OSTEOLOGY OF COLINUS HIBBARDI, A PLIOCENE QUAIL

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The Pliocene quail species *Colinus hibbardi* was first made known by Alexander Wetmore. His description (1944:96) was based on two bone fragments, part of a right tarsometatarsus, which he designated as the type, and the distal end of a right humerus. These fragments were collected by Claude W. Hibbard, now at the University of Michigan, and his field assistants in 1937. Subsequent collecting by Hibbard, Richard Rinker, and Charles Carpenter in the summer of 1947 has made available approximately 170 additional bone fragments of birds of the same fauna—namely, the Rexroad fauna, Rexroad formation, Blancan age, of the Upper Pliocene of Meade County, Kansas. In identifiying specimens from this latter collection, I encountered 31 bones, mostly fragmentary, but a few complete, which seemed referable to this large Pliocene *Colinus*. Fortunately, the present collection includes both the elements which Wetmore described. The right tarsometatarsus herein figured is in better condition than the type. Dr. Wetmore personally examined eight fragments of the present collection which I identified as *Colinus hibbardi* and confirmed my determinations.

The Rexroad fauna is "now the most completely known fauna from a given horizon of the High Plains" (Hibbard and Riggs, 1949:859). Baker (1938), Hibbard (1941), and Franzen and Leonard (1947) have reported on the invertebrates. Taylor (1941; 1942) has described the herpetological material, while Hibbard (1941; 1950) and Hibbard and Riggs (1949) described the mammals. Wetmore (1944) has reported on the birds from "Localities 2 and 3," about 10 miles northeast of the locality of the present collection, taken in Meade County, Kansas, XI Ranch, NW¼ sec. 35, T. 34S., R. 30 W. (Fox Canyon). Wetmore speculated at some length on the probable environment of the Rexroad birds, but Dr. Hibbard tells me that the specimens described by Wetmore probably are from a pond or bog deposit, whereas the Fox Canyon deposits here reported on are apparently stream deposits.

In the course of identification of the specimens at hand, many forms have been found which were lacking in Wetmore's material. The relatively large number of quail bones (approximately 18 per cent of the total collection) and their excellent state of preservation made it seem worth while to devote special attention to a fairly detailed comparison of *Colinus hibbardi* with the modern Bob-white, *Colinus virginianus*.

To Dr. Hibbard I owe the largest debt of gratitude for his work in procuring the fossil material and in guiding me in the study of it. Dr. Wetmore's comments on the specimens that he examined for me have been helpful. George M. Sutton aided me in determining which measurements should be taken. Jane S. Mengel made the drawings here reproduced, and to her I owe my thanks.

Wetmore's allocation of this Pliocene quail to the genus *Colinus* seems unquestionably correct. Comparisons with genera of quail other than *Colinus* have been made here only to verify the allocation of the individual elements to *Colinus*, and not to bring out all the differences between the genus *Colinus* and the related genera.

The nomenclature of the bones used in this paper is that of Howard (1929). The modern Bob-white skeletons used for comparative material are in the University of Michigan Museum of Zoology. All are Michigan or Wisconsin specimens of *C. v. virginianus*. The fossils described are in the University of Michigan Museum of Paleontology (abbreviated UMMP below). The abbreviation KUMVP in table 7 refers to the University of Kansas Museum of Natural History (Vertebrate Paleontology).

ELEMENTS IDENTIFIED

Cervical vertebra.—One well preserved cervical vertebra (the sixth or seventh) I have identified as belonging to this species because of its resemblance to that of *C. virginianus* and because its size is slightly larger than the same element of a modern adult male Bob-white. Four other, fragmentary cervical vertebrae probably also are *C. hibbardi.* However, these elements often fail to supply any

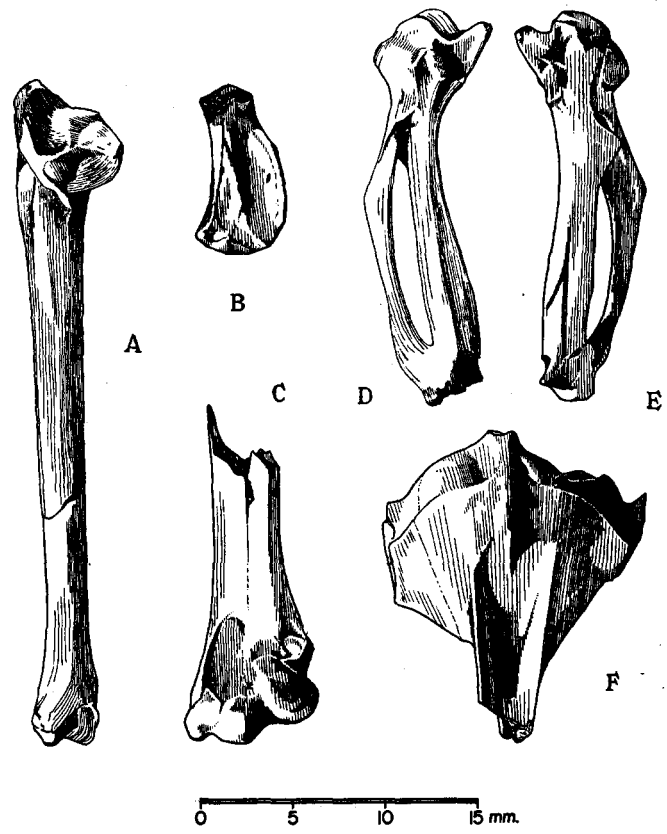

Fig. 1. *Colinus hibbardi.* A, left ulna, UMMP no. 24757. B, proximal phalanx, digit 2 of right manus, UMMP no. 26859. C, distal end of left humerus, UMMP no. 26850. D and E, left carpometacarpus, UMMP no. 24753. F, anterior portion of sternum, UMMP no. 26840.

characters sufficiently diagnostic to separate even the modern quail genera (except where size is conclusive); thus, specific identifications based on these elements alone are hazardous. The five fossil vertebrae are grouped under UMMP no. 26842.

Sternum.—Three fragments of the anterior ends of sterna, UMMP nos. 26840 and 26841 (two bones), are referable to this species. Upon comparison with eight modern quail genera, these fragments prove to be larger than the corresponding parts of *Cyrtonyx, Callipepla, Lophortyx,* and *Colinus,* and approximately the same size as those of *Oreortyx, Dactylortyx,* and *Perdix.* The elements are smaller than in *Alectoris.* The three fragments are distinguishable from the sternum of each of the aforementioned genera except *Colinus* in the size and shape of the pair of depressions on the anterior internal side of the sternum, the degree of anterior extension and lateral divergence of the double

anterior carinal margin, and in the degree to which the origin of the crest of the ventral manubrial spine is produced posteriorly. That portion of the sternum which is preserved in two of the three fossils (no. 26841) is especially difficult to measure precisely because there are few definite points of reference preserved. However, in the better preserved third fragment (no. 26840, fig. 1F), the ventral lip of the coracoidal sulcus is intact. Table 1 shows the transverse distance between the well defined ends of this sulcus of the fossil to be distinctly larger than in the modern specimens at hand.

Table 1

Measurements of Sternum and Coracoid

Specimens	Breadth of ventral lip of coracoidal sulcus of sternum	Greatest breadth of proximal (sternal) end of coracoid	Breadth of sternal facet of coracoid
C. hibbardi			
UMMP no. 26840	13.4 mm.	.....	.....
" 26843 (right)	.....	11.3 mm.	7.5 mm.
C. virginianus			
8♀♀, 2♂♂			
Mean, with standard error	10.9 ± 0.2	8.8 ± 0.2	6.2 ± 0.1
Range	10.4 — 12.3	7.8 — 9.4	5.8 — 6.6
Standard deviation	0.5	0.5	0.3

Coracoid.—Six of the seven fragments of coracoids found of this species are from the distal (humeral) end, whereas the seventh is a well preserved proximal (sternal) end. Again the specimens resemble modern *C. virginianus,* except for their larger size. The measurements given in table 2 are those described and illustrated by Howard (1929:354-355) for coracoids of cranes (*Grus*).

No. 26843 is the proximal 16 mm. of a right coracoid (fig. 2H). The tip of the internal distal angle and the tip of the sterno-coracoidal process are both slightly abraded. Otherwise, the specimen is perfectly preserved. The ridge running down the ventral face of the shaft and swinging out toward the

Table 2

Measurements of Distal (Humeral) End of Coracoid

Specimens	Distance from glenoid facet to head, c-d*	Breadth from glenoid facet to procoracoid, e-f*	Depth posterior to furcular facet, g-h*
C. hibbardi			
UMMP. no. 26844 (right)	9.7 mm.	4.0 mm.	3.8 mm.
" 26845 (left)		4.4	3.7
" 26846 "	10.0	4.9	3.8
" 26847 "	9.1	3.7	3.4
" 26848 "	9.6	4.3	3.5
" 26849 "		4.0	3.4
Mean, with standard error		4.2 ± 0.2	3.6 ± 0.1
Standard deviation		0.4	0.2
C. virginianus			
8♀♀, 2♂♂			
Mean, with standard error	8.5 ± 0.1	3.9 ± 0.1	3.2 ± 0.1
Range	8.1 — 9.0	3.5 — 4.0	2.9 — 3.7
Standard deviation	0.3	0.2	0.3

* See Howard, 1929:354-355, fig. 55.

sterno-coracoidal process is less prominent and less sharply defined in the fossil than in modern *C. virginianus.* As table 1 shows, this specimen is considerably larger than the corresponding element of the modern species.

No. 26844 is the distal 15 mm. of a right coracoid (figs. 2F and 2G). It is well preserved and little worn. Its greater bulk is evident upon direct comparison with the coracoid of modern Bobwhites (see also table 2). In the fossil, the scapular facet and the procoracoid seem smaller in relation to the thickness of the shaft than in *C. virginianus,* although the fossil is actually larger in all dimensions.

No. 26845 is the distal 25 mm. of a left coracoid. The head of the bone is lacking, thus destroying the characters of the furcular facet and the coraco-humeral surface. The missing piece was perhaps 3 to 4 mm. long. Otherwise, the fossil is well preserved and little worn. This fragment includes the central part of the shaft, which is missing on the two terminal fragments illustrated. On the basis of this fragment, and no. 26843 (above), I would estimate the total length of the coracoid of *C. hibbardi* to be about 37 mm. The coracoids of six modern *C. virginianus* (three from males) average 29.1 (28.3-31.2) mm. in total length.

No. 26846. Distal end of a left coracoid (fragment 17 mm. long), slightly worn, with the brachial tuberosity broken off, agrees with the other fossils in other respects.

No. 26847. Same part as preceding (12.5 mm. long), tip only of brachial tuberosity worn off. Well preserved and little worn.

No. 26848. Same part as 26846 (10 mm. long), considerably worn on the distal articular surfaces.

No. 26849. Same as 26846 (10 mm. long), little worn, except for broken tip of furcular facet and brachial tuberosity.

Humerus.—The distal end of a left humerus, no. 26850, including the shaft up to a length of 18 mm., is in a very good state of preservation (fig. 1C). Except for the missing ectepicondyle and ectepicondylar prominence, the details of the distal articular surfaces are well preserved and little worn. In general, this bone is like that of *C. virginianus*. Wetmore (1944:97-98), describing the distal end of a right humerus of *hibbardi*, says that the fossil differs from modern Bob-whites in that it is slightly larger and that the "brachial depression is relatively larger, with the ridge bordering it longer, extending farther up the shaft." This is true also of no. 26850 (see table 3). A distinct difference in bulk is noticeable upon direct comparison with a series of modern *C. virginianus*. Table 3 also shows that the present fossil is wider across the trochleae than is any one of the 11 measured individuals of the Recent species. A further point of difference which is evident on direct comparison is the straighter (at the distal end, at least) and heavier shaft in the fossil species.

Table 3

Measurements of Humerus

Specimens	Breadth across distal trochleae	Distance from proximal edge of impression of brachialis anticus to distal end of internal condyle
C. hibbardi		
UMMP no. 26850 (left)	7.6 mm. actual (broken) 8.0 estimated, if intact	6.9 mm.
C. virginianus		
9 ♀♀, 2 ♂♂		
Mean, with standard error	7.1 ± 0.1	5.9 ± 0.1
Range	6.9 — 7.5	5.5 — 6.5
Standard deviation	0.2	0.3

In regard to breadth across the trochleae of the distal end of the humerus of these two species of *Colinus*, I should point out that Wetmore (1944:98), whose fossils have come, apparently, from individuals of about the same size as the specimen at hand, gives measurements for four specimens—two fossils, both 18 mm., and two modern birds, 16.7 and 17.1 mm. These measurements clearly are erroneous; that is, they are too large, as a glance at table 3 will show. The error seems to be 10 mm. in each case, and probably resulted from a misreading of the calipers. Wetmore's measurements, less 10 mm., can be compared with mine.

Ulna.—Two complete (nos. 24757 and 24758) and three fragmentary (nos. 26851, 26852, and 26853) ulnae are referable to this species (see fig. 1A). Each of the complete bones, both from the left side, has been broken into two pieces and repaired. In preparing table 4, the breadth of the distal end has been measured perpendicular to the longest diameter of the external condyle, to the tip of the internal carpal tuberosity. The breadth of the proximal articular face has been measured perpendicular to the longest diameter of the internal cotyla, across the external cotyla. As the measurements show, the fossils are approximately 5 mm. longer than are ulnae of modern *C. virginianus*. Proportionally, this size difference is evident also upon direct comparison with other dimensions. Also, the impression

of brachialis anticus is relatively deeper and more sharply outlined in the fossils. Otherwise, I find nothing to separate the fossil species from the modern Bob-white on the basis of the ulna.

Table 4

Measurements of Ulna

Specimens	Total length	Breadth of distal end	Breadth of proximal articular face
C. hibbardi			
UMMP no. 24757 (left)	37.4 mm.	4.2 mm.	4.8 mm.
" 24758 "	38.7	4.7	4.9
" 26851 "		4.5	
" 26852 (right)		4.8	
C. virginianus			
7 ♀♀, 2 ♂♂			
Mean, with standard error	32.3 ± 0.3	4.1 ± 0.1	4.2 ± 0.1
Range	31.5 — 34.1	3.9 — 4.3	4.0 — 4.6
Standard deviation	0.9	0.2	0.2

Carpometacarpus.—One complete left carpometacarpus (figs. 1D and 1E) and fragments of six others are clearly gallinaceous, and differ from that of *C. virginianus* only in averaging slightly larger. Except for size (and there is overlap here in some measurements), I am unable to find any constant differences between the fossils and the *C. virginianus* carpometacarpi (see table 5).

No. 24753, from the left side, is complete except for a small piece, about 2.8 × 2.5 mm., broken from the anterior face of the distal end of the shaft of metacarpal II (figs. 1D and 1E).

No. 26855. Left side, proximal end intact, with about 8 mm. of metacarpal II (including intermetacarpal tuberosity) and 2.5 mm. of metacarpal III attached.

No. 26854. Left side, intact except for most of process of metacarpal I and most of shaft of metacarpal III.

Table 5

Measurements of Carpometacarpus

Specimens	Total length	Greatest breadth of proximal end, to tip of metacarpal 1	Height of distal metacarpal symphysis*
C. hibbardi			
UMMP no. 24753 (left)	22.0 mm.	5.8 mm.	3.3 mm.
" 26854 "	22.4		3.1
" 26855 "		5.7	
" 26857 "			3.7
" 26856 (right)		6.2	
C. virginianus			
7 ♀♀, 2 ♂♂			
Mean, with standard error	19.3 ± 0.3	5.5 ± 0.1	3.1 ± 0.1
Range	18.6 — 21.2	5.2 — 5.9	2.6 — 3.6
Standard deviation	0.8	0.3	0.3

* From distal end of intermetacarpal space to distal end of facet for digit 3.

No. 26856. Right side, proximal end intact, with about 5 mm. of metacarpal II (including metacarpal tuberosity) and 1 mm. of metacarpal III attached.

No. 26857. Left side, distal end intact, with 5 mm. of the split shaft of metacarpal II and 1 mm. of the shaft of metacarpal III attached.

No. 26858. (Two specimens.) One right and one left metacarpal II, with badly worn and broken portions of the distal and proximal ends attached.

Proximal phalanx, digit 2 of manus.—This bone, UMMP no. 26859 (fig. 1B, table 6), is much larger than in the modern species. This element shows relatively little size variation in my series of Recent birds, thereby emphasizing the importance of the size difference noted. The specimen, from the right side, may not belong to *C. hibbardi,* because of its large size. However, except for size and the

Table 6

Measurements of Limb Elements

Specimens	Proximal phalanx, digit 2 of manus: Length, taken perpendicular to line across digital facet	Proximal phalanx, digit 2 of manus: Greatest breadth	Proximal end of tarsometatarsus, transverse breadth of head
C. hibbardi			
UMMP no. 26859 (right)	9.1 mm.	4.3 mm.	.....
" 26860 (left)	.....	.....	6.5 mm.
C. virginianus			
7 ♀♀, 2 ♂♂			
Mean, with standard error	7.6 ± 0.1	3.8 ± 0.1	5.9 ± 0.1
Range	7.2— 7.9	3.5 — 4.0	5.6 — 6.6
Standard deviation	0.3	0.2	0.4

slightly greater angularity of the conformation of its external side, the fossil agrees closely with *C. virginianus.* It is well preserved, unbroken, and only slightly worn. In addition to some wear on the edges, a small hole has been worn through the thin area just anterior to the middle part of the posterior margin.

Tarsometatarsus.—One fragment, UMMP no. 26860 (figs. 2A-2C, table 6), the proximal end (about 15 mm. long) of a left tarsometatarsus, probably belongs to this species. The fossil is excellently preserved, and, except for a small piece broken from the back of the hypotarsus, exposing the tendinal canals, the details of the articular surfaces are intact. In size this bone agrees with male specimens of *C. virginianus,* but in conformation it differs in the following ways from examples of the modern species which I have examined: the intercotylar prominence is somewhat more rounded in the fossil (this may be due to weathering or wear); the depression just over the posterior edge of the internal cotyla is somewhat more angular and sharply marked in the fossil; the lateral face of the hypotarsus of the fossil bears a more sharply defined ridge leading proximad from the outer proximal

Table 7

Measurements of Distal End of Tarsometatarsus

Specimens	Transverse breadth of shaft below center	Transverse breadth across trochleae	Transverse breadth of middle trochlea	Depth of middle trochlea
C. hibbardi				
UMMP no. 26861 (left)		6.8 mm. (approx.)	2.6 mm.	3.4 mm.
" 26862 (right)	3.0	6.6	2.4	3.1
KUMVP no. 3981 (right), type	3.1	7.0 (approx.)	2.9	
C. virginianus				
6 ♀♀, 2 ♂♂				
Mean, with standard error	2.8 ± 0.1	6.1 ± 0.2	2.3 ± 0.1	3.1 ± 0.1
Range	2.6 — 3.1	5.6 — 6.7	2.1— 2.6	3.0 — 3.5
Standard deviation	0.2	0.4	0.2	0.2

foramen than does any of the modern specimens at hand. Modern Bob-whites show considerable variation in the proximal end of this bone, however, and most of the differences between the fossil and the most similar of the modern bones can be equalled within the series of modern *C. virginianus.*

Since the type of *C. hibbardi* is the distal end of a right tarsometatarsus, the three fragments representing this element in the present collection are especially important. The most nearly perfect of the three bones, UMMP no. 26862, has been confirmed by Wetmore as representing *C. hibbardi.* The

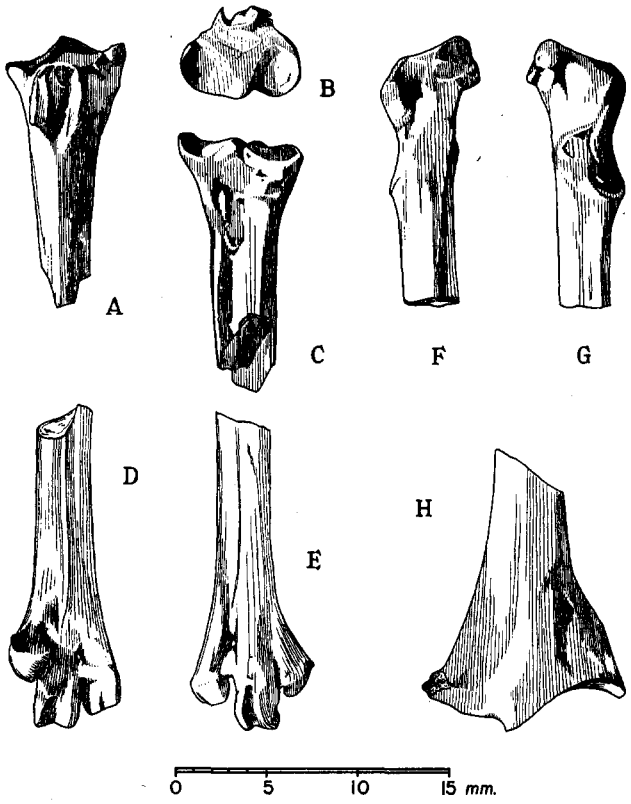

Fig. 2. *Colinus hibbardi*. A, B and C, proximal end of left tarsometatarsus, UMMP no. 26860. D and E, distal end of right tarsometatarsus, UMMP no. 26862. F and G, distal (humeral) end of right coracoid, UMMP no. 26844. H, proximal (sternal) end of right coracoid, UMMP no. 26843.

type, from the right side, lacked the main parts of the outer trochleae, while no. 26862, also from the right side, has all three trochleae intact. As is indicated in table 7, two of the fossils are from individuals slightly smaller than the type. The third specimen, UMMP no. 26863, is too fragmentary to be measured.

No. 26861. Distal end of a left tarsometatarsus; shaft broken just above the distal foramen; trochlea for digit 2 missing. Otherwise similar to no. 26862, though from a slightly larger individual.

No. 26862 (figs. 2D and 2E). Fragment, about 18 mm. long, of a right tarsometatarsus; shaft broken approximately at the middle of the bone. Trochlea for digit 2 strong and well developed; shorter than trochlea for digit 3 and produced posteriorad, with result that, from medial view, trochlea 2 does not cover any of trochlea 3; a decided knob (wing of trochlea for digit 2) projects posteromediad from the posterior medial edge of the trochlea; middle trochlea as in Wetmore's description of the type—"strong, elliptical in lateral outline, with its lateral faces slightly excavated; a shallow groove extending clear around the articular surface, beginning in a definite depression on the anterior face; the outer flange bordering this groove slightly heavier than the inner, and on the posterior face extending farther up toward the inferior foramen." Outer trochlea (for digit 4) strongly developed; in lateral aspect the two flanges bordering the groove of the articular surface appearing as two ellipses, the outermost smaller and somewhat posterior to the inner one; the inner flange slightly heavier and produced farther distally, as well as anteriorly, than the outer flange; however, the outer flange

extending farther proximad on the posterior face than the inner flange; this trochlea slightly excavated on its inner and outer faces; as in the type, shaft "strong, flattened distally, with three sharply angular lines marking tendinal grooves on posterior surface; facet for hallux large and well marked; anterior face with a broad, shallow groove leading down into the relatively large inferior [= distal] foramen."

No. 26863. A fragment of a right tarsometatarsus about 18 mm. long. All three trochleae are broken off at the level of the distal foramen, and the shaft is split in such a manner that its breadth cannot be measured accurately. However, in general shape, in conformation of the tendinal grooves on the posterior side, in the shape and position of the facet for the hallux, and in conformation of the groove on the anterior face leading down to the distal foramen, this fossil agrees completely with UMMP no. 26862 described above.

DISCUSSION

The frequency of occurrence of bones of *Colinus hibbardi* in the collections thus far examined indicates that this species must once have been abundant, or it may indicate that the bone deposit accumulated under some sort of selectivity, as would be true if, for instance, these fragments represented the remains of pellets of predatory birds (see Hibbard, 1950). It will be interesting to see if more material, when it becomes available, will confirm the difference in proportion between *hibbardi* and *virginianus* which is suggested by the specimens here described, namely, that the Pliocene species, while larger throughout, tends to be proportionately longer-winged than the modern form, with relatively less difference in the dimensions of the leg bones. If this proves to be so, then we may picture the Pliocene quail as a stronger flyer than the modern Bob-white—perhaps even a migratory form.

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