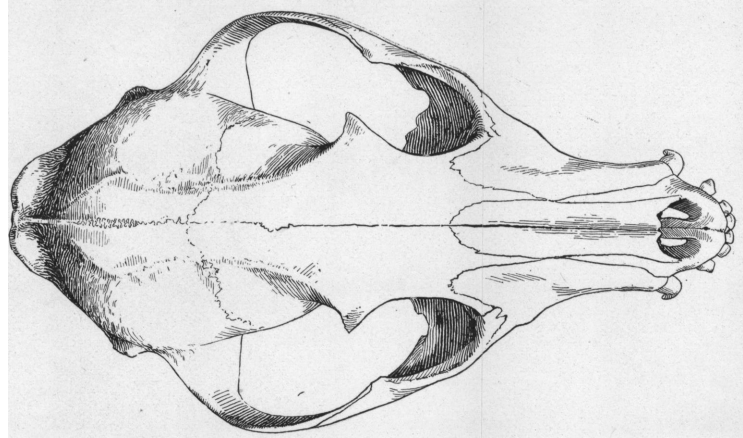

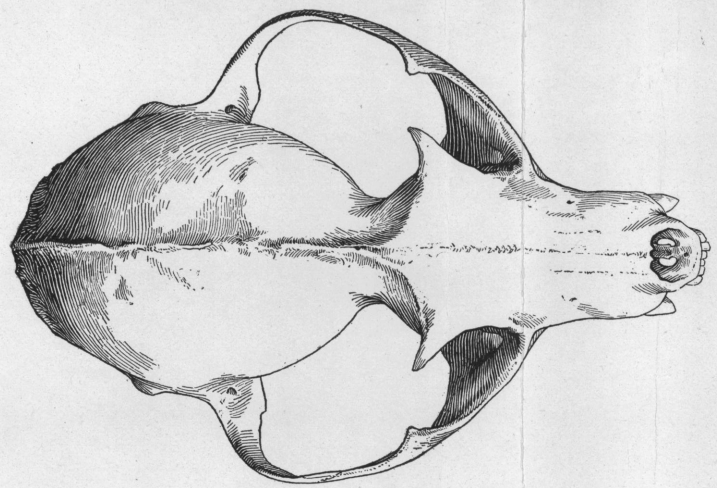

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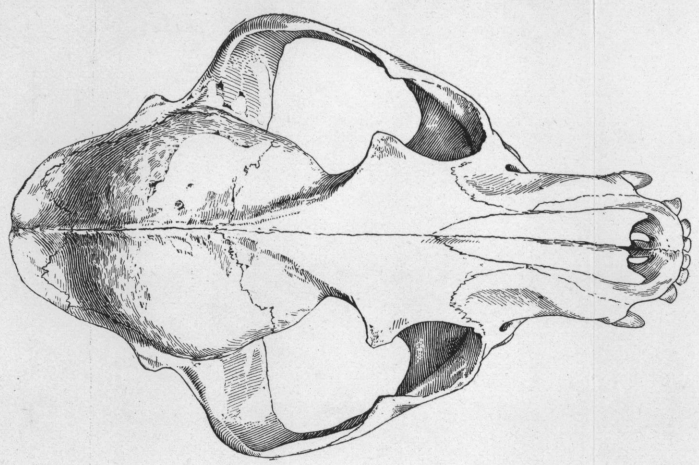

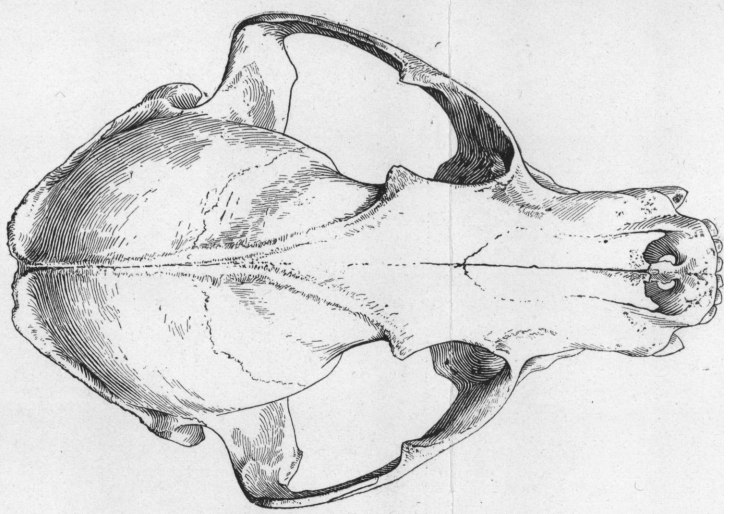

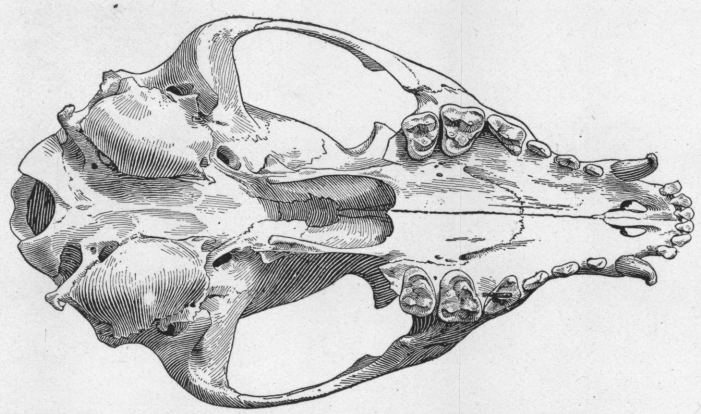

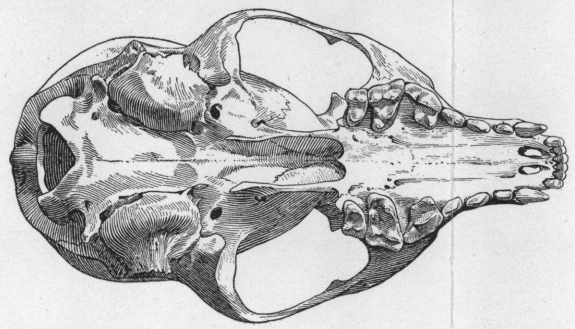

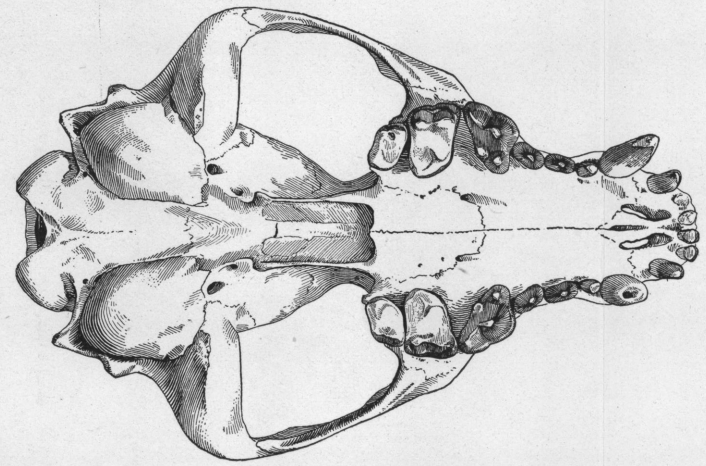

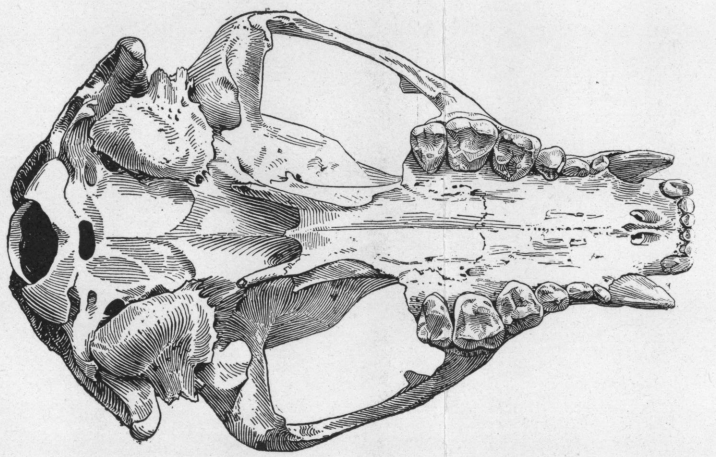

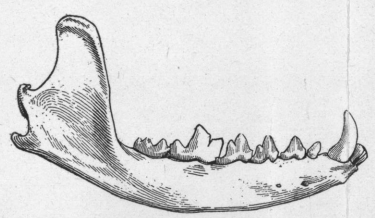

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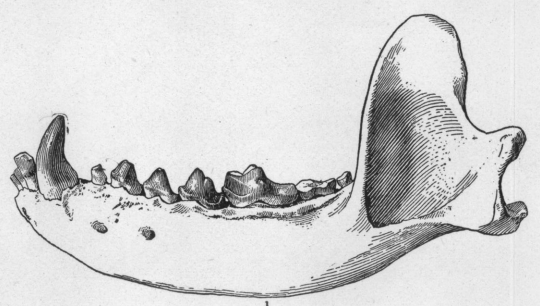

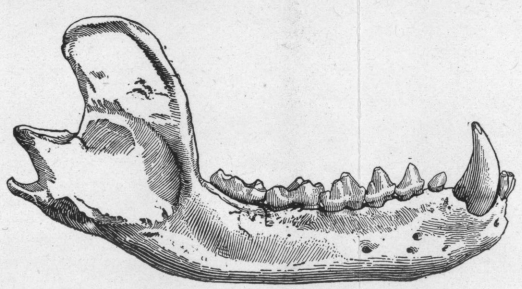

½ NOTHOCYON.

BASSARISCUS.

½ PHLAOCYON.

⅜ PROCYON.

CONNECTING LINKS BETWEEN THE CANIDÆ AND PROCYONIDÆ.

Article VI.—THE ANCESTRY OF CERTAIN MEMBERS OF THE CANIDÆ, THE VIVERRIDÆ, AND PROCYONIDÆ.

By J. L. WORTMAN AND W. D. MATTHEW.

PLATE VI AND TEN TEXT FIGURES.

The Eocene deposits of North America have yielded from time to time a large number of remains of primitive flesh-eating mammals whose nearest affinities appear to be with the modern Carnivora, although not a few of them, so far as their dentition is concerned, exhibit resemblances to certain of the Insectivora. This group has been held by some to represent a distinct order, and is considered by many authors under the name Creodonta, originally proposed for it by Cope. By others it has been placed as a suborder of the Carnivora, while still others have referred to it under the name Carnivora Primitiva.

Without entering into a discussion of the merits of this group to rank as a separate order or even a suborder, it is sufficient to observe in the present connection that it is not capable of very exact definition, and if it is desirable to retain a separate grouping of these forms it must be done with the understanding that it is purely as a matter of convenience.

That they stand in direct ancestral relationship to the later appearing families of the modern Carnivora, there can be no question whatever, but whether these families arose from one or several points among the Creodonta has never been demonstrated. In fact no actual contact between the two groups has ever been satisfactorily traced, and while many suggestions have been made in regard to these connections, they have, up to the present, been unsupported by any direct proof.

It is the object of the present paper, therefore, to trace the ancestry of two important modern families of the Carnivora directly backward into the Creodonta. We will also take occasion to point out the descent of several somewhat aberrant species of the existing Canidæ.

Another important discovery included in the present paper deals with the origin of the American family Procyonidæ, which is now shown to have existed as far back as the upper Oligocene.

I.—The Short-jawed Dogs of the Eocene.

Uintacyon[1] *Leidy.*

This group of species has been found thus far in the Wasatch, Wind River, and Bridger beds, and is represented so far only by more or less complete specimens of the lower jaws. In one species, *Uintacyon vorax* from the Bridger, a few fragments of the skeleton are known, but beyond this the materials are very deficient. Most of the species which we place in this genus have been referred to *Miacis*, a genus originally established by Cope upon a jaw fragment from the Bridger.[2] It now appears, however, that this first described species, and therefore the genus *Miacis*, is synonymous with the genus *Vulpavus*, previously established by Marsh upon a first superior molar.[3] The name *Miacis* will therefore have to be abandoned and the name *Uintacyon*, given by Leidy, substituted. Leidy's type of *Uintacyon edax* is anomalous, in that it possesses five premolars instead of the normal number four, but this is not open to very serious objection, since the shape and position of the extra tooth will convince almost any one at a glance of its abnormal nature.

As the genus stands at present no very striking or trenchant characters can be assigned to it which will separate it sharply from its Bridger contemporary, *Vulpavus*. Although the upper dentition is completely unknown, there can be very little doubt that the most important distinctions between the two will be found to consist in the number of superior molars. In *Vulpavus* they are reduced to two, as in the modern genus *Canis*, while there can be very little doubt that the number was three in *Uintacyon*. The only positively known character by which the two genera can be separated at present, is seen in the thick, heavy lower jaw, together with the abruptly rounded chin. In *Vulpavus*, on the other hand, the jaw is relatively slender and without the abrupt chin, quite as in the modern Canidæ.

There are apparently several distinct lines of species in this genus reaching from the Wasatch into the Bridger. In one precocious series the jaw is remarkably deep and short, the lower

[1] Proc. Acad. Nat. Sci. Philada. 1872, 277.
[2] Proceed. Amer. Philos. Soc. Aug. 1872, 740.
[3] Amer. Jour. Science, Aug. 1871.

canines laterally flattened, and the anterior premolars much reduced. In another line the jaw is somewhat more slender but still very short, the lower canines laterally compressed, but the premolars are not especially reduced in size. A third section includes a single very small species from the Bridger in which the jaw is very short and deep, the canines not flattened, and the premolars unreduced. In a fourth section the jaw is much more elongated and shallower, the canines not flattened, and the premolars are not reduced.

The dentition of the lower jaw is I. $\frac{3}{3}$, C. $\frac{1}{1}$, Pm. $\frac{4}{4}$, M. $\frac{3}{3}$. The second pair of incisors is much displaced, being pushed back out of the transverse line. The sectorial is made up of an elongated trigon and a basin-shaped heel; the second molar exhibits a crown of similar composition, but the trigon is much lower and the anterior cusp considerably reduced. In some species the last molar is very small and single-rooted, while in others it is larger and is implanted by two distinct roots. One peculiar feature of all the short-jawed species of the genus is the great length of the molar as compared with the premolar series. In many the molars occupy quite one half of the tooth-line of the jaw.

Uintacyon promicrodon, sp. nov.

This species is represented in the collection by a single specimen of an almost complete lower jaw (No. 83), in which the sectorial and fourth premolar are in good state of preservation; portions of the third premolar and second molar, as well as the roots and alveoli of all the remaining teeth, are present. The species belongs in the first section of the genus mentioned above, and is its oldest known representative, coming as it does from the Wasatch. The chief distinctions between it and *U. canavus* from the Wind River is seen in the size of the fourth lower premolar in comparison with that of the first molar. In the species under consideration it is of normal size and holds about the same relations to the succeeding tooth in this respect as is commonly observed in the modern Canidæ, whereas in *U. canavus* this tooth is much more reduced.

The remaining premolars were remarkably small and weak, if we can judge by the size of the roots; the first was implanted by a single root, while the second and third each had two. The

crown of the fourth premolar has a prominent submedian cutting heel. The length of the lower dental series from the alveolus of the first premolar is 41 mm.

Uintacyon canavus[1] (*Cope*).

This species is represented by the jaws of four individuals in the collection, all from the Wind River beds [Nos. 4783 (type), 4784, 4786, 4798]. The type consists of a lower jaw bearing the first premolar, but displaying the roots of all the remaining teeth. In the other specimens the crowns of the other teeth are moderately well preserved, so that the lower dentition can be determined.

As compared with the preceding species, the jaw is not quite so deep and heavy, especially in the region of the symphysis, the anterior premolars are smaller and more spaced, and the fourth much more reduced than in the preceding species. Two of the specimens show the alveolus for the last molar, and indicate that this tooth was implanted by two distinct roots, whereas in the preceding species the alveolus is not divided.

In this connection it is proper to mention a specimen from the Wind River, consisting of the last two molars (No. 84), which does not agree with either of the Wind River species, *U. canavus* and *U. brevirostris*, in that the last molar is single-rooted, as it is in the Wasatch *U. promicrodon.* The premolars belonging to this type are entirely unknown, and it would not be at all surprising if another species is indicated by this specimen. If the anterior premolars are reduced, it undoubtedly represents the direct successor of *U. promicrodon* in the Wind River. Until better specimens are known, we refrain from proposing another specific name.

The entire length of the lower molar series of the present species as indicated by the type is 42 mm.

Uintacyon brevirostris[2] (*Cope*).

The type of this species consists of a lower jaw (No. 4785) from the Wind River beds; it is the only specimen known from this horizon. The jaw is short and deep, as in the preceding species, and the canine is laterally compressed. The premolars,

[1] Bull. U. S. Geolog. Surv. Terr. VI, Feb. 1881, 186.
[2] Bull. U. S. Geolog. Surv. Terr. VI, Feb. 1881, 190.

of which the crown of the fourth is preserved, show little or no reduction, differing in this respect from the preceding species in a marked degree. The second molar, whose crown is preserved in perfect condition, has a squarish outline with low tubercular cusps; the trigon is very slightly raised above the heel, and the anterior cusp is much reduced. The last molar was distinctly two-rooted. The length of the molars and premolars is 38 mm.

There are five specimens of lower jaw fragments in the collection from the Big Horn Wasatch which agree very closely with the above type and which we provisionally refer to this species. The premolars were apparently unreduced, the jaw of the same depth and shortness, and the last molar strongly two-rooted. In one specimen (No. 4224), however, the anterior portion of the second molar is less elevated, and the anterior cusp of the trigon more reduced than in the type specimen from the Wind River.

Uintacyon vorax *Leidy*.[1]

This species is not represented in the Museum collection and the description here given is from the type of *U. bathygnathus* of Scott,[2] which name is undoubtedly synonymous with that of the above species.

The specimen, like that of the type, is from the Bridger, and consists of the greater part of both lower jaws, one of which contains the heel of the sectorial and the second molar in perfect condition. There are also present the proximal end of the femur, distal end of the tibia and fibula, part of the proximal end of the ulna, distal end of radius, a complete fifth metacarpal, a part of a metatarsal, and two phalanges. The original type of the species consists of a fragment of the lower jaw bearing the second molar, preserved in the collection of the Philadelphia Academy.

As in the preceding species the premolars are not especially reduced, and the jaw is relatively deep and short. The last molar is single-rooted, and the size is considerably greater than in *U. brevirostris;* the length of the lower molar and premolar series is 51 mm.

The fragments of limb bones are not certainly known to belong with the jaws, but they seem to agree so well in every respect

[1] Proc. Acad. Nat. Sci. Phila. 1872, 277.
[2] Some Little Known Creodonts. Jour. Acad. Nat. Sci. Phila. Vol. IX, 172.

that there is comparatively little doubt that they do. They do not display any special characters which will serve to distinguish them from either the early Cats or Dogs. The more salient features may be stated to be a moderately well-developed third trochanter on the femur, a very slight grooving of the astragalus, as well as a well-flattened distal end of the radius, all of which belong to certain members of the early Canidæ and Felidæ.

Uintacyon pugnax, sp. nov.

This smallest known species of the genus is represented in the collection by a single nearly complete lower jaw (No. 1744), bearing the second and third molars in good preservation, together with the roots of the remaining teeth. The jaw is remarkably short and heavy, especially in the region of the symphysis, the canine is not laterally flattened, and the premolars apparently unreduced. The crowns of the second and third molars display the usual cusps, but the trigons are more elevated than in any of the preceding species. The length of the molar and premolar series is 27 mm.

Uintacyon edax *Leidy.*[1]

The type of this species and that of the genus is represented by a moderately complete lower jaw preserved in the collection of the Philadelphia Academy. The chief characters of this species are seen in the comparatively shallow, elongated jaw, as well as its smaller size. As already stated, the type displays an extra premolar, which is undoubtedly abnormal, since it is placed with its long axis transverse to the long axis of the jaw. Length of molar and premolar series, including the extra premolar, 33 mm.; canine not laterally flattened and premolars unreduced.

Several fragments of jaws from the Big Horn probably represent this species, but the specimens are so imperfect that the reference is uncertain.

Prodaphænus scotti,[2] gen. et sp. nov.

We propose this genus upon a series of upper molars (No. 11,238) of the Princeton collection, together with a lower jaw (No.

[1] Proc. Acad. Nat. Sci. Phila. 1872, 277.

[2] This species is dedicated to Professor W. B. Scott, of Princeton, whose contributions to Palæontology are so well known.

2510) of the American Museum collection, both from the Uinta. The distinctions between it and *Daphænus* of the White River Oligocene are especially seen in the characters of the superior molars; in *Prodaphænus* the external cusps are flanked by a broad cingular ledge which anteriorly is developed into two distinct cusps. The unusual extension of this ledge serves to increase the transverse diameter of the tooth, especially upon its anterior border, and on this account it resembles the corresponding tooth of *Viverravus* more than that of the Dogs in general. Another important distinction is the small development of the postero-internal cusp, which in *Daphænus* is as large as it is in the modern Canidæ. In the specimen under consideration the tooth is broken in such a way as not to show this postero-internal ledge very distinctly, but there can be little doubt that it was present though small.

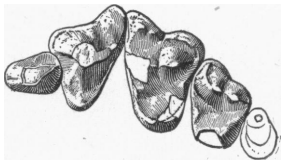

Fig. 1. *Prodaphænus scotti* W. & M. Upper teeth, crown view, natural size. Type specimen No. 11,238, Princeton Coll.

Its technical distinction from *Uintacyon* cannot at present be given on account of our lack of knowledge of the upper teeth of this later genus. That it is a direct descendant of *Uintacyon*, and the immediate forerunner of *Daphænus*, there can be little doubt. The most striking similarity to *Daphænus* is seen in the low rounded cusps of the molars, the absence or very small development of intermediates, the reduced size of the third superior premolar, as well as the molar formula above, which is 3.

Until it can be more clearly distinguished from *Uintacyon* the genus must be regarded as provisional only, but at the same time there is little probability that the genus *Uintacyon* continued into the Uinta without change.

II.—The Ancestry of the Dholes.

Cyon, Temnocyon, Daphænus, Prodaphænus, Uintacyon.

1. *Cyon and Temnocyon.*

The Dhole or Red Dog of India (*Cyon*) can be confidently considered as the living representative of the John Day genus *Temnocyon*, and through this genus is probably descended from a

line which we can trace back with tolerable accuracy into the lower Eocene.

This important connection has been entirely overlooked by previous writers, who have considered *Temnocyon* to be an abortive side-branch of the Canidæ.

The evidence is briefly as follows:

1. Heels of lower molars trenchant. This unusual character is shared by the recent *Icticyon* and the John Day genera *Oligobunis*, *Enhydrocyon* and *Hyænocyon*. All of these have dental formulæ excluding them from the ancestry of *Cyon*.

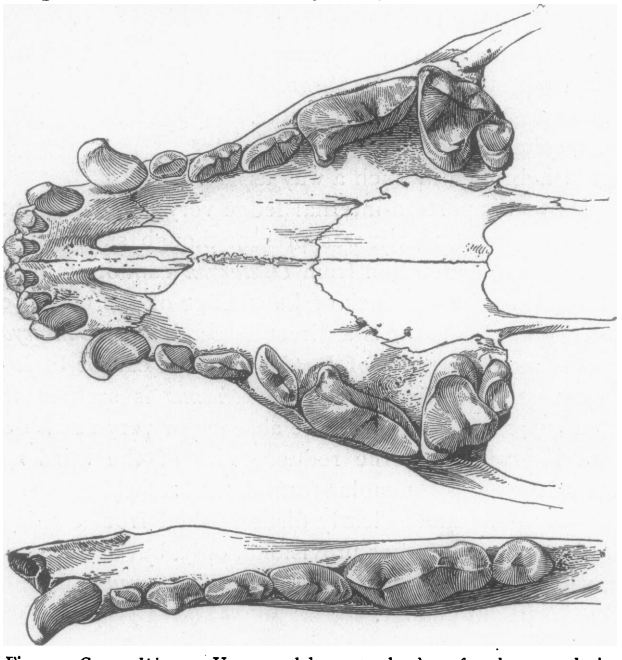

Fig. 2. *Cyon alpinus*. Upper and lower teeth, three fourths natural size. From a specimen in the American Museum collection.

2. Postero-internal cusp of superior molars reduced in *Temnocyon*, obsolete in *Cyon*, antero-internal cone reduced, separated from external cusps by an unusually deep valley, corresponding to the high trenchant heel of the lower molars.

3. Last lower molar reduced in *Temnocyon*, absent in *Cyon*. Last upper molar somewhat reduced in *Temnocyon*, considerably

so in *Cyon*. Premolars unusually large; m^2 unusually small, with internal cusp of the trigon reduced in *Temnocyon*, absent in *Cyon*. Jaw unusually deep under premolars.

The two are separated by the usual progressive characters seen in all modern Canidæ; the hallux is much reduced, mt. II falling from $\frac{1}{2}$ to $\frac{1}{5}$ the length of mt. III. The pollex suffers a similar reduction from $\frac{1}{2}$ to $\frac{1}{3}$ of mc. III. The foot is elongated and narrowed, the brain cavity increased, the skull shortened. Premolar 2 has acquired a posterior cusp in *Cyon*, lacking in *Temnocyon;* the internal cusp of the superior sectorial is more reduced in the modern species. In our skull of *Cyon alpinus* the incisors show a small basal lateral cusp. All these are acquired characters, most of them being developed in almost all species of

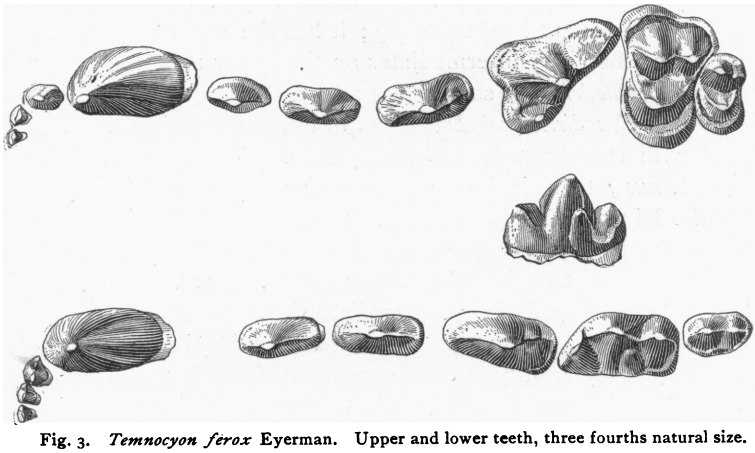

Fig. 3. *Temnocyon ferox* Eyerman. Upper and lower teeth, three fourths natural size. After Eyerman.

dogs. We find no acquired characters in *Temnocyon* that *Cyon* has not, nor any primitive characters in the latter that the former has not.

Cyon, with its congener *Icticyon*, retains more than any of the other dogs the primitive short legs and long body. The tail is much reduced in both genera.

2. *Related Genera.*

Related to the Dhole and *Temnocyon*, and distinguished like it by the trenchant heels to the molar cusps, are the modern *Icticyon*,

and the John Day genera *Enhydrocyon*, *Hyænocyon* and *Oligobunis*, all with a more reduced dental formula. They form the most carnivorous division of the family, approximating the Viverridæ or Felidæ, while *Nothocyon* and *Megalotis* stand at the other extreme, approximating the Procyonidæ.

3. *Daphænus and Temnocyon.*

The relationship between these two genera has been pointed out by Prof. Scott[1] and Dr. Eyerman.[2] All our evidence tends to confirm the view that *Temnocyon* is a descendant of *Daphænus*, although the gap between them is in some respects considerable. Both have the same strong, round-edged, massive cusps, but in *Daphænus* the molars are large and low, while in *Temnocyon* they are small and high-cusped. *Daphænus* is just beginning to develop a trenchant heel on $m \frac{1-2}{}$; it has the same deep jaw, and does not show any intermediates on the upper molars.

Hypotemnodon has a somewhat problematic position intermediate between *Cynodictis* and *Daphænus* in most of the skull characters but with trenchant heel on m_T only. Scott derives it from *Daphænus;* there is, however, a species of *Cynodictis* in the upper White River, which presents a closer approximation in character of teeth, and if our association of specimens is correct, has developed a low trenchant heel on m_T only. For this reason it is placed provisionally in the *Cynodictis* line.

Prof. Scott derives *Cynodesmus* also from *Daphænus*, basing the derivation apparently on the presence of frontal sinuses in both. Whether the presence of these in the larger species of Canidæ is of much phylogenetic value seems uncertain; on other grounds *Cynodesmus* might well be connected with *Cynodictis*.

4. *Prodaphænus and Daphænus.*

5. *Uintacyon and Prodaphænus.*

These have already been considered.

III.—The Eocene Ancestors of Cynodictis.

Vulpavus palustris[3] *Marsh.*

With this species we come to consider the phylum which in all probability terminated in the modern genus *Canis*. Its oldest

[1] Notes on the Canidæ of the White River Oligocene. Trans. Am. Phil. Soc. 1898.
[2] Amer. Geol. 1896.
[3] Amer. Jour. Sci. Aug. 1871, (p. 16 of separate).

known representative comes from the Wind River beds, and is known from only an imperfect fragment of a lower jaw in the Museum collection. In the Bridger the genus is represented by at least two species, one of which, *V. palustris*, was described by Marsh from a single superior molar and forms the basis of the genus; and the other, *V. parvivorus*, was described from a fragment of a lower jaw by Cope and made the type of his genus *Miacis*. In the Museum collection is a specimen which upon careful comparison with Marsh's type of *V. palustris* we identify with this species; it consists of two superior molars of the right side, two nearly complete mandibular rami, together with some fragments of the skeleton of the limbs (No. 2305). It was found by Mr. O. A. Peterson of the Museum party of 1895, and was obtained from the middle horizon near the extreme southern limits of the Washakie Basin.

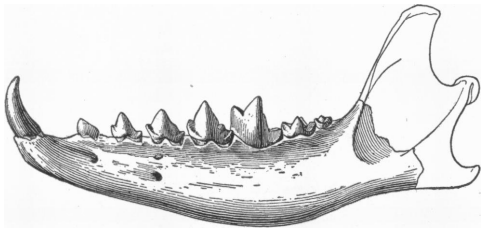

Fig. 4. *Vulpavus palustris* Marsh. Lower jaw, natural size. No. 2305.

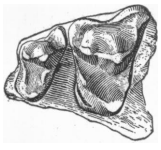

Fig. 5. *Vulpavus palustris* Marsh. Upper teeth, twice natural size. No. 2305.

The superior molars are two in number and display about the same proportions as those of many of the existing Canidæ. They present a number of features, however, very different from the modern Dogs. The first molar is remarkable for the great elongation of its anterior side in comparison with the posterior, and the drawing out of the antero-external angle, as well as the unusually broad ledge intervening between the base of the external cusps and the outer border of the crown. Another marked feature of this tooth is the great disparity in size between the anterior external and the posterior external cusps. The antero-internal cusp is large and lunate and there is a distinct anterior and posterior intermediate. The postero-internal cusp is represented by a strong cingulum in the usual position but it does not rise up into a distinct cusp as in the later Canidæ. The second molar is similar

except that there is no representative of the postero-internal cusp. The general appearance of these teeth is more like that of many Creodonts than that of the modern Carnivora.

The lower jaw is very dog-like in its general proportions; the symphysial region is slender and the ramus is elongated. The teeth resemble those of the early Dogs, especially *Cynodictis;* the canine is long and pointed, being separated from the anterior premolar by a short diastema. The premolars have the usual form in the Canidæ, with compressed pointed crowns and basal cingula; the fourth has a distinct posterior accessory cusp. The sectorial closely resembles that of *Cynodictis.* The anterior and external cusps of the trigon form an effective shearing blade; the internal cusp is large and the heel basin-shaped. The second molar is similar in structure but its cusps are lower and there is no distinctive blade-like shear produced by a union of any of the cusps of the trigon. The last molar is much reduced, as in the later Canidæ.

Some fragments of the limb bones are preserved and they indicate, as do the teeth, a clear affinity with the early Dogs. The distal end of the radius is present, but the facet is cup-shaped

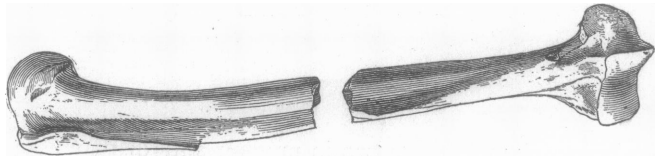

Fig 6. *Vulpavus palustris* Marsh. Humerus, natural size. No. 2305.

and exhibits no distinct ridge separating scaphoid and lunar facets. This is not, however, conclusive proof that the scaphoid and lunar were not separate, since in *Viverravus*, *Oxyæna*, and other Creodonts in which these bones are distinct, the distal end of the radius gives little or no indication of the facet.

Vulpavus parvivorus[1] (*Cope*).

This second species is represented in the collection by a fragment of a lower jaw from the Bridger of Wyoming, and has been figured by Cope as the type of his genus *Miacis.* The fragment

[1] Proc. Amer. Philos. Soc. Aug. 1872, 470.

carries the second molar in an excellent state of preservation, and exhibits the alveolus for the last molar and a portion of that of the first. The species can be readily distinguished from *V. palustris* by its smaller size and the less laterally compressed character of the second molar.

Procynodictis vulpiceps, gen. et. sp. nov.

This genus is proposed upon two specimens in the Museum collection, one of which (No. 2514) includes one upper and both lower jaws, together with the greater part of a hind foot, and the other (No. 2506) includes a part of the skull and the greater portion of the right fore foot. Besides these there are two fragments of jaws (Nos. 1895 and 1995) which we refer to the same species.

The dental formula is the same as in *Vulpavus* and *Cynodictis*, there being but two true molars above, and the systematic position of the genus is entirely intermediate between these two. In the structure of the superior molars it agrees with *Vulpavus* in that there is a great extension of the antero-external part of the

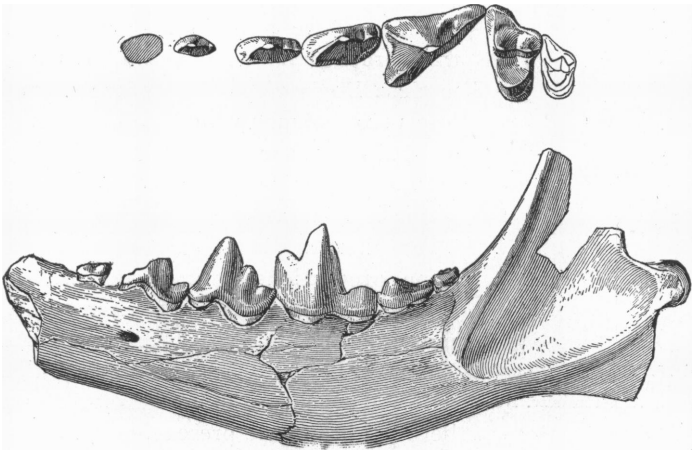

Fig. 7. *Procynodictis vulpiceps* W. & M. Upper and lower teeth, three halves natural size. Type specimen No. 2514.

tooth and a comparatively small development of the postero-internal cusp. In *Cynodictis* this cusp is as well developed relatively as in the modern Dogs, but the great antero-external extension is

lacking. The only important character in which it differs from *Vulpavus* is seen in the nearly equal size of the two external cusps of the first superior molar, whereas in *Vulpavus* the anterior greatly exceeds the posterior in size. This at first sight would seem to be of little significance, but the primitive condition was undoubtedly the one displayed by *Vulpavus*, and the more advanced one that of *Procynodictis* and *Cynodictis*. It therefore represents a distinct advance. The other teeth are very similar in their structure to those of *Vulpavus* and need no special mention.

The hind foot contains five toes; the metapodials are shorter and somewhat heavier than in *Cynodictis*, in which the hind foot had already begun to assume the elongated form so characteristic of the modern Canidæ. The tarsal bones are very like those of *Cynodictis*, as are also the remainder of the podial elements. The claws are much compressed laterally, with heavy subungual processes, and the middle phalanges are unsymmetrical, indicating some degree of retractility of the claw.

The fore foot also contains five toes, but, as in *Cynodictis*, it is much shorter than in any of the modern Canidæ. The scaphoid, lunar, and centrale are completely co-ossified as in the modern Dogs, without any trace of suture, into a scapholunar, which differs from that of *Cynodictis*, according to Scott's figure, in the greater vertical depth anteriorly, which is again a more primitive condition. The other carpals have practically the same proportions as in *Cynodictis*. The fore foot of *Vulpavus* is unknown, but it is more than probable that the scaphoid and lunar were separate in that genus, which if true will constitute an important difference between it and the present genus.

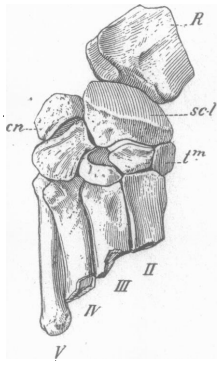

Fig. 8. *Procynodictis vulpiceps* W. & M. Fore foot, three halves natural size. No. 2506.

IV.—Notes on a Skeleton of Cynodictis gregarius.

In the American Museum Collection, Expedition of 1898, is a nearly complete and very well-preserved skeleton of *Cynodictis*

gregarius (No. 8774). Prof. Scott has already fully described nearly all parts of this species, but we are able to fill out the description in one or two points for which his material was incomplete, and to give a series of measurements, which, being taken all from one individual, give the relative proportions with greater accuracy. Some of the individuals which Prof. Scott includes under *C. gregarius* may be referable to *C. lippincottianus.*

Hind Foot.—The *tarsus* has already been described in full by Prof. Scott. There are five *metatarsals*, the first slender, its length two thirds that of mt. III, diameter of the shaft half as great. Head rather small, shaft nearly straight, slender, rather compressed. Second, third, fourth, and fifth metatarsals symmetrical, the central pair a little longer and about one fourth greater in diameter of shaft. The distal articular ends are spheroidal, not at all of the square-cut style seen in all modern Dogs. The upper part of the shaft is somewhat compressed, the distal part not at all, and the distal ends are much more enlarged than in *Canis*, the diameter being one third more than that of the shaft, which in *Canis* increases in diameter at the distal end and is not over one tenth of the shaft diameter. The foot was therefore more spreading, as well as 15 per cent. shorter. The bones are as slender, however, as in a modern Dog. The phalanges are long and slender, quite as long as in modern Dogs. The second phalanx of each toe is asymmetrical and excavated, as in *Daphænus*, indicating, according to Scott, some retractility of the claws. No strong basal sheath appears to have been on the unguals, which are much as in *Canis.*

As the measurements indicate, the hind limb bones were much nearer to their present proportions, while the fore limbs were still quite short. The difference in the feet is yet more marked, for while the fore foot was scarcely more elongated than the Creodont ancestors, the hind foot was already long and slender, though not as narrow nor quite as long as in modern species. In both feet, however, the tetradactyl symmetry is already distinct, and both pollex and hallux are reduced.

The measurements of the skeleton, No. 8774, as far as at present obtainable, are given in comparison with those of the Fennec, the nearest living Canid in point of size.

Measurements of CYNODICTIS GREGARIUS (*Cope*), *in Comparison with* CANIS ZERDA.

	Cy. gregarius.	*Ca. zerda.*[1]
Skull, length, premaxillæ to condyles...	est. 76 mm.	81 mm.
" length of palate (dentition)	" 42	45
" breadth "	" 27	24
" " brain case	29	35
Vertebræ, all pre-caudals.....		291
" cervicals.....		72
" dorsals.....		113
" lumbars.....	105	90
" sacrals.....	23	16
" caudals.....		350
Fore limb, total length.....	180	230
" humerus.....	71	80
" radius.....	56	79
" foot.....	53	71
" carpus.....	6	est. 12
" metacarpus.....	22	28
" phalanges.....	est. 25	est. 25
Hind limb, total length.....	241	272
" femur.....	80	81
" tibia.....	81	98
" foot (astragalus to ungues)...	80	93
" tarsus.....	19	est. 22
" metatarsus	34	" 43
" phalanges.....	27	" 27

Taking the above measurements in order, we see that the skull of *Cynodictis* is shorter and with smaller brain-cavity. The neck and back vertebræ are nearly of the same size as in the Fennec, but cannot be measured at present. The lumbars and sacrum are considerably larger, and the tail was probably as long (no other living Dog has a tail of this length). The fore limb is one fourth shorter, while the hind limb is only one ninth shorter. The greater part of the elongation has been in the lower limb and foot bones. The phalanges have not lengthened at all, there being no tendency to become unguligrade.

V.—THE ANCESTRY OF CERTAIN SOUTH AMERICAN FOXES.

Nothocyon, gen. nov.

A genus or subgenus of Dogs distinguished by:

(1) Short muzzle; (2) upper carnassial very small, trigon of lower carnassial reduced, shear partly transverse; (3) molars

[1] Measurements taken from Mivart's Monograph of the Canidæ.

large, not extended transversely, subquadrate ; (4) lower carnassial broad-heeled, and with an accessory cusp at the postero-external corner of the trigon ; (5) canines slender ; (6) otic bullæ large.

Canis urostictus Mivart, and *C. parvidens* Mivart, both from South America, belong to this genus, to which we also refer provisionally the three John Day species, *latidens* Cope, *lemur* Cope, and *geismarianus* Cope. These latter seem to be directly ancestral forms, and, like all the earlier Dogs, have shorter feet, longer lumbar region, and smaller brain-case than the modern species.

The distinctions above noted may seem hardly to be of generic value ; they are, however, tolerably constant, *Urocyon cinereoargenteus* being the only intermediate type. And if the group was first separated in the Oligocene, as seems probable, it gives it an ancestry that deserves full generic recognition. The alternative to uniting the John Day and modern species is to place the one as a subgenus of *Cynodictis*, the other of *Canis ;* the present method seems, however, to recognize more clearly the actual genetic affinities ; for if the living *Canis parvidens* and *urostictus* are lineally descended from the John Day *Cynodictis latidens lemur*, and *geismarianus*, the two modern species are more nearly related to the three Miocene species than to any living Canidæ. The best way to express this fact is to remove the Miocene species from *Cynodictis*, to the typical forms of which they are not more nearly related than the half-dozen or more distinct genera of the Phosphorites of France, and to unite them with two modern species, disregarding the considerable modernization of the latter, which retain, however, an unusual amount of the Tertiary facies.

Nothocyon urostictus (*Mivart*).

Canis urostictus MIVART, Proc. Zoöl. Soc. Lond. 1890, 112 ; Monograph of the Canidæ, 81.

The type and only specimen hitherto known is in the British Museum. No. 391, Dept. Osteol., Amer. Mus. Nat. Hist., we refer to this species and figure here. In size it is not very different from *Canis azaræ*, but the size and characters of the molars and carnassial easily distinguish it. The lyrate area on top of the skull is shared by many species of Dogs. Limbs and feet about as in modern species of *Canis ;* the lumbars appear to

be larger in proportion. Locality, Chapada, Matto Grosso, Brazil.

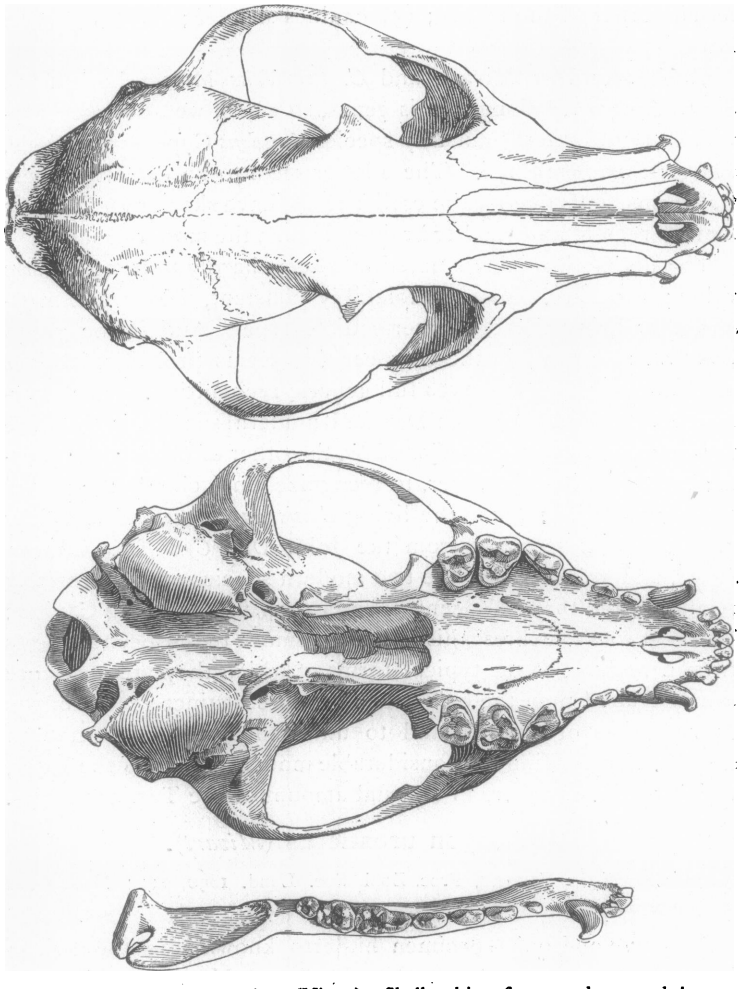

Fig. 9. *Nothocyon urostictus* (Mivart). Skull and jaw, five sevenths natural size. No. 391.

Nothocyon parvidens (*Mivart*).

Canis parvidens MIVART, loc. cit.

The only specimens hitherto known are three in the British Museum. We are enabled to add another skeleton, No. 349,

Dept. Ost., Am. Mus. Nat. Hist., on the somewhat uncertain dental distinction separating it from *N. urostictus.* P^4 is shorter, canines not so slender, m_3 more reduced, m^1 and m^2 seem to be variable in shape. No. 2091 also belongs to this or the preceding species. Locality, Chapada, Matto Grosso, Brazil.

As another division (Primævi) of the same genus, distinguished by relatively small brain, short feet, and long lumbar region, we place the three John Day species.

Nothocyon latidens (*Cope*).

Galecynus latidens COPE, Bull. U. S. Geol. Surv. VI, 1881, 181.
Cynodictis latidens SCOTT, Trans. Amer. Phil. Soc. 1898, 400.

Distinguished by exceptionally broad upper molars. Bullæ very large.

Nothocyon lemur (*Cope*)

Galecynus lemur COPE, Bull. U. S. Geol. Surv. VI, 1881, 181.
Cynodictis lemur SCOTT, Trans. Amer. Phil. Soc. 1898, 400.

Molars narrower, cusps marginal, double entoconid on m_1, postero-external accessory cusp on m_3 doubtful. Bullæ very large.

Nothocyon geismarianus (*Cope*).

Canis geismarianus COPE, Pal. Bull. No. 30, 1879, 9.
Cynodictis geismarianus SCOTT, loc. cit.

Larger species, deuterocone of p^4 more reduced than in the others. Bullæ of more moderate size.

The skeleton of this species is fortunately known and has been described by Cope. It stands intermediate between that of *Cynodictis gregarius* and that of *Nothocyon urostictus.* The following comparisons show the advance in the especially progressive characters of (1) length of feet, (2) length of lumbar region, (3) size of brain.

Cynodictis gregarius, width of carpus, 15 mm.; length of mc. III, 22 mm.; proportion, 1 : 1.5.
Nothocyon geismarianus, width of carpus, 16.5 mm.; length of met. III, 33 mm.; proportion, 1 : 2.
Nothocyon urostictus, width of carpus, 18 mm.; length of mc. III, 48 mm.; proportion, 1 : 2.7.

In the same species we have :

Cynodictis gregarius, length of skull, 76 mm.; width of brain-case, 29, height, 22, length, 43 mm.; proportion of length of skull to width of brain-case, 1 : 0.37; length of seven lumbars, 104; proportion of length of skull to that of lumbar vertebræ, 1 : 1.37.

Nothocyon geismarianus, length of skull, 111 mm.; width of brain-case, 40, height, 33, length, 52 mm.; proportion of length of skull to width of brain-case, 1 : 0.37; length of seven lumbars, 155; proportion of length of skull to that of lumbar vertebræ, 1 : 1.39.

Nothocyon urostictus, length of skull, 112 mm.; width of brain-case, 45, height, 35, length, 52 mm.; proportion of length of skull to width of brain-case, 1 : 0.41; length of seven lumbars, 129; proportion of length of skull to that of lumbar vertebræ, 1 : 1.15.

From the above proportions it appears that the John Day species exhibits an important advance on the White River *Cynodictis* in the increase in length of feet and decrease in their width. The increase in the size and robustness of the species marks the advance in brain capacity, and the lumbar region has not suffered any proportionate reduction. In the modern species there is a further increase in length of feet, the brain increases in capacity, and the lumbar region is greatly reduced. The length of the femur and humerus does not increase in proportion; that of the tibia increases slightly and of the radius considerably.

	C. gregarius.	*N. geismarianus.*	*N. urostictus.*	Proportions, length of skull as unity.
Length humerus..	71	98	106	.93 : .90 : .94
" radius....	55	?	105	.72 : ? : .94
" femur....	79	110	116	1.03 : 1.00 : 1.04
" tibia.....	80	116	120	1.04 : 1.04 : 1.07

The above measurements are from the complete skeletons of *C. gregarius* (No. 8774), *N. geismarianus* (No. 6886), *N. urostictus* (No. 391, Dept. Ost.).

The longer-legged specimens referred by Prof. Scott to *C. gregarius* may be referable to *C. lippincottianus*. These have the limbs, especially the tibia and fibula, much longer than in *C. gregarius* proper, but the feet apparently of the same size.

VI.—Analysis of the Miocene Genera of Canidæ.

It is doubtful whether some of these genera should rank as such, the distinctions being probably of only subgeneric value. They certainly represent well-defined groups, and it would be difficult to invalidate one without invalidating nearly all. The mere *number* of the teeth cannot be considered as a more im-

portant character than their form, and unless certain characters are arbitrarily selected as generic, the representation of natural groups is the only valid foundation for generic distinctness. As a mere matter of convenience, the groups are here used as genera, with the proviso that they are not all of generic value. *Phlaocyon* stands widely apart from the rest, as does also *Oligobunis;* but whether two, three, or several genera are made out of the remaining species is a matter of arbitrary selection rather than natural grouping.

I. Procyonidæ.

Skull short and wide, orbits well forward; carnassial teeth imperfectly or not sectorial; a hypocone on p^4. Pentadactyl, plantigrade. Dentition typically $\frac{3-1-4-2}{3-1-4-2}$.

A. Third lower molar absent, second elongated. Modern genera *Bassariscus, Procyon, Bassaricyon, Nasua, Cercoleptes.*

B. Third lower molar present, second not elongated.

Phlaocyon. Dentition $\frac{3-1-4-2}{3-1-4-3}$.

II. Canidæ.

Becoming tetradactyl, digitigrade. Skull long, orbits not advanced, teeth sectorial and tubercular.

A. Short-footed, pentadactyl, with shear of sectorial partly transverse, small brain and other primitive characters.

1. Dental formula $\frac{3-1-4-3}{3-1-4-3}$.

a. Daphænus Leidy. Upper molars transversely unsymmetrical (paracone more external than metacone). M^2 oval, aligned with inner cusps of anterior molars. Heels of lower molars low-ridged, with low entoconid crest, $m_{\overline{3}}$ a convex nub.

D. vetus Leidy. Amer. Mus., Nos. 1388, 1390.

D. hartshornianus (Cope). Amer. Mus., Nos. 6811, 1387.

D. felina Scott.

D. dodgei Scott.

The first three species are from the Oreodon beds, the last from the Titanotherium beds.

b. Paradaphænus, gen. nov. Upper molars much extended and symmetrical transversely; m^2 aligned with outer cusps of anterior molars. Heels of lower molars wide and deep, basin-shaped; $m_{\overline{2}}$ and $m_{\overline{3}}$ with two anterior cusps and basin-heel.

P. cuspigerus (Cope). Nos. 6852 (type), and probably 6853 (type of *Amphicyon entoptychi* Cope).

P. transversus, n. sp.

Size one third larger (lineal). Upper premolars compressed.
Type No. 6851 (referred to *Amphicyon hartshornianus* by Cope).
Both species are from the John Day.

2. Dental formula $\frac{3-1-4-2}{3-1-4-3}$.

a. Temnocyon Cope. Heels of lower molars trenchant, without internal ridge. Trigon of $m_{\overline{1}}$ trenchant, without internal cusp.

T. altigenis Cope. Nos. 6855 (type), 6856.

T. wallovianus Cope. No. 6858 (type).

T. ferox Eyerman. No. 6857.

b. Hypotemnodon Eyerman. Heels of lower molars trenchant, internal ridge vestigial or wanting. Trigon of $m_{\overline{1}}$ with prd and med of equal size.

H. coryphæus (Cope). Nos. 6859 (type), 6860, 6862, 6922, and doubtfully Nos. 6861, 6920, 6909, etc.

H. josephi (Cope). Nos. 6878 (type), 6863, 6908, 6921.

All from the John Day.

c. Cynodictis Brav. and Pom. Heels of lower molars basin-shaped. Upper molars extended transversely. The American species are:

C. gregarius (Cope). Nos. 5297 (type), 5298, 5299 (fig. sp.), 1004, 1383, 1472, 8774, 5300. No. 6879 is probably a distinct species but does not present any well-marked specific characters.

C. lippincottianus (Cope). Nos. 5327 (type), 8757–63, 1384, 1389, etc. Teeth one fifth greater in lineal dimensions, somewhat more robust. Sectorial proportionately larger, shear less transverse.

? C. temnodon, n. sp. Size of *Hypotemnodon josephi*; lower premolars smaller than in that species and trigon wider; p^4 (in associated upper jaws) with internal cusp almost obsolete, shear rather more longitudinal than in *Cynodictis lippincottianus*, m_1 well extended transversely.

C. gregarius and *C. lippincottianus* come from the Oreodon beds (except the one skull No. 6879, of doubtful reference, which comes from the John Day). *C. temnodon* is from the Protoceras beds.

d. Nothocyon (section Primævi). Upper molars short transversely; p^4 small; lower molars with wide basin heels, trigon of m_1 reduced, and a small accessory cusp at its postero-external corner.

N. latidens (Cope). Nos. 6896 (type), 6897–99.

N. lemur (Cope). Nos. 6888 (type), 6889–94.

All from the John Day.

3. *Premolars* reduced.

a. Enhydrocyon Cope. Dentition $\frac{3-1-3-2}{}$.

E. stenocephalus Cope. Nos. 6901 (type), 6902.

John Day.

b. Hyænocyon Cope. Dentition $\frac{3-1-3-1}{3-1-3?-1}$.

H. basilatus (Cope). No. 6904 (type).

H. sectorius (Cope). No. 6905 (type).

John Day.

4. Molars reduced.

Oligobunis Cope. Dentition $\frac{3-1-4-1}{3-1-4-2}$.

O. crassivultus (Cope). No. 6903 (type). John Day.

B. Modernized species. Long-footed, tetradactyl (functionally), with shear of sectorials nearly longitudinal, large brains and other advanced characters.

1. Dental formula $\frac{3-1-4-3}{3-1-4-4}$. *Otocyon.*

2. Dental formula $\frac{3-1-4-2}{3-1-4-3}$. *Canis*, *Nothocyon*, *Lycaon*, *Urocyon.*

3. Dental formula $\frac{3-1-4-2}{3-1-4-2}$. *Cyon.*

4. Dental formula $\frac{3-1-4-1}{3-1-4-2}$. *Icticyon.*

VII.—An Ancestral Raccoon.

Phlaocyon leucosteus *Matthew*[1]

Founded on an exceptionally perfect skull and jaws, with a nearly complete skeleton, discovered last summer by Mr. Handel T. Martin of the American Museum Expedition of 1898 in north-eastern Colorado. The level is the uppermost beds of the White River formation, associated with *Merycochœrus*, *Anchippus*, *Leptauchenia*, *Hyracodon*, etc. The specimen was found in the rock mixed with skulls and skeletons of two adult and three young *Merycochœri*, all within a space of six feet square.

It represents a new and aberrant genus of Dogs, the characters pointing clearly in the direction of the Raccoons, so that if we adopt the genealogical conception of a family it must be placed in the Procyonidæ, although it is nearer to such primitive Dogs as *Cynodictis* than to the modern Raccoons.

Dentition.—(1) There is a small but clearly marked postero-internal cusp on the upper sectorial, which, however, (2) retains the triangular shape characteristic of the early Canidæ. (3) The dentition is that of *Cynodictis* and *Canis*, (4) but the cusps are low and rounded. (5) Premolars small, stout, and crowded; (6) upper molars short transversely and subquadrate, as in *Cynodon*, (7) the lower molars broad and low. (8) Canines short, the upper ones not dagger-shaped, but curved as in the Dogs. (9) Incisors in an even, transverse row. *Jaw* (10) short and thick, deep in

[1] Bull. Am. Mus. Nat. Hist. 1899, 54.

front, (11) condyles very wide, (12) coronoid process short and wide with deep fossa. *Skull* (13) short and wide, (14) orbits placed as far forward as in *Procyon*, (15) jugal process of squamosal not reaching as far forward as postorbital process of malar. (16) Shape and proportions of skull and jaws resemble those of *Procyon lotor*, except that (17) the brain-case is much smaller proportionately. (18) An alisphenoid canal as in *Cynodictis*. (19) A median and two lateral foramina in palate between canines. (20) Palate not extended posteriorly. (21) Base of skull much less broadened than in *Procyon*, (22) paroccipital process not developed.

Of the above Nos. 1, 4, 5, 9, 10, 11, 12, 13, 14, 15, 16, and 19 are progressive characters in the direction of the Raccoons. Nos. 2, 3, 6, 7, 8, 17, 18, 20, 21, 22, are primitive characters, shared by all early Canidæ.

Skeleton.—The hyoid bones were found perfectly preserved, but offer few characters for distinction.

The atlas is like that of *Cynodictis ;* the posterior opening of the vertebral canal presents a little upward instead of directly upward as in recent Canidæ, or directly backward as in *Procyon*, where the opening is bounded by a strong ridge passing outward from the axial cotylus.

Concerning the other vertebræ no exact account can be given at present, as they are not yet removed from the matrix ; they resemble in most respects those of *Cynodictis*. The ribs are somewhat larger ; the dorso-lumbar formula is not yet known.

Fore Limb.—The *humerus* is of the same length as in *Procyon lotor*, but more slender throughout. The greater tuberosity is higher and the deltoid crest is more marked and extends farther down. The *radius and ulna* are 15 per cent. less in length and of about the same diameter in the shaft. Shafts of both trihedral or irregular in cross-section, instead of regularly oval as in modern Raccoons. *Carpus* with co-ossified scapholunar, thin cuneiform, large unciform, rather small magnum, rather large trapezoid, and small trapezium. Five metacarpals, of which mc. I is only half the length or diameter of III ; mc. V is three fourths as long, but of considerably greater diameter than mc. III ; mc. II and IV equal in diameter to, but a little shorter than, mc. III.

Hind Limb.—The *femur* is of nearly the same length as that of *P. lotor*, and one fifth slenderer. The shape resembles *Cynodic-*

tis; the greater trochanter is much less prominent than in *Procyon*, the lesser trochanter more prominent, the neck longer and more slender. The distal end of the femur is only three fourths as wide as in *Procyon;* condyles projecting more than in that animal, less than in *Canis* and *Cynodictis*.

The *tibia* is one sixth shorter than that of *P. lotor*, somewhat more slender in proportion, stouter than that of *C. gregarius* and of the same length. Its distal trochlea is narrower antero-posteriorly, deeper and more oblique than in *Procyon;* the fibular facet also is twisted around so as to face postero-externally instead of externally as in *Procyon*. The *fibula* is somewhat less reduced, its shaft being as stout as in the Raccoon, the ends somewhat smaller.

The hind foot, though uniformly smaller, is proportioned like that of the Raccoon, with the following differences worth noting. The *astragalar trochlea* is narrower, sharper, less entended backward. The internal hook of the *navicular* is smaller. The *cuboid* is wider and has a small facet for the astragalus. The *entocuneiform* is not nearly so high. The first *metatarsal* is only two thirds as long, though somewhat stouter in proportion; and the fifth is as long as the second, and nearly as large in the shaft; in the Raccoon it is intermediate between mt. I and mt. II in length. The hind feet of *Phlaocyon* have thus a tetradactyl symmetry, while in *Procyon* they are intermediate between tetra- and pentadactyl symmetry. The second row of *phalanges* shows a distinction of some importance, the superior external surface of the shaft being excavated, especially toward the distal end, a character which Scott has observed in *Daphænus* and considers a probable indication of slight retractility of the claws. It is also present in *Cynodictis* and in some Creodonts, and is probably a primitive character. In the Raccoon this excavation of the second phalanx has entirely disappeared.

The *ungual* phalanges are a little larger and less compressed than those of *Procyon lotor*.

Affinities of Phlaocyon.

Plate VI.

Phlaocyon, in both skull and skeleton characters, seems to point towards *Procyon*, standing intermediate between that genus

and *Cynodictis* in almost every character. The entirely intermediate character of the skull and teeth is well shown in our drawings: especial attention should be drawn to the postero-internal cusp on p^4; short jaws with deep muzzle and round blunt premolars; broad low sectorials, with additional postero-external cusp on trigon of m_1; reduced m_3; lower incisors in a straight row. Eyes set far forward, skull short, arches wide. On the other hand the resemblance to *Cynodictis* is closer in the form and cusp-arrangement of the teeth; palate terminating opposite m^2, alisphenoid canal; occiput not so much expanded; retention of m_3; m_2 not lengthened out.

In the skeleton the same story appears. The limb bones are like those of *Cynodictis* with varying amounts of change to *Procyon*. Only in the hind foot is there any difficulty. Here the first toe is more reduced in *Phlaocyon* than in *Procyon*, which makes it seem probable that *P. leucosteus* is slightly off the line from *Procyon lotor*.

The resemblance to *Bassariscus* is even closer. But *Bassariscus* cannot be considered as the living representative of *Phlaocyon*. It shows less departure from *Cynodictis* in many characters, especially in the shape of the upper molars and lower sectorial and slender jaw; the postero-internal cusp of the upper sectorial is not developed in one species, and although it is present in the other, the tooth retains much more of its trenchant function. The loss of m_3 is an advance on *Phlaocyon;* on the other hand, the eyes are not set so far forward, nor is the muzzle so much shortened or the arches so wide. The brain is very much larger in proportion, as might be expected, but the feet are precise copies of those of *Cynodictis*.

With *Nasua* the comparison is not so close as with *Procyon*. The long skull, large dagger-shaped canines, comparatively narrow, square occiput, reduced and peculiarly shaped bullæ, carry it out of the probable line of evolution pursued by *Phlaocyon*. The limbs and feet are somewhat nearer to *Phlaocyon* in some characters; the feet have the internal toe unreduced.

Cercoleptes is much more aberrant in the skull and teeth and *Ælurus* has a different pattern of teeth. Altogether *Procyon* seems to come nearest to fulfilling the conditions required of a descendant of *Phlaocyon*.

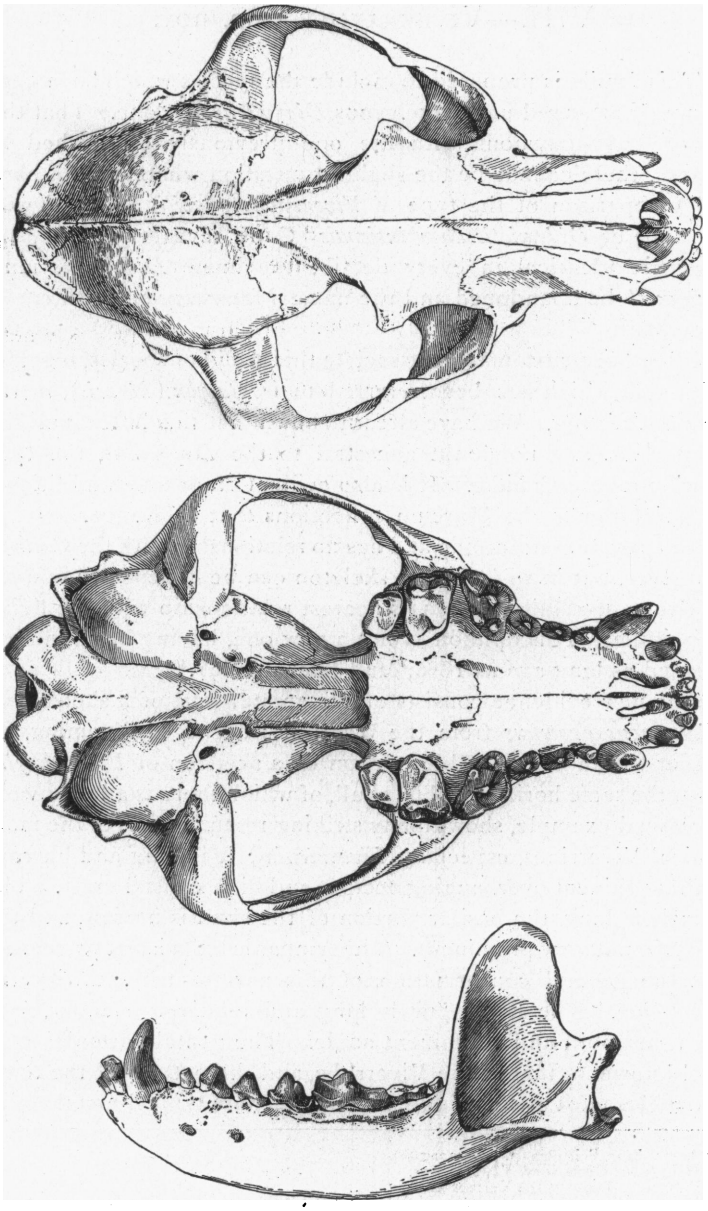

Fig. 10. *Phlaocyon leucosteus* Matthew. Skull and jaw, natural size. Type specimen No. 8768.

VIII.—VIVERRAVIDÆ, fam. nov.

This family is proposed to include the species which have been formerly arranged under the genus *Didymictis* of Cope. That this genus is synonymous with the one previously established by Marsh, there cannot be the slightest question whatever. A careful comparison of the type of *Viverravus gracilis* Marsh,[1] with the type of *Didymictis dawkinsianus*[2] Cope, reveals the fact that they are identical in every detail; the name *Didymictis* must therefore be abandoned and the name *Viverravus* substituted for the genus.

It has been customary to associate this group of species, together with that which has been referred to *Uintacyon* (*Miacis*), in the family *Miacidæ*. We have already shown that this latter is clearly related to, and no doubt ancestral to the *Daphænus*, the *Cyon* section of the Canidæ. It is also evident from much additional material now in the Museum collections that *Viverravus* belongs to an entirely distinct line and has no relationship with the Canidæ whatever, but in so far as the skeleton can be depended upon for evidence of affinity it finds its nearest relationship with the living Viverridæ. This opinion is not a new one, having been first expressed as long ago as 1886,[3] and later in 1891.[4]

The new evidence consists of the greater part of a skeleton of *Viverravus protenus* from the Wasatch Eocene of Wyoming, together with a considerable portion of a skeleton of *V. leptomylus* from the same horizon. The skull, of which there is a fairly well-preserved example, shows many striking resemblances to the more typical Viverrines, especially *Viverricula*; it is long and narrow, with prominent overhanging occiput and high sagittal crest. The muzzle is long, the basilar portion of the skull is narrow, and the mastoid not very prominent. The tympanic bulla is not preserved, but the general conformation of this part of the skull is very Civet-like. The lower jaw is long and relatively slender, with high coronoid and prominent angle. The dental formula, as is well known, is that of the Viverridæ, and the pattern of the teeth resembles most astonishingly that of the more typical members of

[1] Amer. Jour. Sci. 1872 (p. 7 of separate).
[2] Bull. U. S. Geol. Surv. VI, 1881, 191.
[3] Wortman, Teeth of the Vertebrata, 457.
[4] Flower and Lydekker, Mammals Living and Extinct, 539.

this family. This is especially seen in the superior sectorial, in which there is a deep vertical notch separating the two halves of the blade, and a prominent anterior basal cusp, which is invariably present in the carnivorous Civets. The superior molars, moreover, have the same characteristic pattern, and the lower teeth, with the exception of some unimportant details, are very viverrine. The atlas has the same arrangements of the perforations for the vertebral artery as is found in the Civets, differing in this respect from the other known families of the Carnivora. The remaining vertebræ agree with those of the Viverridæ, and the lower end of the radius has the same characteristic triangular form in cross-section as in *Viverricula*. The feet and limbs are also very like those of the Viverrines, with the exception that the scaphoid and lunar bones of the carpus are free and not united as in the modern family.

Altogether we think it may be stated with considerable certainty that the group represents the forerunners of the Viverrine phylum whose members towards the close of the Eocene migrated to Asia. This view receives strong additional support from the fact that the typical genus *Viverra* runs backward without change into the Upper Eocene of Europe, showing a remarkable degree of persistence of structure, which also characterizes the genus *Viverravus*, passing as it does with only slight specific modifications from the Torrejon beds of New Mexico through to the Bridger.

The technical definition of the group rests upon the exclusive development of the fourth superior premolar and the first inferior molar into enlarged typical sectorials, thereby distinguishing it from all the other known Creodonts except the early members of the Canidæ. From this latter family it is distinguished by having only two molars in the lower jaw and an anterior basal cusp upon the superior sectorial. From the Viverridæ it is separated by the free condition of the scaphoid, lunar, and probably the centrale as well.

The species are numerous and range in time from the Torrejon to the Bridger.

Summary.

The principal points brought out in the foregoing paper may be briefly summarized as follows:

(1) The tracing of the *Daphænus* ancestry back into the Wasatch Eocene by way of *Prodaphænus* and *Uintacyon*, which latter has always been considered a Creodont.

(2) The establishment of the relationship of *Daphænus* to *Temnocyon*, and that of *Temnocyon* to the living genus *Cyon*.

(3) Tracing the ancestry of the *Canis-Cynodictis* line back into the Eocene through *Procynodictis* and *Vulpavus*.

(4) Some additional points in the structure of *Cynodictis*.

(5) The descent of certain South American Foxes from North American Miocene species, with the establishment of a new genus, *Nothocyon*, for their reception.

(6) Classification of the Miocene genera of the Canidæ.

(7) The discovery of the origin of the Procyonidæ from the Canidæ through the new genus *Phlaocyon*.

(8) The discovery of the genus *Viverravus* and the establishment of a new family.

PHYLOGENETIC TABLE OF THE AMERICAN TERTIARY CANIDÆ AND PROCYONIDÆ