and separated from the canine and second premolar by short diastemata; the second, third, and fourth are not spaced, but are in contact; the first molar is the smallest and the second is slightly larger than the third; the trigon of the first molar is considerably less elevated than that of either the second or third; the heels of the molars are relatively wide and basin-shaped, that of the third or last being noticeably smaller and narrower than the others; the edge of the rim surrounding the heel is interrupted on its postero-external border by a moderately deep notch, which, when seen from the outside, gives the heel the appearance of being bicusped.

There is also in the collection a fragment of an upper jaw, which includes the fourth superior premolar somewhat damaged and the first and second molars in fairly good condition. I place the specimen in this category more by exclusion than by any real evidence which it exhibits. The size of the teeth corresponds very well with those of the lower jaw, and they display just such characters as we should expect to accompany the lower series above described. Their chief characters are the following: The fourth premolar has a large internal cusp and a well-developed blade-like postero-external cusp; the first and second molars are subequal, the internal cusps are relatively large and lunate, the two primary external cusps are well separated, and the antero-external angle of the second is not produced into a cutting blade. I give the following principal measurements:

Length of inferior molar and premolar series from base of canine	55 ^{mm}
Length of premolars	32 [•]
Length of molars	23 [•]
Depth of jaw at second molar	18 [•]
Length of fourth superior premolar and first and second molars	23 [•]
Width of first molar	7 [•]
Width of second molar	9 [•]

The more perfect of the lower jaws was found by Professor Marsh, at Grizzly Buttes, where Dr. Leidy's type was collected. No locality is given on the labels for the other two specimens.

Sinopa agilis Marsh.

Limnocyon agilis Marsh, this Journal, 1872, vol. iv, p. 202 ;

Stypolophus breviculcaratus Cope, Proc. Amer. Philos. Soc., 1872, p. 469.

The materials from which this species was originally described consist of the larger part of the skeleton of a young individual, somewhat crushed. There are represented numerous vertebræ, ribs, limb bones, an almost complete fore foot, and considerable portions of the skull, with nearly the entire dentition. Fortunately, this specimen is supplemented by a second skeleton of a somewhat older individual, in which the skull is very well preserved, but the teeth are considerably worn. This specimen also includes numerous parts of the remainder of the skeleton, so that between the two a very accurate understanding of the osteological structure may be had. Upon the most careful comparison, there is no doubt of the specific identity of the two specimens, and I have accordingly not hesitated to use all the skull material in the restoration of the skull represented in the accompanying plates, VII, VIII.

The Skull.—The general appearance of the skull is not unlike that of many living Carnivores, exhibiting an unusually narrow, elongate type, with a remarkably straight, superior outline, and with crests and arches of moderate proportions. The skull, as a whole, is much smaller in proportion to the rest of the skeleton than is usually the case among the Creodonts. In length, it holds nearly the same relation to the tibia and humerus as that seen in *Herpestes*, and, except for the length of the face in *Sinopa*, the other proportions are not very different. This feature gives the skeleton a much more modern appearance than many of its contemporaries. The brain case is exceptionally long and narrow, the postorbital constriction, which is well marked, being placed a little posterior to the middle of the cranium. The facial portion is not unlike that of some of the Canidæ, relatively long and narrow, with a considerable constriction posterior to the roots of the

canines. The nasals, of which the extreme anterior portions are missing, are narrower in front than behind, as in the carnivorous Marsupials, although the posterior widening is not nearly so marked as in this group. They terminate posteriorly in a pointed extremity, which is situated near the center of an unusually broad and deep frontal depression. The nasals are not so wide posteriorly as to restrict the contact between the frontals and maxillaries, as is the case in certain of the carnivorous Marsupials, and in *Dromocyon* already described, so that this feature of the skull is decidedly more Carnassident in appearance. The maxillary is large and has a form common to the carnivorous skull. The posterior suborbital region, however, is exceptionally broad, and is in every way more extensive and primitive looking than in any of the Carnassidents. Owing to the large facial development of the lachrymal, the maxillary lacks considerable of reaching the rim of the orbit. The infraorbital foramen is of goodly size, and issues a short distance above the hinder edge of the third premolar, about as in the fox. As already stated, the lachrymal is relatively large and spread out upon the face, having about the same proportions and degree of facial development as that of the opossum. It is perforated by a distinct lachrymal canal, which lies wholly within the rim of the orbit. The zygomatic arches are not preserved in either specimen, but, if we are able to judge by their roots, they may be said to have been intermediate in stoutness between those of the dog and of the opossum. The anterior part of the malar is preserved, and this, as is usually the case, furnishes the lower anterior boundary of the orbit. In the Carnassidentia, it joins the maxillary by means of a bifurcated extremity. In the fossil, the lower ramus of this bifurcation is very slightly developed—a condition which approximates that of the opossum, in which it is entirely wanting.

The frontals are rather broad anteriorly and terminate opposite the infraorbital foramen, in triangular extremities which do not meet the ascending processes of the premaxillæ. The position of the inconspicuous postorbital processes is indicated by the termination of the strongly-marked, rapidly diverging anterior branches of the sagittal crest, which furnish the posterior boundary of the frontal depression. The sagittal crest is not well preserved, but enough is shown to indicate that it had about the same relative degree of development as that of *Gymnura* and the Dasyures. The form of the brain case is much like that of certain of the civets, except that it is longer, narrower, and of less capacity; it is conical in front with a slight median swelling, after which follows a relatively long subcylindrical posterior portion. The parietals and

squamosals exhibit about the same relations as those of the dog, with the possible exception that the squamosal is larger. The parietal foramina, which in this region form such a conspicuous feature of the skulls of so many of the Creodonts, are very small; in fact, in the specimen under consideration, the one on the right side is practically absent.

The lambdoidal crest is only moderately developed, showing about the same degree of elevation as that seen in the living insectivorous genus *Gymnura*, which the superior and occipital portions of the skull resemble somewhat closely. The occiput is not very broad, and rises almost vertically to the plane of the long axis of the skull. It overhangs the condyles but very slightly, in marked contrast with its great backward projection in some of the Creodonts. The condyles are relatively very large, obliquely placed, and well separated. In comparison with those of a red fox, in which the size of the two skulls agrees very well, the occipital condyles of *Sinopa* are quite one-third larger. The extent to which the mastoid portion of the periotic is exposed upon the posterolateral wall of the cranium cannot be made out with certainty, but it appears to be very little, if any.

The base of the skull is in a state of excellent preservation, and its anatomy can be quite fully determined. The basioccipital is broad, and at the point of its articulation with the basisphenoid exhibits two prominent tubercles, separated by a longitudinal groove. The office of these eminences, which are roughened for muscular attachment, was doubtless for the origin of the *recti capiti*. The paroccipital is large, considerably flattened from above downward, and has a very marked outward and backward direction, as in the Insectivora. Just how much of this, however, is due to crushing, it is difficult to say, but it appears to be natural. The mastoid, which is separated from the paroccipital by a groove, is prominent, as in the Marsupials. The petrosal portion of the periotic is not covered by any tympanic bulla below, and if a tympanic bone were present it was not attached to the skull. There are, moreover, no expansions of the alisphenoid contributing to the formation of an otic bulla, as is so frequently the case in the skulls of the Marsupials and Insectivores. The petrosal portion of the periotic, when seen from below, appears as a small rounded eminence, near the outer posterior extremity of which, in a deep transverse groove, is seen the opening of the *fenestra rotunda*. In the Carnassident skull, this transverse groove is absent, and the opening of the fenestra is larger and somewhat tubular in appearance. Above, and anterior to this, is seen the opening of the *fenestra ovalis*, into which the base of the stapes is received. The absence of any groove leading

to the *fenestra ovalis* from below may be taken as conclusive evidence that the course of the entocarotid artery was essentially different from that in the modern Insectivora. Just external to the *fenestra rotunda* may be observed the peripheral termination of the fallopian aqueduct, through which the facial nerve made its exit from the skull. In front of the occipital condyle is placed the opening of the main condyloid foramen, and at some little distance in advance of it is the accessory or second condylar foramen—so constant a feature of the Marsupial skull, and occasionally found among living species of the Insectivora. Its office is apparently unknown. Immediately posterior to the petrosal eminence is situated the rather large elliptical opening of the foramen lacerum posterius, the size of which, in connection with the almost vestigial condition of the postglenoid foramen, would seem to indicate that the chief venous channel through which the cranial cavity was drained, made its exit at this point. A broad, but distinct, groove internal to this foramen leads forward to the fissure between the periotic and basioccipital, thence into the foramen lacerum medius situated in the angle at the junction of the periotic, basioccipital, and basisphenoid. That this was the point of entrance of the entocarotid artery is clear from its close resemblance to the corresponding parts in the skull of all of the Carnassidentia. In this important particular, it is therefore fundamentally different from the Insectivora and Marsupialia, and like the Carnassidentia. The foramen ovale is large and is placed as usual opposite to the glenoid cavity, at a considerable distance from the posterior edge of the alisphenoid. Just in advance of this foramen, and almost within the same aperture, is a small, but distinct, foramen leading into the *antrum* of the basisphenoid. In the opossum, this foramen is large and opens further in advance of the foramen ovale, but is connected with it by a distinct groove. Its office in this latter species is the transmission of a vein, a branch of which gains access to the cranial cavity through a small foramen in the floor of the pituitary fossa. There is no alisphenoid canal, but a slight groove marks the forward course of the ectocarotid at this point. The foramen rotundum and the sphenoidal fissure present separate openings, and are situated in a deep groove above the pterygoids. The opening of the rather large optic foramen is above, and considerably in advance of these two. Above and in advance of this, again, is the opening of the ethmoidal foramen for the passage of a branch of the nasal nerve.

The region of the glenoid cavity is considerably broken, but there is enough preserved to indicate that there was a strong postglenoid process, behind which is a small postglenoid

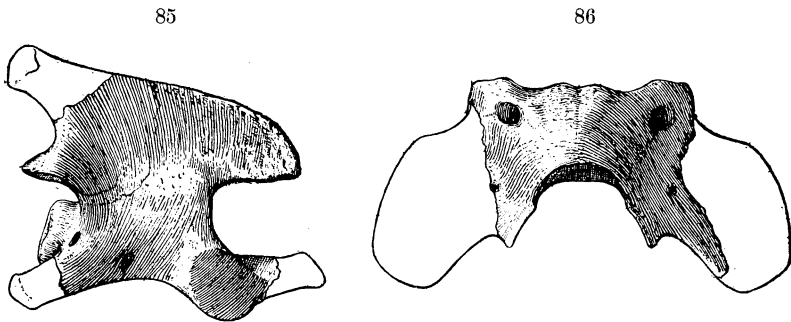
foramen. The pterygoids are well developed and the postnasal gutter is long and deep, much as in the dog and other typical Carnassidents. The posterior edge of the palatines is thickened and lies considerably behind the last molar. The palatal region is narrow in front and widens rapidly behind, being rather concave from side to side. The posterior palatine foramina have their usual position opposite the first molar, and behind them, in the palatines themselves, are numerous smaller accessory foramina. The incisive foramina are not well preserved, but there is evidence of their having had the usual slit-like openings.

The lower jaw is long and slender, with a well-curved inferior border. The coronoid is wide and much elevated, the masseteric fossa well marked, and the angle produced into a long slightly inflected hook. The condyle is placed rather high and has the scroll-like pattern of many of the Carnivora.

The Dentition.--The teeth exhibit very marked progress toward the extreme sectorial structure of the later and more specialized members of the family. The dental formula is $I. \frac{3}{3} (?)$, $C. \frac{1}{1}$, $Pm. \frac{4}{4}$, $M. \frac{3}{3} = 44$. Of the superior series, the outer incisors have much the same form as the corresponding teeth in the Carnassidents. The canines are long, pointed, and curved. The first premolar has a compressed, bluntly pointed crown, and is implanted by two roots about midway between the canine and second premolar, with a considerable interval or diastema in front and behind it. The second premolar has a more pointed principal cusp, which is inclined to be hook-shaped; there is in addition a small posterior basal talon. The third premolar is missing. The fourth has all the usual elements of the superior sectorial of the Carnassidents, but it is much less perfect as a shearing organ. The external parts of the crown include a low indistinct basal cusp in front, a slightly flattened conical principal cusp, and a posterior blade-like extension separated from the main cusp by a deep vertical fissure. There is a distinct lunate internal cusp. The first and second molars are subequal in size, the second being slightly larger than the first. The antero-external angle of the first is less distinct than that of the second, in which it is produced into a short, transverse, shearing blade. In other respects, the structure of the two teeth is the same. The two primary external cusps are connate for the greater part of their extent, only the points being separated. The posterior spur is enlarged, blade-like, and, in connection with the drawn-out posterior edge of the more or less fused externals, constitutes the chief shearing apparatus of the upper jaw. There is, in addition, a somewhat reduced internal lunate cusp, which, upon its anterior rim, supports a small intermediate. The last molar is transverse

and reduced; its antero-external angle is produced into a strong blade-like spur; the postero-external is wanting, and the internal is large.

In the lower jaw, the incisors and canines are unknown. The first premolar is small, single-rooted, and separated from the canine in front and second premolar behind by diastemata. The second premolar is two-rooted and also separated from the tooth in advance and the one behind by considerable intervals. The third and fourth are in contact. The first molar is the smallest of the three, and not only differs from its fellows in this respect, but the cusps of the trigon are less elevated. In all of them the trigon is well developed, the shear is little oblique, and the internal cusp is much reduced. The heels are relatively small, with a high single posterior cusp and a faint median ridge, that of the last molar being the largest.



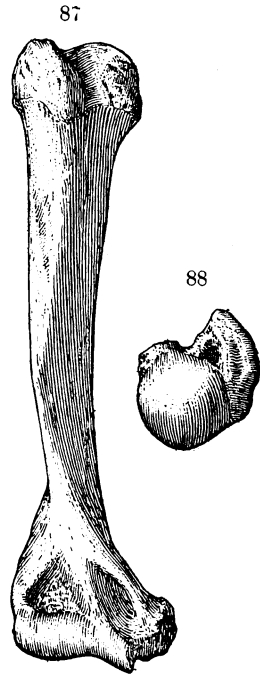
FIGURES 85, 86.—Atlas and axis of *Sinopa agilis* Marsh; natural size. (Cotype.)

While many other parts of the axial skeleton are preserved, they are not sufficiently perfect to merit a very detailed description. Of the series of cervical vertebræ, the atlas and axis, figures 85, 86, and the body of the third or fourth are present. The chief characters of these bones are the following: The transverse process of the atlas is relatively large, extends well behind the articular surfaces for the axis, and is thickened and perforated at the base for the passage of the vertebral artery; the further course of the artery forward is similar to that of the cat; the *sinus atlantis* is large, the cotyles deeply cup-shaped, the superior arch broad from before backward, and the inferior ring narrow and complete; the axis has a large, laminate, hatchet-shaped neural spine, which overhangs the odontoid in front; it is broken behind, but was presumably well extended; the odontoid is rather small and peg-like; the transverse spines are long, pointed, and pierced by the vertebralarterial canal; the ventral surface of the centrum has a very strong median keel, which increases rapidly in depth poste-

riorly, and on either side of this is a deep longitudinal cavity whose lateral boundary is furnished by the unusually dependent edge of the transverse process, much as in the fox; a third or fourth cervical centrum exhibits an elongated, depressed form, with strong median keel. The dorsals have elevated spines and comparatively small centra. The lumbar increase rapidly in size posteriorly; they have large strongly-interlocking zygapophyses, which exhibit distinct traces of the double tongue and groove articulation; they also develop distinct anapophyses.

The sacrum is relatively much longer and stouter than that of the fox, and its transverse diameter is proportionally quite as great, which latter fact would indicate a pelvic outlet of goodly proportions. This, in connection with the proportional size of the skull, is in marked contrast with the conditions in *Dromocyon* previously pointed out (p. 424). It may be here remarked that the same proportionally small pelvic outlet associated with the large head is also true of some species, at least, of *Hyænodon*. There are three cöossified vertebræ in the sacrum, the two anterior only of which contribute to the formation of the auricular process for the attachment and support of the ilium—an essential and very constant feature of the Carnassidentia. Among the Marsupials generally, only one of the vertebræ, the anterior, furnishes this support, while in the living Insectivora, as many as three vertebræ are thus involved. The size of the sacrum is apparently in relation to the long and powerful tail, of which the numerous caudal vertebræ give ample evidence. These bones do not differ, as far as can be observed, from the caudals of other Creodonts.

Of the appendicular skeleton, many parts are preserved. The scapula, while represented by numerous pieces, is not sufficiently complete to furnish any information of its general form or outline. The glenoid cavity betrays some resemblances to that of the opossum, in the extent of the transverse diameter and the large size of the coracoid. In this latter feature,



FIGURES 87, 88.—Right humerus of *Sinopa agilis* Marsh; front and proximal end views; three-fourths natural size. (Cotype.)

it differs from *Hyænodon*, in which the coracoid is very short and vestigial. The humerus, figure 87, may be said to be intermediate in structure between that of the more generalized Carnassidents and the opossum. In its general outline, it bears a close resemblance to that of *Hyænodon* and differs markedly from any of the Insectivora. Its chief characters may be stated as follows: The head, figure 88, is not very pointed behind; the greater tuberosity is thick and rises to a level with the head; the lesser tuberosity is distinct and separated from the greater tuberosity by a moderately wide bicapital groove; the deltoid crest is long and powerful, extending down more than half the length of the shaft; the distal end is characteristically broad, with unusual development of the internal condyle and supinator ridge; there is a large entepicondylar foramen, imperforate anconeal and anticubital fossæ, and a distinct division of the articular surface into trochlea and capitellum.

The bones of the fore arm are not complete, both ulna and radius being represented only by their proximal and distal ends. The ulna, as in *Hyænodon*, is much less reduced, in comparison with the size of the radius, than that of the Carnassidents; it has a long, slightly incurved, and proximally grooved olecranon, a deep sigmoid cavity, and a moderately well-developed styloid process. The head of the radius is cup-shaped, subcircular, and capable of extensive pronation and supination, much more so, in fact, than that of *Hyænodon*, in which the ulnar contact is much flattened. The distal end is considerably expanded, of a trihedral form, and has a deeply impressed articular surface.

With the exception of the magnum, trapezoid, and centrale of the carpus, one phalanx, and a few inconsiderable fragments, the manus, figure 89, is complete. As compared with that of a specimen of *Hyænodon crucians* in the Marsh collection, the carpus agrees very closely in all the more important characters. The chief osteological features of the foot may be briefly stated as follows: The scaphoid, lunar, and centrale are free;* the lunar, upon its distal ulnar side, shows a considerable articular surface for the unciform, upon which it partially rests; internal to this is a larger facet by which it articulated with the head of the magnum; the pisiform, cuneiform, and unciform exhibit the usual form and relationship of the more generalized carnivorous type; the trapezium is large

* The superior articular surface of the scaphoid is not well represented in the accompanying drawing; it should be made to extend much further forward.

and supports a somewhat divergent pollex, which, however, is in no degree opposable; there are five metapodials arranged in the usual manner; they have but moderately developed interlocking articulations, and the toes are spreading; the third

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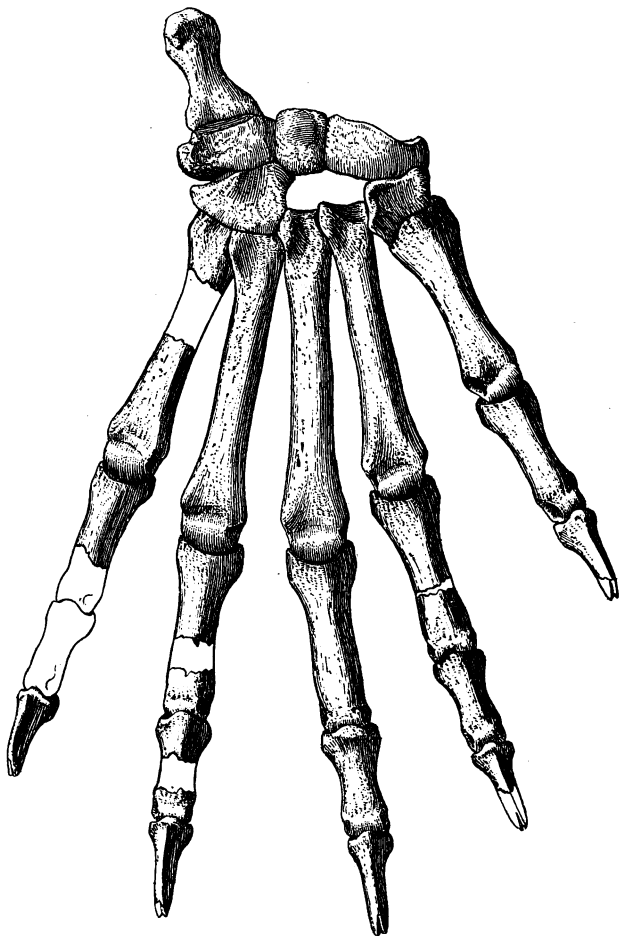


FIGURE 89.—Right fore foot of *Sinopa agilis* Marsh: three halves natural size. (Type.) The superior articular surface of the scaphoid is not well shown. As drawn, it appears to have great vertical depth in front, which is not the case.

metacarpal is the longest, and the second and fourth are about equal; the first is the stoutest and the fifth the smallest of the series; the phalanges are elongate and slender, and the bony

claws are compressed and pointed, figure 90, but at the same time slightly fissured at their extremities.



FIGURE 90.—Terminal phalanx of fore-foot of *Sinopa agilis* Marsh; three halves natural size. (Type.)

Although the magnum, trapezoid, and centrale are missing, the distal articular facets of the lunar render it certain that the position of the centrale was entirely under the scaphoid, as in *Hyænodon*. In this connection, I wish to call attention to a specimen of *Hyænodon* in the present collection, which agrees very closely with *H. crucians* of Leidy. A portion of the carpus is preserved, and it is of much interest to note

that the scaphoid, lunar, and centrale, figure 91, are coössified, with the remains of the sutures still visible. This carpus differs from the one figured by Scott,* in that the lunar has a large contact with the unciform, and the centrale lies wholly upon the radial side of the lunar, under the scaphoid.



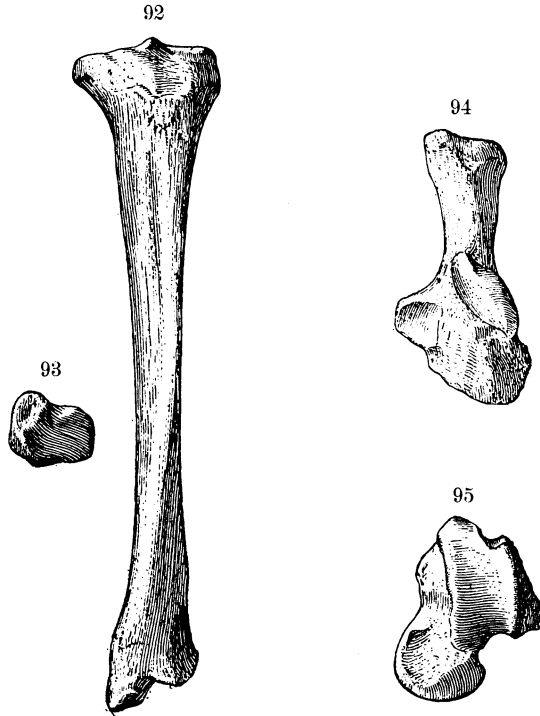
FIGURE 91.—Coössified scaphoid, lunar, and centrale, of *Hyænodon crucians* Leidy; natural size. a, top view; b, front view; c, inner view.

considerably expanded, and has a strong downward and outward curvature, as in *Hyænodon*; the peduncle is short and the tubercle for the *rectus* is large and rugose. The ischium is elongate and slightly expanded at its distal end. The pubis is not preserved.

The femur has a strong resemblance to that of *Hyænodon*; the hemispherical head is supported by a moderately short, stout neck; the *fovea* is distinct, the digital fossa deep, and the major trochanter rises almost to a level with the head; the trochanter minor is large, and the third trochanter is distinct and placed at a considerable distance down the shaft. The distal end of the bone exhibits the characteristic thickening of the lower end of the shaft, just before joining the condyles, as well as the general clumsy appearance seen in *Hyænodon*. The patella is relatively small, elongate, and narrow. The tibia, figures 92–93, is also markedly *Hyænodont* in character. The cnemial crest extends more than half-way down the shaft; the internal malleolus is large, and the trochlea is little grooved. The fibula is not so much reduced as it is in *Hyænodon*, but, as in that genus, there is a large contact with the calcaneum. The calcaneum, figure 94, has a moderately elongated tuber, and very convex astragalar and concave sustentacular facets.

* Jour. Acad. Nat. Sci., Phila., 1886.

The astragalus, figure 95, has a rather obliquely placed, vertically flattened, rounded head, a slightly grooved trochlea, and a vertical fibular facet. The astragalar foramen is distinct and



FIGURES 92, 93.—Left tibia of *Sinopa agilis* Marsh; front and end views; three-fourths natural size. (Cotype.)

FIGURE 94.—Left calcaneum of *Sinopa agilis* Marsh; dorsal view; one and one-eighth natural size. (Type.)

FIGURE 95.—Left astragalus of *Sinopa agilis* Marsh; dorsal view; one and one-eighth natural size. (Type.)

occupies its usual position. The remainder of the pes is unknown.

The principal measurements are given herewith :

Measurements of the Type.

Length of superior molar and premolar series, including canine	68·mm
Length of superior molar and fourth premolar	29·
Antero-posterior diameter of fourth superior premolar	9·
Antero-posterior diameter of first molar	9·
Antero-posterior diameter of second molar	8·

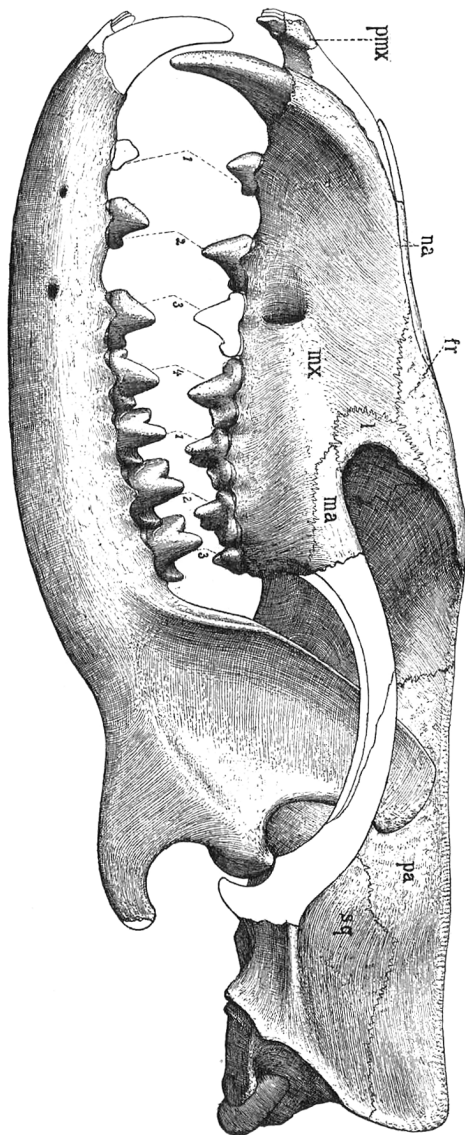
Antero-posterior diameter of third molar.....	3 ^{·mm}
Transverse diameter of fourth premolar.....	5·5
Transverse diameter of first molar.....	7·
Transverse diameter of second molar.....	9·
Transverse diameter of third molar.....	8·
Length of inferior molar and premolar series, from posterior base of canine.....	66·
Length of inferior molars.....	24·
Antero-posterior diameter of first molar crown.....	7·5
Antero-posterior diameter of second molar (not type) ..	9·
Antero-posterior diameter of third molar (not type) ...	8·5
Length of manus.....	74·
Length of humerus.....	113·5
Length of third metacarpal.....	32·
Length of first phalanx, third digit.....	16·
Length of second phalanx, third digit.....	10·
Length of claw, third digit.....	9·
Length of sacrum.....	49·
Transverse diameter of sacrum.....	27·
Length of pelvis (estimated).....	128·

Measurements of the Church Buttes Specimen.

Total length of cranium.....	149 ^{·mm}
Length from incisive border to termination of palate ..	81·
Length from posterior border of palate to condyles	68·
Width of condyles.....	23·
Width of palate at and including second molars.....	40·5
Width of palate between canines.....	12·
Length from anterior border of orbit to condyle.....	94·
Length from anterior border of orbit to incisive border	58·5
Height of axis.....	27·
Length of humerus.....	115·5
Length of tibia.....	118·5

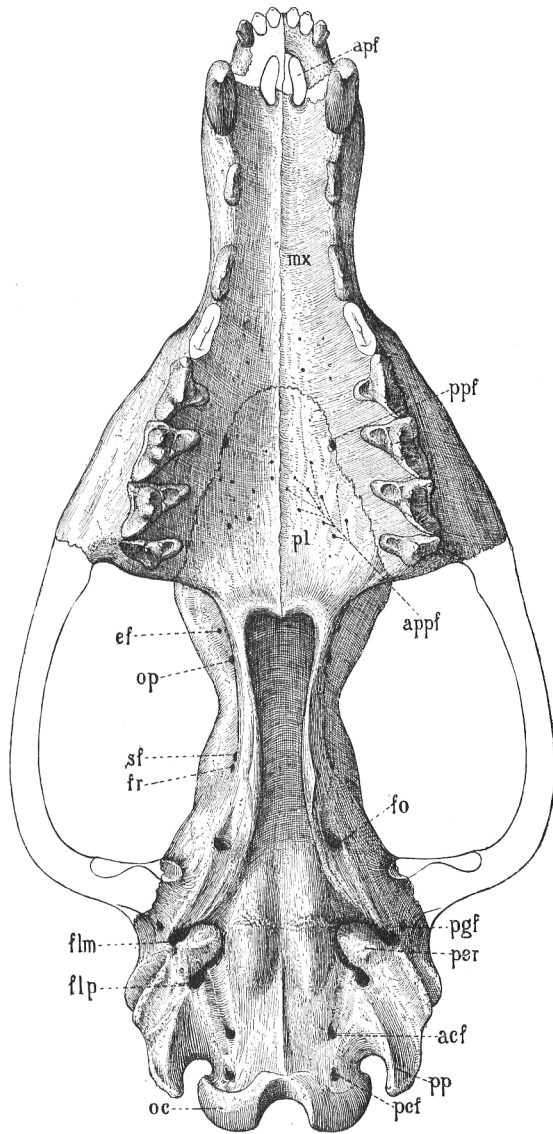
The type specimen was discovered by Professor Marsh, at Grizzly Buttes, and the cotype by R. Son, at Church Buttes, Bridger Basin, Wyoming.

[To be continued.]



EXPLANATION OF PLATE VII.

Skull of *Sinopa agilis* Marsh : side view ; natural size ; combination of the type and another specimen in the collection. *pa*, parietal ; *sq*, squamosal ; *ma*, malar ; *mx*, maxillary ; *l*, lachrymal ; *fr*, frontal ; *na*, nasal ; *pnx*, premaxilla.



EXPLANATION OF PLATE VIII.

Skull of *Sinopa agilis* Marsh; inferior view; natural size; combination of the type and another specimen in the collection.

apf, anterior palatine foramen; *ppf*, posterior palatine foramen; *appf*, accessory postpalatine foramina; *fo*, foramen ovale; *ppf*, postglenoid foramen; *per*, periotic; *acf*, anterior condyloid foramen; *pp*, paroccipital process; *pcf*, posterior condyloid foramen; *oc*, occipital condyle; *flp*, foramen lacerum posterius; *flm*, foramen lacerum medius; *fr*, foramen rotundum; *sf*, sphenoidal fissure; *op*, optic foramen; *ef*, ethmoidal foramen; *pl*, palatine; *mx*, maxillary.