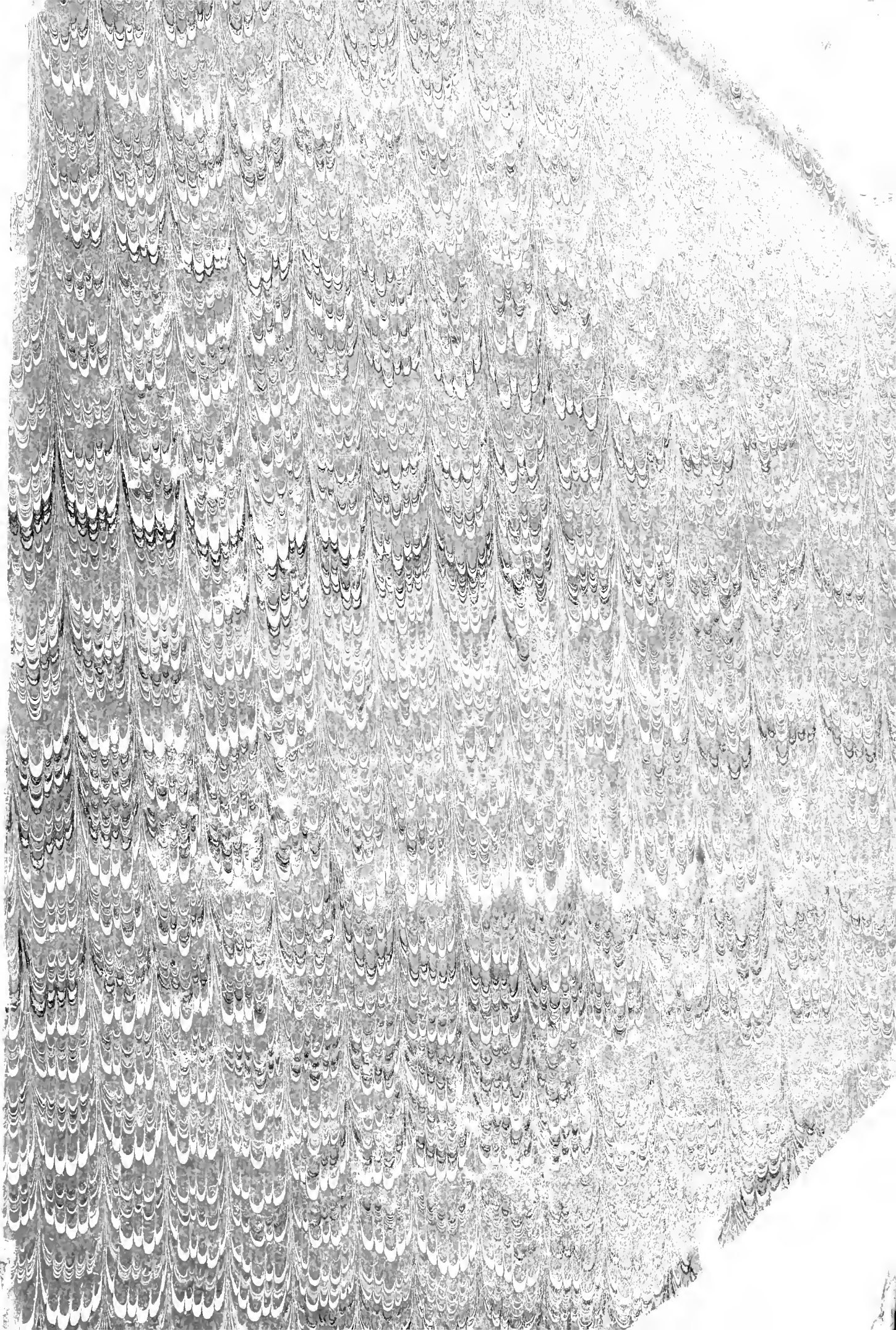

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ON AN EXTINCT TYPE OF DOG

FROM

ELY CAVE, LEE COUNTY, VIRGINIA.

By J. A. ALLEN.

PUBLISHED BY PERMISSION OF N. S. SHALER AND J. R. PROCTOR,
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WITH THREE PLATES.

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ON AN EXTINCT TYPE OF DOG FROM ELY CAVE, LEE COUNTY, VIRGINIA.

The five bones which form the subject of the present paper were found by Professor N. S. Shaler in Ely Cave, Virginia, close to the Kentucky line. They consist of a scapula, a humerus, a femur, and a tibia, all belonging to the right side, and a pelvis. A comparison of each singly with the corresponding bones of a dog or wolf shows at once their canine affinities; taken collectively, however, they indicate an animal of very different proportions from any of the ordinary wild *Canidæ*, or from any race of domestic dog. The bones were found together, and appear to have belonged to the same individual. As cave finds are sometimes open to suspicion, especially in the case of remains of animals from or near the surface of a cave floor, my first endeavor, on finding that these bones were not referable to any existing indigenous species, was to identify them with some small stout form of domestic dog; here, however, no nearer approach was found to the type in question than among the wild species. The conviction, therefore, that these bones represent an extinct type of the dog family has gradually become strengthened by the comparisons made until no other hypothesis seems tenable.

These bones differ from those of ordinary dogs, wild or domestic, in the shortness of the humerus as compared with the scapula, and of the femur as compared with the pelvis, but especially in the form of the pelvis, which is arched to a most remarkable degree, more so than in any other species known to me. Other details in which these bones differ from those of the fox, wolf, and dog are pointed out in the descriptions here following. As regards the relationship of the type in question with exotic or extinct forms, I can say little, being without means of making the necessary comparisons. In general form it was evidently a very short-limbed, heavy-bodied animal, recalling the proportions of the badger rather than those of a dog. For this reason it would be desirable to compare it with the short-legged *Icticyon venaticus* of South America; in lack, however, of the opportunity, I can only add that the descriptions of this animal do not lead one to expect even here a very close affinity. In regard to extinct species, of few only are the limb-

bones known. As regards those from North America, referred to *Canis* and allied genera, a comparison is needless, the differences are at once so obvious. With the Miocene genus *Amphicyon* there are some points of resemblance; both are stout, short-legged forms; and both lack the supracondylar foramen so characteristic of the ordinary dogs. The *Amphicyon vetus*, described by Dr. Leidy, from the bad lands of White river, Dakota, from parts of the skull and fragments of jaws, was evidently an animal of about the same size. From what is known of the cave fauna of the region in question, however, it seems hardly probable that the remains here described are referable to a Miocene genus. Unfortunately the skull, which would give a much better clue to the affinities of the beast, is lacking, although it is not improbable that it still exists, as well as many other parts of the skeleton, in the cave near the point where the bones here described were gathered.

PACHYCYON, *gen. nov.*

Scapula equal in length to the humerus. Pelvis greatly arched, equal in length to the femur. Tibia a little shorter than the femur. Limb-bones remarkable for their thickness in comparison with their length.

PACHYCYON ROBUSTUS, *sp. nov.*

SCAPULA (pl. I, figs. 1—4).—The scapula, in comparison with this bone in the fox, coyote, wolf, and various races of the dog, presents, separately considered, several points of interest: (1.) The angle near the proximal end of the anterior border (see pl. I, fig. 1) is unusually strongly developed, and is placed much nearer the suprascapular border than in the animals named. (2.) The portion below the origin of the spine is much elongated, so that while the acromion process is well developed, it falls short of a plane parallel to the glenoid surface, instead of passing slightly beyond it, as in the coyote, dog, wolf, etc. This portion of the scapula is actually 1^{mm} longer than in the coyote, while the whole length of the scapula is one eighth less. (3.) The posterior border is strongly everted. This is in part due to the warping of the bone, as is shown by minute fractures; yet there is evidence of a considerable amount of normal eversion, much more than is usual in the *Canidæ*. With these exceptions, there is nothing in this bone by which it is especially distinguishable from the scapula of a dog of corresponding size, except possibly the greater depth of the spine. Taken, however, in connec-

tion with the humerus, it is remarkable for its length, which is to the humerus as 110 to 100. The same proportion in the fox is as 66 to 100; in the coyote as 74 to 100; in the wolf as 76 to 100; in the bull terrier and Newfoundland dog as respectively 80 to 100. The relative length of the scapula, compared to the humerus, is thus 30 per cent. greater than in one of the most thickly-set races of domestic dog (bull terrier), 35 per cent. greater than in the coyote and wolf, and 44 per cent. greater than in the fox. This proportion between scapula and humerus results not so much, however, from the lengthening of the scapula as from the excessive shortening of the humerus, which, like the femur and tibia, is very short and thick.

MEASUREMENTS OF THE SCAPULA.*

	Pachycyon robustus.	Common fox.	Bull terrier.	Coyote.	Common wolf.	Newfoundland dog.
Extreme length	95	71	100	116	169	168
Greatest breadth	53	44	51	61	86	84
Antero-posterior diameter of glenoid cavity	21	14	22	23	34	34
Transverse diameter of glenoid cavity	13	9	14	16	22	23
Greatest height of spine	17	10	17	19	. .	26

* The measurements given in these tables are in millimetres.

HUMERUS (pl. II, figs. 1—6).—The humerus differs from this bone in the ordinary Canids in its much greater thickness in proportion to its length, in its stronger curvature, and in the supracondylar fossa being imperforate, the usual broad foramen at this point being solidly closed by a heavy plate of bone. All of the ridges and tuberosities are strongly developed; the front border of the head forms a heavy overhanging ridge, and the deltoid ridge terminates in a broad, strongly projecting process (pl. II, figs. 2—3). The absence of the supracondylar foramen, so characteristic of the family *Canidæ*, is especially noteworthy; but its value as a distinctive feature in the present species is lessened by the fact that it is sometimes partly, and in rare instances wholly, closed in old age in the domestic dog. It should be noted, however, that it is similarly absent in *Amphicyon*.

The following table of measurements of the humerus shows the relative dimensions of this bone not only in the present species, but in the fox, coyote, wolf, and in two widely different races of dogs. In respect to

thickness and other dimensions, except length, it will be noticed that there is a close agreement between the cave specimen and that of the bull terrier. In length, however, the latter exceeds the former in the ratio of 100 to 70, which, taken with the other dimensions, throws into strong light the exceeding shortness and stoutness of the humerus in the cave example:

MEASUREMENTS OF THE HUMERUS.

	Pachycyon robustus.	Common fox.	Bull terrier.	Coyote.	Common wolf.	Newfoundland dog.
Extreme length	87	112	126	157	210	205
Greatest antero-posterior diameter of proximal end	33	24	34	37	50	51
Greatest transverse diameter of proximal end	25	16	24	24	35	36
Greatest antero-posterior diameter of distal end	19	11	19	22	29	30
Greatest transverse diameter of distal end	12	10	14	14	21	21
Greatest antero-posterior diameter of shaft	23	19	30	30	40	44
Greatest circumference of shaft	48	31	54	58	76	77
Least circumference of shaft	33	25	38	38	53	53

PELVIS (pl. III).—The pelvis in the present species differs from that of ordinary *Canidæ* in only one important feature, namely, the high angle formed by the pre- and post-acetabular portions. In respect to the relative size of its different parts, and their individual contours, including even the ridges and tuberosities for muscular attachment, the differences are not greater, with possibly one exception, than obtains between different races of the domestic dog, or between different species of the genus *Canis*. The posterior portion of the ilium is narrower antero-posteriorly in relation to its more expanded anterior part than is the case with any of the other types with which it is here compared. Its truly remarkable feature is the high angle formed by the pre- and post-acetabular portions (pl. III, fig. 1), which gives to the pelvis as a whole a most peculiar and striking aspect. Placing the pelvis with the ventral surface upward, it is found that the ischiac axis, or a line passing through the tuberosity of the ischium and the center of the acetabulum, forms in the fox an angle with the plane of rest of 29°; in the coyote the same angle is 31°; in the wolf, 32°; in the bull terrier, 31°; in the Newfoundland dog 32°, from which it rises in the present species to 45°, or is nearly fifty per cent. greater than in the others. In respect to size, the pelvis is about one fifth shorter than that of the coyote, and about one tenth less in other dimensions.

MEASUREMENTS OF THE PELVIS.

	Pachycyon robustus.	Common fox.	Bull terrier.	Coyote.	Common wolf.	Newfoundland dog.
Extreme length	102	82	110	130	184	178
Greatest breadth (at ischyiac tuberosities)	75	61	83	87	123	132
Breadth at acetabula	62	44	67	65	96	100
Distance between innominate bones at posterior upper border of sacral surface	34	27	40	37	53	60
Distance between the most diverging points of the suprailiac borders (below)	60	45	81	68	98	122
Distance between the most convergent points of the suprailiac border (above)	43	34	67	56	60	61
Greatest breadth of innominate bone	36	24	37	40	59	61
Height at anterior end of pubic symphysis	40	26	35	41	57	62

FEMUR (pl. I, figs. 5—10).—The great trochanter rises slightly above the head of the femur, instead of being on a level with or slightly below it, as is usually the case in the *Canidæ*, and the lesser trochanter forms a very prominent conical point fully 2^{mm} in length. The well-marked ridge bounding the outer border of the head is situated on the median line of the shaft, and in line with the inner crest of the greater tuberosity. The cavity at the top of the shaft is thus nearly concealed when viewed from behind, while the head occupies one-half of the diameter of the shaft instead of one-fourth to one-third as in the dog, wolf, and fox (pl. I, fig. 5). The posterior surface of the proximal end of the shaft thus presents an appearance widely different from what ordinarily obtains in the *Canidæ*. The distal extremity descends obliquely, the trochlear portion having an extension posteriorly beyond the line of the posterior border of the shaft equal to nearly twice the antero-posterior diameter of the shaft, instead of merely equaling it as in the other forms with which the present species is here compared. The condyles are narrower and less widely separated by the intercondylar notch; the trochlear articular surface is also narrow, prolonged, and looks more directly forward. The shaft immediately above the condyles has its posterior face greatly expanded and deeply hollowed. In other respects the femur is noteworthy only for its shortness and consequent stoutness of form. This feature becomes a striking one when the femur is considered in relation to the pelvis, which it only barely equals in length instead of greatly exceeding. In the fox the ratio of the length of the pelvis to that of the femur is as 71 to 100; in the coyote, the bull terrier,

and Newfoundland dog, respectively, as 80 to 100; in the wolf as 83 to 100. In the species under consideration this ratio is as 100 to 100, or nearly the same as that of the scapula to the humerus. The femur is thus one-fifth to one-fourth shorter, as compared with the length of the pelvis, than in the ordinary *Canidæ*. As will be seen from the table of measurements, it most nearly agrees in size with that of the bull terrier, but is about one-third shorter.

MEASUREMENTS OF THE FEMUR.

	Pachyeyon robustus.	Common fox.	Bull terrier.	Coyote.	Common wolf.	Newfoundland dog.
Extreme length	102	115	143	164	218	222
Transverse diameter of proximal end	27	23	30	39	50	49
Transverse diameter of distal end	25	20	28	29	39	40
Least circumference of shaft	33	25	37	39	54	54

TIBIA (pl. II, figs. 7—12).—The tibia, like the humerus, is noteworthy for its unusually high degree of curvature, and, like this latter and the femur, for its stoutness in proportion to its length. It differs, also, to a well-marked degree in the contours of its extremities, especially those of the distal end.

MEASUREMENTS OF THE TIBIA.

	Pachyeyon robustus.	Common fox.	Bull terrier.	Coyote.	Common wolf.	Newfoundland dog.
Extreme length	99	129	142	177	222	223
Antero-posterior diameter of proximal end	30	23	31	36	47	50
Transverse diameter of proximal end	27	22	30	32	45	45
Antero-posterior diameter of distal end	14	10	14	15	17	17
Transverse diameter of distal end	18	15	20	20	30	30
Least circumference of shaft	32	23	33	33	48	50

ON THE AGE OF THE ELY CAVE.

The foregoing description of certain remains of canine animals which were found in Ely Cave, in Lee county, Virginia, require for their elucidation a general description of the geological conditions of this cavern. In 1877 the attention of my friend and colleague, Mr. Lucien Carr, Archæologist of the Kentucky Survey, was called to this cave on account of the quantity of human bones that were found in it. In the course of his explorations he came upon some small fragments of what seemed to be human Tibæ, the proportions of which were very surprising. On account of these discoveries I made a visit to this cavern, and spent a day in endeavoring to ascertain whether it would repay a careful excavation. The rocky condition of the floor, and other circumstances, made this seem undesirable. Unfortunately, my notes made on the ground have been lost, so that I have to give the following statement principally from memory, aided by the recollections of Mr. Carr, who spent some weeks in this neighborhood.

Some general statements concerning the geological structure of this district is necessary to a proper understanding of the conditions of this cavern. If the reader will consult a map of this district, he will perceive that its principal geographical features are the Cumberland Mountains on the west, a very continuous ridge of the Alleghanean type, that extends for over a hundred miles like a wall, and the mountain known as Wallen's Ridge on the east, and between them the valley of Powell's river. The whole section, from Wallen's Ridge on the east, across the valley of Powell's river, to the western side of Cumberland Mountains, constitutes a great anticlinal of very gentle curves. The caverns in this section are found either in the Subcarboniferous limestone or in the limestones of the Cambro-Silurian series. Those in the Subcarboniferous limestone are by far the larger; but as this part of the section is subject to a rather rapid erosion, they do not represent a very long duration of geological time. This Subcarboniferous series of limestones lie at the base of the Cumberland Mountains, and, with the overlying millstone grit, forms the greater part of the eastward wall of that ridge. Beneath them is the Devonian black shale, the Ohio shale of this Survey. This last named deposit consists of very soft bituminous clays, arranged in shaly layers. Frost or running water, aided by the capilarity of these closely adjoined layers, rapidly decomposes this shale

into a fine clay that is easily borne away by the streams that run at the foot of the mountain. In this way the Cumberland escarpment has been forced to make a very rapid retreat from the middle of the great anticlinal, in which lies Powell's river, back to its present position. The total amount of its retreat since the elevation of the Powell anticlinal, which probably took place in the Triassic time, is not less than five, and may be as much as seven miles. As the caves do not extend more than two or three hundred feet back from the face of the escarpment, it is evident that they cannot represent a very great lapse of geologic time. I do not believe that the present series of caverns in this escarpment have endured more than *about* one hundredth part of the time occupied in the retreat of the escarpment from the centre of the Powell anticlinal. Estimating the duration of time since the Triassic period at from thirty to forty millions of years, the caverns now lying in the bed of the Subcarboniferous limestone cannot have been in existence for more than about three to four hundred thousand years. Owing to the peculiar position of these escarpment caverns, there is little chance that the waste arising from the destruction of one set of caverns can be carried into another successive set of caves, as is the case in many other regions. These considerations make it clear that a very great geological age cannot well be represented in these caves of the Subcarboniferous series.

The other series of caves in this region, the series to which the Ely cave belongs, are very differently conditioned. They do not lie in vertical escarpments, but upon the surface of a broad field of limestones, which have a structure eminently adapted to favor the preservation of caves. These limestones are of the Cambro-Silurian age, corresponding approximately in geological position to the series of rocks elsewhere called the Cincinnati group. These beds represent a thickness of over a thousand feet of limestones, which are, in the main, of the ordinary carbonate of lime, but contain many thick beds of a dolomitic nature. These dolomitic layers here, as everywhere, afford stout barriers to erosion. Water works its way through joints in their layers into the more erodable beds below, and there excavates broad, flat caverns, which extend their arches until the roof becomes too wide to support itself, when the cavern is opened to the day. These layers of dolomitic limestone prevent any rapid ablation of the surface they cover, so that, while the face of the escarpment in which the caverns of the Subcarboniferous limestone are found has retreated

about thirty to forty thousand feet, these lower deposits have not lost more than about five to eight hundred feet of their depth. The result is that this set of caverns remain far longer in existence than do those in the Subcarboniferous limestone. I am inclined to believe that one of these caverns in the high-lying ridges of Powell's Valley may be five or ten times as ancient as those in the Subcarboniferous escarpment; they may perhaps date their origin back to the early part of the Pliocene time.

It is clear that the cave in which the bones before described were found is one of the oldest of these very ancient caverns. It is well elevated above the present drainage level of the country, lying upon one of the flat-topped ridges which rise from one to two hundred feet above the small spurs that intersect the ground. It is near the top of the ridge, a position that indicates that it is very ancient. The streams that must have cut it out are now seen in channels far below its level and horizontally far away.

The cave is not conveniently placed for the use of even primitive man. The entrances are by difficult and rather blocked-up ways. The space within is not large, there being only a few hundred feet of narrow and rather damp chambers. During the civil war it was used as a place of storage for valuables and for concealment of small bands of partisans during the various raids made through this country by the two armies. In this occupation the remains of Indians, which had been plentifully deposited here, had been much dragged about in the vague searching of various persons. We did very little digging in the cavern, in no case going more than a foot or two below the surface of the earth. There seemed to be no considerable amount of stalactite matter on the floor of the cavern, the insoluble nature of the overlying rocks not favoring the formation of such deposits. The bones described in Mr. Allen's memoir were obtained somewhere in the course of these slight excavations. At the time I paid no attention to them, supposing that they belonged to some of the ordinary cavern dwelling animals of the country, so that I am unable to state just whereabouts in the cavern they were found. The whole search did not occupy more than half a day's time, and many of the low, tortuous passages of the cavern were left quite untouched. I am disposed to believe that a careful search of this cavern will be likely to disclose the other bones of the interesting creature described in the monograph of Mr. Allen.

For many years I have been carefully observing our American cavernous districts, with a view to determining the points most likely to afford good places for exploration. I am inclined to believe that the caves of this district are more likely to furnish important paleontological data than those of any other region known to me. The reasons for this belief are as follows:

In the first place, the very extensive caves in the Subcarboniferous escarpment are peculiarly well fitted for the use of the primitive races of men who may have inhabited this country. They are well placed for the purposes of refuge, being easily defensible, and abounding in water. The region near these springs was rich in game and fish, and well fitted for agriculture. It still abounds in the remains of its aboriginal peoples. If our American caves were ever extensively used by the primitive peoples of the country, evidence of such occupation will surely be found here.

The caves in the Cambro-Silurian series, on which the Ely cave lies, are not so well placed for human use as those in the Subcarboniferous escarpment, yet, as we have seen, they are found under conditions that favor their preservation for far longer periods of time. They are often found under conditions such as to make it certain of their having come down from times so remote that we may fairly hope to find within them fossils of the Pliocene age. All this region abounds in this class of caves, and among them are many which, occupying the hill-tops at points of several hundred feet above the present level of the streams, are certainly far more ancient than the beginning of the last glacial period.

This valley of the upper Tennessee lies in the southernmost part of the region that was occupied by the glaciers of the last ice time. The edge of the great ice-field came down to near the Ohio in the country one hundred miles to the north, and local glaciers occupied the higher districts in the North Carolina Mountains, hills that are within sight of this valley. Here must have flourished the remarkable fauna that occupied the regions near this ice sheet, and here, if anywhere, we may hope to find the remains of man associated with extinct groups of animals.

The great extent of this cavernous district is also a very advantageous feature for the naturalist's work. Between the head waters of the Tennessee river system in southwestern Virginia and the neighborhood of Chattanooga, over an east and west width of about sixty miles, there are some thousands of these caverns; so that the explorer will have an abundant

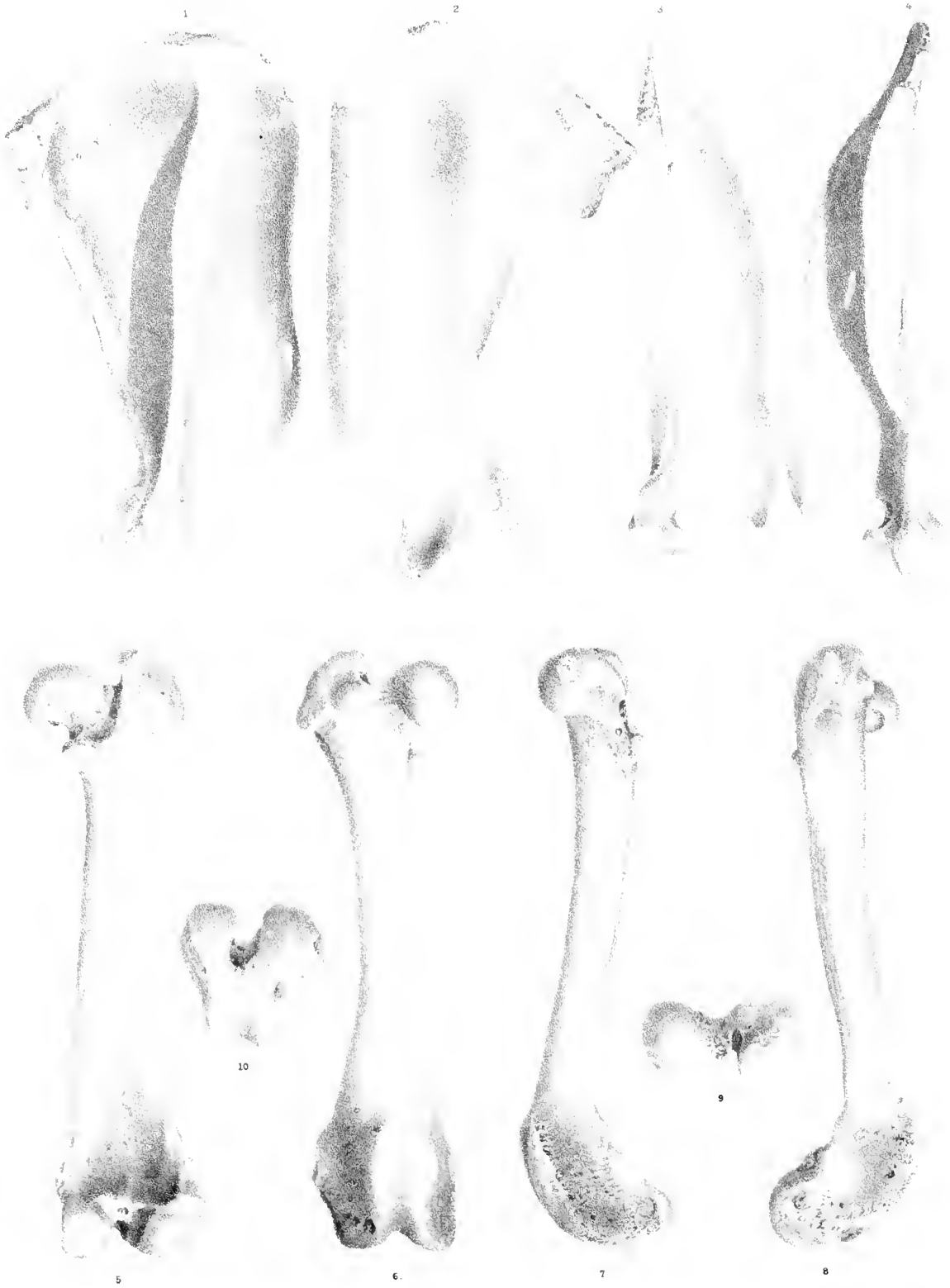
chance to so select his places of exploration as to secure caverns of recent or very ancient date, according to the end he has in view. I know no other part of the United States that is so favorably placed for this class of inquiries.

N. S. SHALER.

EXPLANATION OF PLATE I.

Pachycyon robustus. (All the figures are of natural size.)

Fig. 1. Right scapula, external surface.
Fig. 2. The same, internal surface.
Fig. 3. The same, anterior view.
Fig. 4. The same, posterior view.
Fig. 5. Right femur, posterior view.
Fig. 6. The same, anterior view.
Fig. 7. The same, internal surface.
Fig. 8. The same, external surface.
Fig. 9. The same, proximal end, seen from above.
Fig. 10. The same, distal end, seen from below.



A. Meisel lith. Boston

PACHYCYON ROBUSTUS

EXPLANATION OF PLATE II.

Pachycyon robustus. (All the figures are of natural size.)

Fig. 1. Right humerus, external surface.
Fig. 2. The same, internal surface.
Fig. 3. The same, anterior surface.
Fig. 4. The same, posterior surface.
Fig. 5. The same, proximal end, from above.
Fig. 6. The same, distal end, from below.
Fig. 7. Right tibia, anterior surface.
Fig. 8. The same, posterior surface.
Fig. 9. The same, external surface.
Fig. 10. The same, internal surface.
Fig. 11. The same, proximal end, from above.
Fig. 12. The same, distal end, from below.

A Meisel lith Boston

PACHYCYON ROBUSTUS

EXPLANATION OF PLATE III.

Pachycyon robustus. (All of the figures are of natural size.)

Fig. 1. Pelvis, external surface.

Fig. 2. The same, ventral surface, direct view of ischiopubic portion.

Fig. 3. The same, ventral surface, direct view of iliac portion.

Fig. 4. The same, dorsal view.

A. Meisel lith. Boston

PACHYCYON ROBUSTUS