

## PLEISTOCENE BIRDS FROM THE JONES FAUNA OF KANSAS

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Avian skeletal remains have not been described from the Pleistocene of Kansas except in a brief abstract summarizing the results reported here and dealing with the Jones avifauna (Downs, 1949). Other paleontological studies of vertebrates from Kansas mention the occurrence of avian elements only in faunal lists. Our knowledge of birds from the Pleistocene in central North America is relatively meager compared to that of the western and southeastern portions of the continent. It is worthwhile, therefore, to present this account of birds taken from the Jones fauna of Kansas even though relatively few specimens are available and no new forms are described.

The material which is the basis for the present study was obtained in Meade County, western Kansas, by Claude W. Hibbard and members of his field parties. The locality is University of Kansas loc. no. 13 (Hibbard, 1940:417). This area is also referred to as the Jones sink (sec. 8, T 33 S, R 27 W; see Smith, 1940). The fauna is generally considered to be late Pleistocene in age.

Avian specimens from this fauna were sent by Dr. Hibbard, formerly at the University of Kansas, to A. H. Miller of the University of California Museum of Vertebrate Zoology for study by Dr. Miller or his associates. It was the author's privilege to examine this material and benefit from Dr. Miller's invaluable assistance during the course of the study. The writer is also indebted to Dr. Hibbard, now of the University of Michigan, for criticisms and for providing information on the geology and stratigraphy of the area. R. A. Stirton and Morgan Harris, both of the University of California, and Hildegard Howard of the Los Angeles County Museum have given helpful criticism and advice in the preparation of the manuscript. D. Dwight Davis of the Chicago Natural History Museum, Herbert Friedmann of the United States National Museum, and their respective institutions graciously permitted the use of material for comparisons. I wish to express thanks to Mrs. Theda C. Downs for assistance in typing and checking many parts of the manuscript.

The stratigraphy and vertebrate paleontology related to the Jones fauna have been studied by Hibbard (1949a). It is his conclusion that the fauna may be correlated with the upper part of the Vanhem formation, late Pleistocene age. The deposit occurred in a simple, isolated sink-hole fill probably not more than three miles in diameter, according to Smith (1940). The bird material was taken from a narrow stratum of sand of high lime content in a deposit not over fourteen inches thick at the center and lensing out to a periphery varying in thickness from six to four inches. In the section outlined by Hibbard (1940), the Jones fauna is about thirteen feet below the top soil in a sixty-one foot exposure along Sand Creek. After nearly filling with sediment, the original sink was tapped by Sand Creek. The dissection of the sink occurred in very late Pleistocene or in the early Recent.

Today sink-holes may develop with a rapid "collapse" as demonstrated in the recent Meade salt sink appearing in 1879 south of Meade, Kansas. This hole had an original depth of about eighty-nine feet, and salt water rose to within fourteen feet of the surface. Ground water and surface precipitation soon replaced the salt water (Johnson, 1901). It is known from recent observations that the walls or sides of sinks are attacked quickly by erosion. Many gullies and subsequent extension of the sink areas develop, followed by formation of gentler slopes and filling of the collapsed area to produce level bottoms in the sinks. It is also possible, according to Frye (1942), that the process of sink formation could occupy considerably more time than the period required for the type of simple collapse development discussed here.

Vertebrates other than birds and invertebrates have been described and referred to the Jones fauna. The fossil flora is not known. Hibbard (1940) published the first description of the fauna, including a summation of work by Goodrich (1940), who identified several mollusks. Of particular interest is the presence of the mollusk *Lymnaea stagnalis* subsp., which is represented by *L. s. appressa* today at Gunnison, Colorado, the locality nearest the Meade County site. The presence of *Lymnaea stagnalis* subsp. suggested to Goodrich that there were waters colder the year round than now exist in southwestern Kansas. Tihen (1942) has given a complete analysis of the high concentration of 1250 or more fossil individuals of neotenic *Ambystoma tigrinum*. He has suggested that these remains represent a large colony that was exterminated with the drying of the sink. He notes the similarity in size of these amphibia with neotenic specimens from Colorado Springs, Colorado.

Hibbard has reported on the mammalian fauna (1940, 1942, 1943, 1949a and 1949b). *Sorex cinereus* Kerr, *Citellus richardsonii* (Sabine) and *Microtus pennsylvanicus* (Ord) were most abundant and represent a more southern distribution than that of today. Other rodent species included are: *Citellus tridecemlineatus* (Mitchill), *Cynomys ludovicianus* Ord, *Geomys* sp., *Perognathus* sp., *Onychomys leucogaster* (Wiel), and *Peromyscus* sp. Carnivora reported are *Mephitis mephitis* (Schreber) and *Taxidea taxus* (Schreber). A tayassuid artiodactyl, *Platygonus* sp., was present as also *Camelops*, both of which are now extinct.

#### METHODS

Single specimens of isolated skeletal elements were the only fossil materials available for many of the identifications, and this increased the necessity for care in discerning individual differences as opposed to species distinctions. Different bones within the various families and orders of birds display varying degrees of usefulness in differentiation. Recent species that are difficult to separate on the basis of external features prove even more difficult to separate by means of single elements of the internal skeleton. Generic identifications of single fossil elements might have been given a specific designation if a complete skeleton had been available. Qualitative features such as relative positions of tuberosities or depth of fossae proved to be as important as quantitative data in showing probable genetic differences or affinities between living species and the fossils. When practical to do so, measurements of bones were made. If gross size distinctions between a fossil bone and a living species were obvious, the latter species was immediately eliminated from consideration. Comparisons with extremes and averages of series of measurements of recent species were made where differences could be satisfactorily determined from such data. In many instances in the study, determinations of statistically significant distinctions between measurements were made using either of two formulae: comparison of the single fossil specimen with a large sample, or a single specimen with a small sample (Simpson and Roe, 1939:188, 203). It is impractical, for the present, to attempt to include all of the data on measurements of the recent avian skeletons used in this study.

Morphologic terminology follows Howard (1929). The initials UKMNH refer to material from the University of Kansas, Museum of Natural History.

#### SPECIES ACCOUNTS

The order of classification follows the American Ornithologists' Union Check-list (1931) with the following exceptions: I follow Delacour and Mayr (1945) in the classification of the Anatidae and Peters (1934) in the placement of the subfamily Arenariinae in the family Scolopacidae.

## FAMILY COLYMBIDAE (fig. 1).

*Colymbus caspicus* Hablizl. Eared Grebe. Complete (except for slight chipping at distal end) carpometacarpus; UKMNH no. 5676. Although slightly smaller than the means or extremes of measurements of the total length of carpometacarpi of *Colymbus caspicus*, *C. auritus* and *Podilymbus podiceps* (see table 1), this specimen shows no significant difference from *C. caspicus* in the total complex of characters. The pollical facet and metacarpal 1 are larger in *C. auritus* and *P. podiceps*. *P. podiceps* is distinct in having a shorter and more angular posterior edge of the external flange and carpal trochlea.

Table 1

Comparison of Total Length of Carpometacarpus No. 5676 with Samples of Recent Colymbidae<sup>1</sup>

Species	Number of specimens	Mean	Observed range	Standard deviation	Dimensions of fossil specimen	Difference <sup>1</sup> Stan. dev.	P <sup>1</sup>
<i>Colymbus auritus</i>	8	33.75±0.37	32.1-35.0	1.04	28.8	4.7	<.01
<i>Colymbus caspicus</i>	18	30.88±0.19	29.7-32.5	0.82	28.8	2.0	<.05
<i>Podilymbus podiceps</i>	14	33.50±1.50	31.2-37.1	2.98	28.8	1.6	..... <sup>2</sup>

<sup>1</sup> See Simpson and Roe, 1939:137, 191, 206.<sup>2</sup> Not significant.

## FAMILY ANATIDAE (fig. 1).

*Anas acuta* Linnaeus. Pintail Duck. Incomplete proximal ends of coracoids, UKMNH nos. 5644 and 5641. *Anas americana* closely resembles the fossils but differs in having a more deeply excavated triosseal canal; slightly longer and more posterior glenoid facet (as viewed ventrally); slightly greater extension of the brachial tuberosity beyond the shaft contour; and slightly deeper and narrower brachial notch. *A. acuta* is similar to the fossils in size (see table 2) and in the features noted above (also see fig. 2 for comparisons).

*Anas* Linnaeus. Teals. One anterior part of the coracoid, UKMNH no. 5679; three carpometacarpi, UKMNH no. 5649 complete, no. 5668A distal fragment, no. 5647 proximal half; two tibiotarsi, UKMNH no. 5683C distal, no. 5683B proximal. None of these specimens can be identified specifically. The single coracoid seems to show marked resemblance to *Anas cyanoptera*, whereas the other elements are nearer *A. carolinensis* and *A. discors*. It seems that at least two species of teals were present in this avifauna.

*Anas clypeata* (Linnaeus). Shoveller Duck. One nearly complete coracoid, UKMNH, no. 5639. With the exception of a slightly longer glenoid facet, the fossil is remarkably similar to Recent specimens of *Anas clypeata* in the characters compared (see table 3 and fig. 2). *Aythya affinis* is closely related but shows distinction in: significantly greater length; greater ventrad angulation of the anterior

Table 2

Comparison of Coracoid No. 5644 with Samples of Closely Related Anatidae\*

Characters	Number of specimens	Mean	Observed range	Standard deviation	Dimensions of fossil specimen	Difference Stan. dev.	P
Head thickness							
<i>Anas platyrhynchos</i>	7	5.42±0.16	4.8-6.1	0.43	4.4	2.4	.05
<i>Anas acuta</i>	33	4.82±0.52	4.1-5.5	0.30	4.4	1.4	.....
<i>Anas americana</i>	9	4.72±0.07	4.4-5.1	0.21	4.4	1.5	.....
Anterior width							
<i>Anas platyrhynchos</i>	7	10.85±0.36	9.0-11.5	0.96	9.1	1.8	.....
<i>Anas acuta</i>	33	9.54±0.14	8.5-10.5	0.84	9.1	0.5	.....
<i>Anas americana</i>	9	8.92±0.12	8.4-9.7	0.35	9.1	0.5	.....

\* See footnotes of table 1.

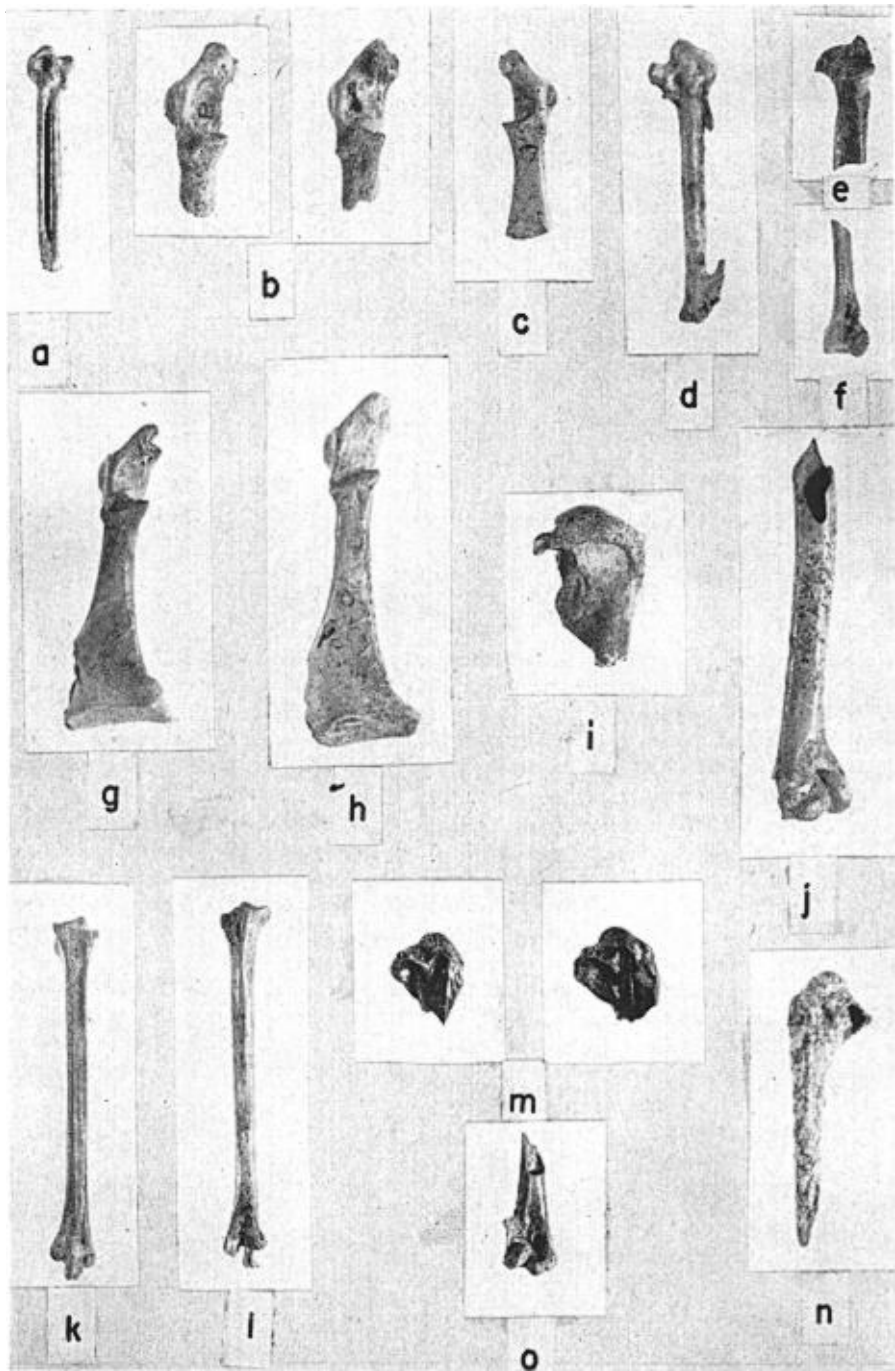


Fig. 1. Bones of Pleistocene birds from the Jones Fauna of Kansas. All photos  $\times 1$ . *a*, *Colymbus caspicus*, UKMNH no. 5676; *b*, *Anas acuta*, anterior coracoids, UKMNH nos. 5641 and 5644; *c*, *Anas* (teal), anterior coracoid, UKMNH no. 5679; *d*, *Anas* (teal), carpometacarpus, UKMNH no. 5649; *e*, *Anas* (teal), tibiotarsus, UKMNH no. 5683B; *f*, *Anas* (teal), distal tibiotarsus, UKMNH no. 5683C; *g*, *Anas clypeata*, coracoid, UKMNH no. 5639; *h*, *Aythya*, coracoid, UKMNH no. 6052; *i*, *Aythya*, proximal humerus, UKMNH no. 5652; *j*, *Aythya*, distal humerus, UKMNH no. 6057; *k*, *Bartramia longicauda*, anterior view of tarsometatarsus, UKMNH no. 6394; *l*, *Bartramia longicauda*, posterior view of tarsometatarsus, UKMNH no. 6394; *m*, *Bartramia longicauda*, proximal humeri, UKMNH nos. 5653 and 5654; *n*, *Bartramia longicauda*, proximal humerus, UKMNH no. 5659; *o*, *Bartramia longicauda*, distal humerus, UKMNH no. 5655.

portion of the coracohumeral surface; greater distance between the intermuscular line and edge of the shaft; and longer glenoid facet.

Table 3

Comparison of Coracoid No. 5639 with Samples of Recent Anatidae\*

Characters	Number of specimens	Mean	Observed range	Standard deviation	Dimensions of fossil specimen	Difference Stan. dev.	P
<b>Total length</b>							
<i>Anas cyanoptera</i>	7	34.99±0.28	33.8-35.8	0.75	38.0	4.0	<.01
<i>Anas americana</i>	9	42.20±0.33	40.5-43.5	1.00	38.0	4.2	<.01
<i>Anas clypeata</i>	6	40.00±0.62	38.1-42.2	1.51	38.0	1.3	.....
<i>Aythya affinis</i>	12	43.00±0.37	41.1-44.5	0.96	38.0	5.2	<.01
<b>Head thickness</b>							
<i>Anas acuta</i>	33	4.82±0.08	4.1-5.5	0.43	3.7	2.6	<.01
<i>Anas americana</i>	9	4.72±0.07	4.4-5.1	0.21	3.7	4.9	<.01
<i>Anas clypeata</i>	6	4.02±0.08	3.7-4.3	0.21	3.7	1.5	.....
<b>Canal width</b>							
<i>Anas cyanoptera</i>	7	4.57±0.05	4.4-4.7	0.02	5.6	5.2	<.01

\* See footnotes of table 1.

*Aythya* Boie. Scaup Ducks. Three coracoids, UKMNH no. 6052, nearly complete and nos. 6170 and 5642 incomplete; two fragments of humeri, UKMNH proximal portion no. 5652 and a distal piece no. 6057. Coracoids of surface-feeding ducks of the tribes Anatini and Cairinini are distinct from the fossils and from *Aythya* in the lesser degree of twist or angulation of the head of the coracoid relative to the longitudinal axis of the shaft. This feature is most readily observed from an anterior view. Other features of the coracoids suggest relationship to *Aythya*, also; specific identification, however, is not possible.

The proximal humeri cannot be distinguished from *Aythya marila* or *A. affinis* in any of the features compared. The distal humerus (no. 6057) resembles *Aythya* in many features, but the attachment of the anterior articular ligament is broader and the scar for the pronator brevis is more palmar in position in *Aythya* than in the fossil.

Because of similarity in size, these fossil coracoids and humeri are more likely to be related to *Aythya marila*, *A. affinis* or *A. collaris* than to *A. americana*.

Aythiini, indeterminate. Distal end of humerus UKMNH no. 5662 and proximal end of tibiotarsus no. 6054. The small size of the humerus, the position of the pronator brevis scars and shape of the brachial depression suggest possible affinity with *Bucephala albeola*, the Bufflehead. The tibiotarsus appears to be distinct from species of the tribes Anatini and Cairinini in that the flexor attachment is opposite rather than proximal to the fibular crest, and the external articular facet is highly convex.

FAMILY SCOLOPACIDAE (figs. 1 and 5).

*Bartramia longicauda* (Bechstein). Upland Plover. Nearly complete tarsometatarsus, UKMNH no. 6394; proximal ends of humeri nos. 5653, 6554 and 5659, distal end of humerus no. 5655. The tarsometatarsus, no. 6394, has the trochleae eroded, and the calcaneal ridges of the hypotarsus are absent (except the inner ridge). The only species of shore bird that has dimensions equal to this fossil tarsometatarsus is *Bartramia longicauda* (see table 4). Other qualitative features of the fossil are nearly identical to this species. The humeri strongly resemble *B. longicauda* in size and in the several characters compared in figs. 3 and 4.

There were at least two individuals of this species in the fauna. This is the first record of the genus as a fossil.

*Erolia* Vieillot. Sandpipers. Complete tarsometatarsus UKMNH no. 6064 with slight defacement on the lateral edges of the external and internal cotylae. This fossil cannot be identified as to the species. *Erolia melanotos* or *E. alpina* appear to resemble the fossil more closely than do other small

sandpipers. *E. melanotos* differs somewhat in greater size, whereas *E. alpina* has one of the calcaneal ridges smaller than in the fossil.

Calidridiinae, indeterminate. Distal ends of humeri UKMNH nos. 5677 and 5670. The morphology of available features suggests some resemblance to *Crocethia* or *Erolia* but generic affinity is not determinable.

Scolopacidae, indeterminate. Coracoids UKMNH nos. 6058 and 5674; carpometacarpi no. 6063 (proximal), no. 5683E (distal), and distal end of ulna no. 5675. The coracoids show greatest re-

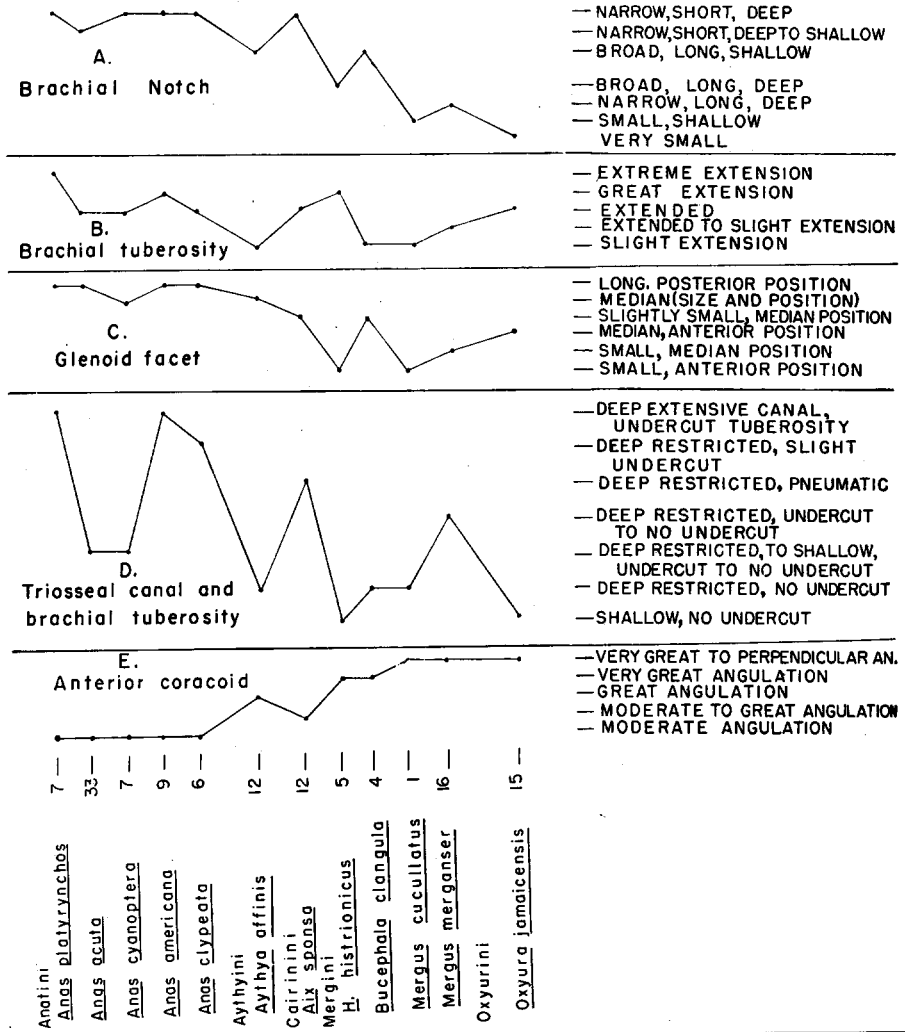


Fig. 2. Comparison of structure of coracoid in Anatidae. Each character listed at left was classified according to categories listed at right. A, shape of brachial notch; B, degree of extension of brachial tuberosity beyond contour of shaft; C, size and position of glenoid facet relative to proximal end in ventral view; D, degree of excavation of triosseal canal area and undercut beneath overhanging lip of brachial tuberosity; E, angle between longitudinal axis of head, or plane of surface of brachial tuberosity, and transverse axis of shaft viewed from anterior end of bone. Numbers of specimens examined are given to the right of scientific names.

semblance to *Limnodromus* and *Bartramia* on the basis of length, contour of shaft, distance across the triosseal canal, and position and shape of the glenoid facet. The proximal end of the fossil carpometacarpus suggests resemblance to *Arenaria*, *Totanus*, and *Limnodromus*, but the features are not satisfactory for determinations. Likewise, the distal end of the carpometacarpus has few diagnostic characters; however, there is some suggestion of resemblance to *Calidris* or *Bartramia*. The ulna resembles *Tringa solitaria* and *Erolia melanotos* in size and contour of the carpal tuberosity.

FAMILY COLUMBIDAE (fig. 5).

*Zenaidura macroura* (Linnaeus). Mourning Dove. A proximal end of carpometacarpus UKMNH no. 5650. The fossil is identical to *Zenaidura macroura* in width of the carpal (3.2 mm.), length of the symphysis (6.3 mm.), the scar for the attachment of the flexor digit III being parallel to the anteroposterior plane of the bone. Its size is equal to the corresponding element in *Z. macroura*. The internal flange of the carpal is longer than broad, and the base of the pisiform process is also of similar size.

FAMILY ICTERIDAE (fig. 5).

? *Agelaius* Vieillot. Blackbird. Complete carpometacarpus UKMNH no. 5648. Comparisons were

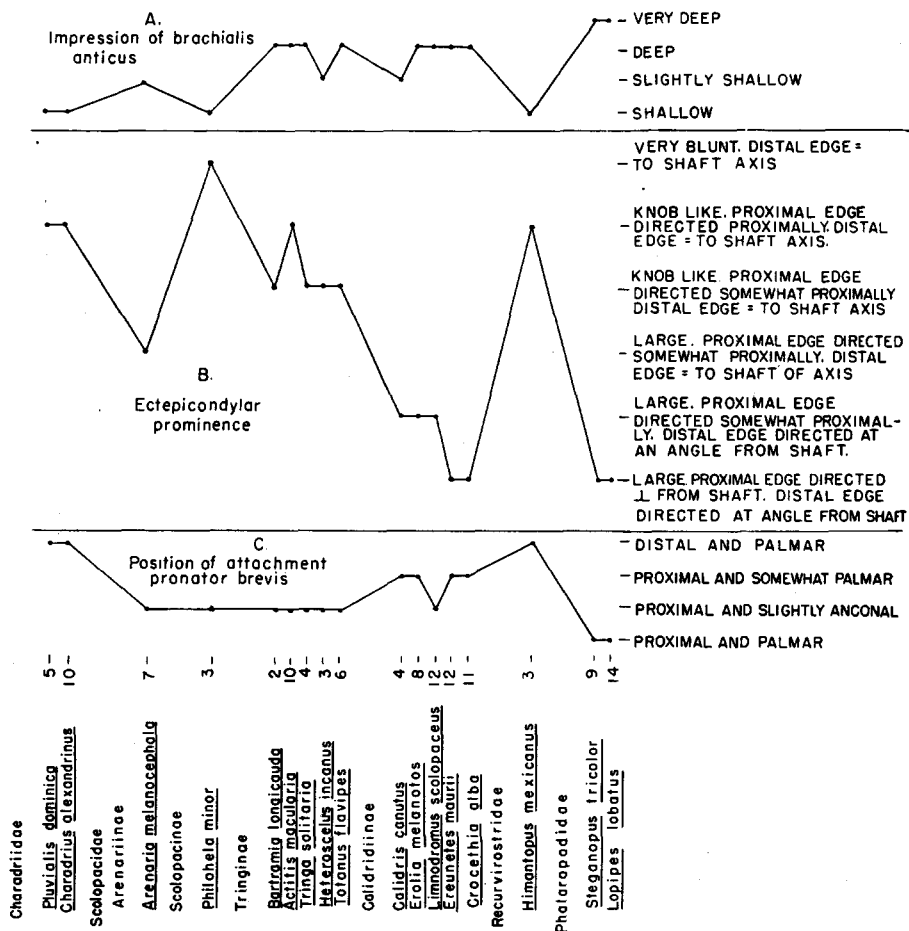


Fig. 3. Comparison of structure of distal humerus in Charadriodea. Data organized as in figure 2 (see legend).

made with *Xanthocephalus*, *Agelaius* and *Euphagus*, and though all are similar to the fossil, nearest affinity seems to be with *Agelaius*. A definite generic assignment is not possible.

? *Molothrus* Swainson. Cowbird. Incomplete carpometacarpus UKMNH no. 5669 and proximal end of humerus UKMNH no. 6062. The fragmentary carpometacarpus appears to be most closely

Table 4

Comparison of Tarsometatarsus No. 6394 with Samples of Recent Scolopacidae\*

Characters	Number of specimens	Mean	Observed range	Standard deviation	Dimensions of fossil specimen	Difference Stan. dev.	P
Total length							
<i>Bartramia longicauda</i> (skins and skel.)	16	47.78±0.54	44.2-52.5	2.15	46.3	0.7	.....
<i>Totanus flavipes</i> (skins and skel.)	15	52.17±0.43	48.3-54.8	1.65	46.3	3.6	<.0004
<i>Limnodromus scolopaceus</i>	12	41.29±0.84	36.7-44.7	2.43	46.3	2.1	<.04
<i>Micropalama himantopus</i> (skins)	10	41.35±0.75	37.9-44.9	2.36	46.3	2.1	<.04
Distal width							
<i>Bartramia longicauda</i> (skins and skel.)	14	5.82±0.56	5.3-6.2	0.21	5.9	0.3	.....
<i>Totanus flavipes</i> (skins and skel.)	15	4.28±0.76	3.9-5.0	0.30	5.9	5.5	<.00006
<i>Limnodromus scolopaceus</i>	12	4.56±0.48	4.2-4.9	0.16	5.9	8.1	<.00006
<i>Micropalama himantopus</i> (skins)	10	3.63±0.75	3.1-4.0	0.24	5.9	9.6	<.00006

\* See footnotes of table 1.

related to *Molothrus ater*. The partial humerus is certainly a small icterid, possibly an immature *Molothrus*, although *Icterus galbula* and *I. bullockii* show certain resemblances also.

Icteridae, indeterminate. Proximal ulna, UKMNH no. 6067.

#### FAMILY FRINGILLIDAE (fig. 5).

*Calamospiza melanocorys* Stejneger. Lark Bunting. Incomplete upper mandibles UKMNH nos. 5674 and 5674B. In no. 5674 the posterior half of the internarial bridge, the right maxillary and small portion of the premaxillary and posterior borders of the narial openings are absent. No. 5674B has only the anterior part of the mandible present, but features available for comparison show resemblance to no. 5674.

These fossils show marked resemblance to *C. melanocorys* in the broadly based, fully arched premaxillary. On the posterior vertical surface of the maxillary area of the fossil (no. 5674) there are two foramina, near the vertical margin. These foramina may be observed in recent skulls through the external narial openings. It appears that extensions of the fifth (trigeminal) and seventh (facial) nerves and branches of the maxillaris artery and vein might pass through these foramina; a specimen of *Carpodacus mexicanus frontalis*, MVZ no. 63138, has a transparent mandible and the foramina may be traced as channels with small end branchings at the tip of the mandible. These foramina in *Dolichonyx*, *Guiraca* and *Carpodacus* tend to be more widely separated from each other than in the fossil and *Calamospiza*. Additional features that resemble *Calamospiza* are the prominent central grooves bordering a narrow well-developed median ridge on the palatal surface, the internarial bridge widened anteriorly and gently arched, and a moderately stout maxillary. This is the first fossil record of this species, which is today a common summer resident in Kansas.

*Calcarius* Bechstein. Longspur. Incomplete upper mandible, UKMNH no. 6068, the left maxillary, tip of premaxillary and posterior borders of narial openings are absent. *Calcarius* resembles the fossil in the relatively deep and wide central grooves of the palatal surface, the foramina of the maxillary area (*Plectrophenax* has the foramina closer together and they are larger than in the fossil and



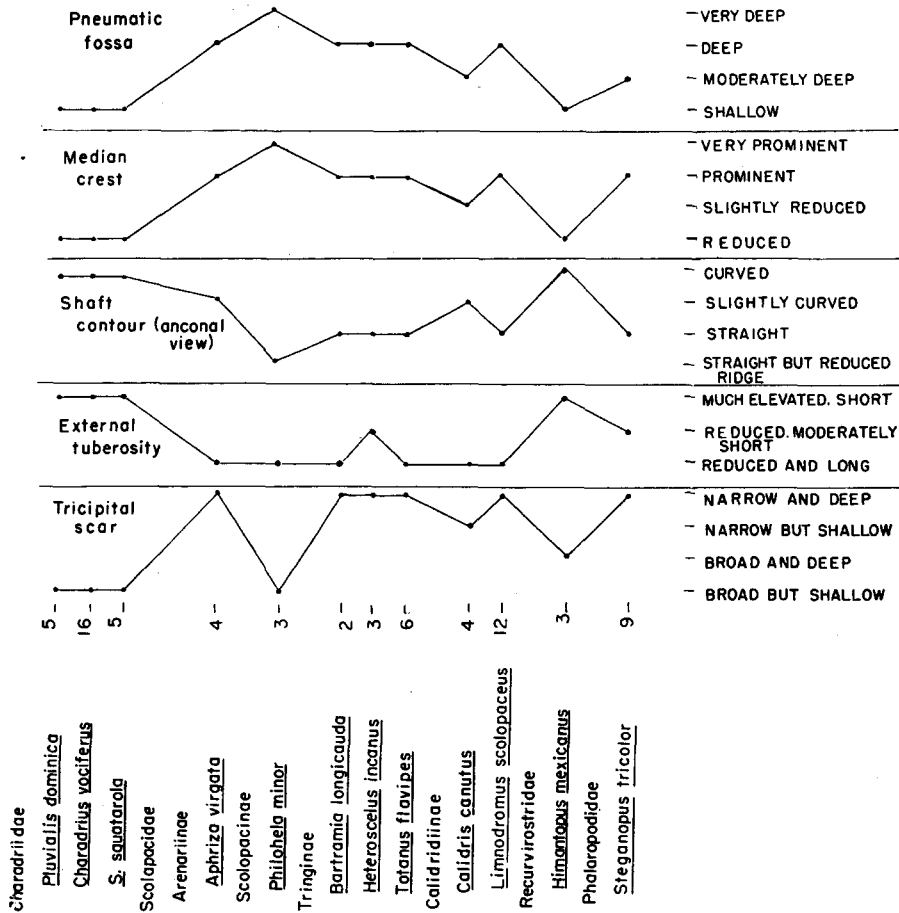


Fig. 4. Comparison of structure of proximal humerus in Charadrioidae. Data organized as in figure 2 (see legend).

*Calcarius*), the slim premaxillary with slightly incurving lateral edges, the widely arched contour of the anterior border of the external naris, the narrow but relatively deep internarial bridge, and a maxillary wide anteriorly with marked narrowing to a point at the posterior tip (the tip is directed ventrally). Specific distinction is not possible although it appears that *C. ornatus* is smaller than the fossil. *C. pictus* (of equal size to the fossil) is reported from eastern Kansas today whereas *C. lapponicus* (also the same size as the fossil) commonly occurs as a winter resident in western Kansas. *C. lapponicus* is, therefore, more likely to be the species represented by the fossil. This is the first occurrence of the genus in the fossil record.

Lambrecht (1933) has shown that there are records of "*Passerina (Calcarius, Plectrophanes) nivalis*," the Snow Bunting, in the Pleistocene of Europe. On the basis of nomenclature used in the A.O.U. Check-list (1931), Witherby *et al.* (1939), and the synonymy of Ridgway (1901), it is assumed that the species referred to by Lambrecht is *Plectrophenax nivalis*, not the longspurs of the genus *Calcarius*.

Emberizinae, indeterminate. Complete humerus, UKMNH no. 5656, distal end of humerus no. 5667, proximal end of humerus no. 6059, complete tibiotarsus no. 5683F, distal fragments of tibiotarsi no. 5683E, J, and K, proximal fragment of tibiotarsus no. 5683H, complete ulna no. 5671, incomplete lower mandible no. 6066, complete carpometaarpus no. 6061.

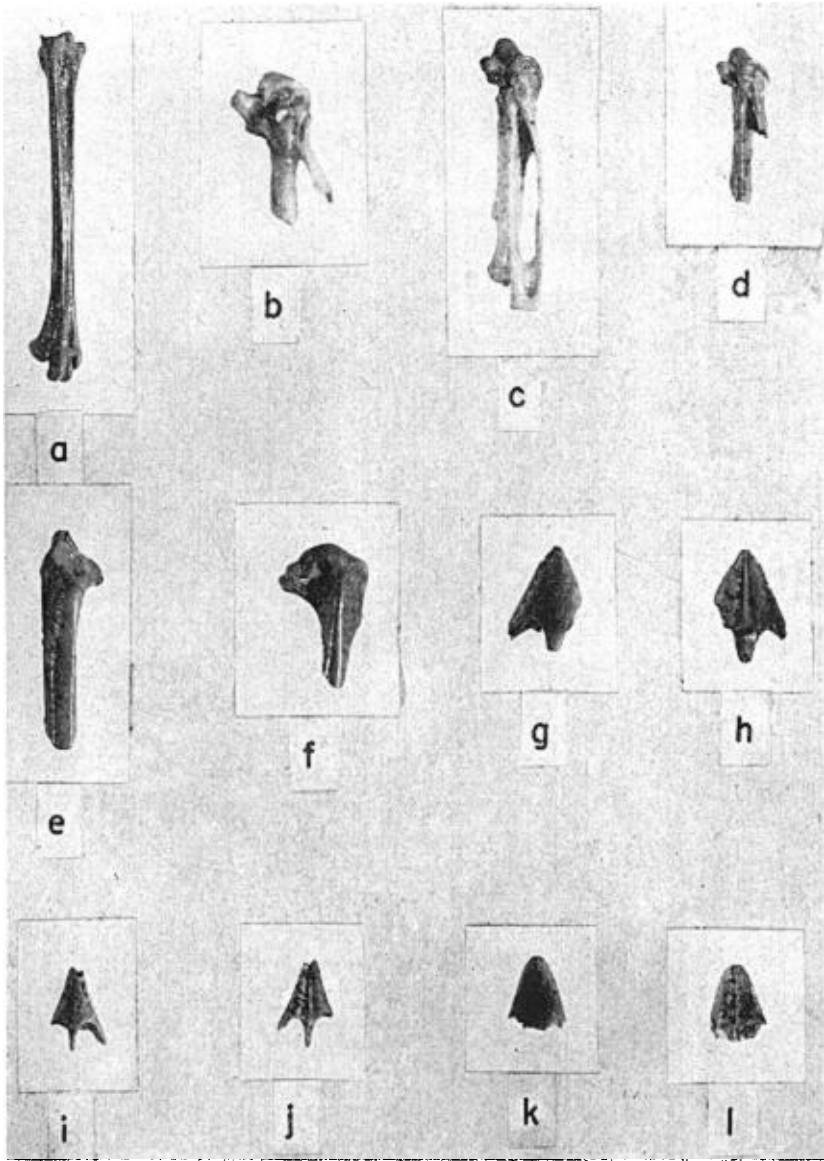


Fig. 5. Bones of Pleistocene birds from the Jones Fauna of Kansas. All photos  $\times 2$ . *a*, *Erolia*, tarsometatarsus, UKMNH no. 6064; *b*, *Zenaidura macroura*, proximal carpometacarpus, UKMNH no. 5650; *c*, ? *Agelaius*, carpometacarpus, UKMNH no. 5648; *d*, ? *Molothrus*, proximal carpometacarpus, UKMNH no. 5669; *e*, Icteridae, proximal ulna, UKMNH no. 6067; *f*, ? *Molothrus*, proximal humerus, UKMNH no. 6062; *g*, *Calamospiza melanocorys*, dorsal view of upper mandible, UKMNH no. 5674; *h*, *Calamospiza melanocorys*, ventral view of upper mandible, UKMNH no. 5674; *i*, *Calcarius*, dorsal view of upper mandible, UKMNH no. 6068; *j*, *Calcarius*, ventral view of upper mandible, UKMNH no. 6068; *k*, *Calamospiza melanocorys*, dorsal view of upper mandible, UKMNH no. 5674B; *l*, *Calamospiza melanocorys*, ventral view of upper mandible, UKMNH no. 5674B.

Fringillidae, indeterminate. Two incomplete coracoids UKMNH nos. 5678 and 6060.

Many of these small specimens of fringillids are indeterminate type of sparrows and buntings which, in their various characters, could represent *Passerculus*, *Ammodramus*, *Junco*, *Aimophila*, *Spizella*, *Melospiza*, *Zonotrichia*, *Chondestes* or *Poocetes*.

In addition to the specimens noted above, there are fifteen unidentified elements probably referable to Anseriformes, four to Charadriiformes, five to Passeriformes, and thirty-two miscellaneous bird bones. The total number of fragments or complete elements from the Jones avifauna is 115.

#### NOTES ON COMPARATIVE OSTEOLOGY

Some general, though tentative conclusions as to the characterization of critical features in elements of Recent ducks and shorebirds that were compared with the fossils are included in chart form in figures 2, 3 and 4. The charts reflect subjective evaluation in most instances and cannot be used as keys to identification of a particular group in a strict sense; they may, however, be of some assistance in segregating isolated bones. Since the study did not include a survey of all species of ducks and shorebirds, the conclusions cannot be interpreted as applicable to all members of the subfamilies listed. The statements apply only to the groups included. Further investigations along these lines may be worthwhile and should be attempted before conclusions of general taxonomic significance can be made.

In the study of the coracoid in ducks an attempt may be made to correlate structure and function. The data interpreted from figure 2 suggest that the habits of surface feeding and quick vertical ascent from the water (see Bent, 1923; Witherby *et al.*, 1939; and Delacour and Mayr, 1945) in species of the tribes Anatini and Cairinini may be correlated with slight angulation of the head, great excavation of the triosseal canal (the teals appear to vary more than the other species of Anatinae in this character), a wide triosseal canal relative to total length of the bone, and the posterior position and large size of the glenoid facet. In contrast the tribes Aythyini, Mergini, and Oxyurini, predominantly diving birds and types tending to patten or paddle along the surface of the water before taking fully to the air, have greater twist of the head regions of the coracoid and relatively narrower triosseal canal. The other characters analyzed show greater variability in these tribes than the tribes Anatini and Cairinini.

The perching ducks of the tribe Cairinini are a distinct group but show affinity with the river ducks or tribe Anatini, according to Delacour and Mayr (1945). The features of the coracoid studied in this report further indicate this relationship.

In the process of analysis of recent species of shorebirds, it became apparent that certain characters show particular trends in the various groups studied. Figures 3 and 4 present some of these trends graphically and require no detailed comment here. *Philohela* shows similarity to the other scolopacids in the feature of the external tuberosity of the proximal end of the humerus, but has possibly distinctive specialization in the development of the pneumatic fossa, the median crest, and the contour of the shaft in this element. Study of the coracoid (not shown in the charts) has revealed a resemblance of species of Charadriinae and Recurvirostridae (including *Himantopus* and *Recurvirostra*) in the presence of the small coracoidal fenestra. Species of the subfamilies Arenariinae, Scolopacinae, Tringinae and the family Phalaropodidae lack this fenestra.

From the viewpoint of taxonomic relationships, it is notable that the features of the distal end of the humerus and the coracoid in species of the subfamily Arenariinae show consistent resemblance to species of the subfamilies Tringinae and Calidridiinae rather than to those of the Charadriidae. This evidence appears to support the placement of the Arenariinae in the family Scolopacidae as Peters (1934:2), Lowe (1931), and Witherby *et al.* (1940) have done rather than in the Charadriidae as shown in the A.O.U. Check-list, 1931.

The families Charadriidae and Recurvirostridae (as represented in this study) consistently show resemblance to each other in all the characters of the humerus and coracoid that were examined. Further examination of skeletal elements should be made to determine the possible significance of this apparent phyletic relationship.

#### ENVIRONMENTAL RELATIONSHIPS

The area of the Jones fauna locality today is characterized by relatively rough terrain with portions of flat upland, some steep slopes (Frye, 1942) and plains grasslands mixed locally with deciduous trees (Pitelka, 1941; Dice, 1943). A summarization of general ecological associations represented by the types of birds found in the fossil avifauna from this locality is shown in table 5. The local habitats and distribution of recent

Table 5

Species	Recent local habitat and distribution in Kansas	Associations	
<i>Colymbus caspicus</i>	Formerly common migrant, now rare. Goss records occasional breeding in colonies. Found on fresh water, marshy shallow lakes, alkali or reedy streams and undisturbed ponds. Diving birds.	}	
<i>Anas acuta</i>	Common migrant, in large numbers. Found on fresh water, shallows, marshes, ponds in prairie country. Surface feeders.		
Anas (teals)	<i>A. carolinensis</i> fairly common migrant; <i>A. discors</i> common migrant, occasional summer resident; <i>A. cyanoptera</i> rare migrant, formerly possible summer resident. Found on sloughs, shallow pools, lakes, ponds and streams. Surface feeders.		
<i>Anas clypeata</i>	Common migrant, formerly rare summer resident. Found typically on marshy shallows, ponds, lakes. Nests in grassland or sloughs. Rests on open water or lakes. Surface feeders.		Pond or lake
<i>Aythya</i> (? <i>americana</i> , <i>affinis</i> , <i>collaris</i> or <i>marila</i> )	<i>A. americana</i> rare migrant; <i>A. affinis</i> common migrant; <i>A. collaris</i> occasional migrant; <i>A. marila</i> (?). Found on marshy lakes, sometimes shallow to deep and on open ponds or lakes. Usually diving ducks.	}	
? <i>Bucephala albeola</i>	Rare migrant; formerly common. Found on fresh water, alkali lakes and ponds. Diving duck.		
<i>Erolia</i> ; other Scolopacidae	Many species are common migrants, occurring in flocks. Found on muddy flats, shores of ponds, lakes; some on uplands, rainpools. Fresh or alkaline water.		
Icteridae: ? <i>Agelaius</i> or <i>Euphagus</i> ; <i>Molothrus</i>	Common summer residents. Nest in grassland, meadows, marshes, lakes and reedy areas. Forage on upland fields, prairies and alluvial areas.		Marsh and upland
<i>Bartramia longicauda</i>	Common summer resident, south and western Kansas. Prefers upland prairies or grass plains for food and nests. Seldom near water's edge as are other sandpipers or plovers.	}	
<i>Calamospiza melanocorys</i>	Common summer resident, western Kansas. Abundant, characteristic bird of open plains. Nest on ground in same area. Feed on seeds and insects. Flock after breeding.		Upland plains
<i>Calcarius</i> (? <i>lapponicus</i> , <i>pictus</i> or <i>ornatus</i> )	Common winter resident, especially <i>C. lapponicus</i> and <i>C. ornatus</i> in western Kansas. Found in open treeless prairies and grasslands. Large flocks. Feed on seeds and insects.		
<i>Zenaidura macroura</i>	Abundant summer resident. Found in plains or woodland. Flock. Go to water usually twice daily.	Various	

birds listed have been summarized on the basis of reference to Goss (1891), Sclater (1912), Bailey (1928), Long (1940) and Grinnell and Miller (1944). In general it appears that the faunal picture was not different from a similar association of birds and environment today in many parts of the plains region of western Kansas and eastern Colorado. However, the local, relatively dry situation which exists today in the immediate area of the fossil locality indicates that this particular area has undergone significant change. One prominent element of the habitat that must have been present much of the time was a marshy lake area that could support diving and surface feeding ducks. Tall marsh grasses or reeds possibly provided nesting sites for blackbirds and the Eared Grebe.

Hibbard (1940) believes, on the basis of study of mammalian material and the conclusions of Goodrich (1940), that climatic conditions at the time of the existence of the fauna were more humid and cooler than those of today. Evidence presented from analysis of bird material neither supports nor denies the idea of a cooler climate having been present in the area; but it has been shown that some of the bird species do verify the thesis that the immediate area may have been more humid than it is today. Tihen's proposal (1942) that the deposition may have occurred during dry years, in even as little time as two seasons, cannot be supported directly or modified by a study of bird material, for the avian remains could have accumulated during several seasons of varying wet and dry character.

The total number of individuals represented by the fossil record is probably a minimum indication of the original populations. There are at least 19 individuals among the 115 fragments and complete elements. Approximately 37 per cent of these individuals represent ducks, 21 per cent fringillids, 21 per cent shorebirds, 11 per cent icterids, 5 per cent colymbids and 5 per cent columbids. Catastrophic or unusual causes of death are not indicated by the quantity of remains present nor by the probable mode of deposition. Death from age, disease, accidents or predation probably occurred; however, no predatory species of birds have been found.

Geologic relationships, the details of which have been discussed previously, imply that a unique process of deposition of the fossil material may have occurred. Possibly the nature of the history of this sink-hole area would have allowed convergent washing of remains of upland species toward the level of the sink by way of many incising erosional channels. Thus, the chance for a central concentration of bone material could have increased as compared to deposition of similar fossil material in a running stream bed. The lack of an outlet drain in the area would also increase the chances for permanent placement of the remains of the water dwelling types in the bottom of the sink. The time necessary to complete the deposit of the sediments containing the fossils has not been determined; considering the history of recent sink-hole deposition, it seems likely that not many years were needed to accumulate the bones. Knowing the circumstances of the probable method of deposition at that time, it is possible to assume that a fairly complete representation of the variety of birds present in the immediate area of the Jones fauna has been recovered. However, the number of individuals found cannot be considered indicative of any probable population size.

#### COMPARISON WITH SOME OTHER PLEISTOCENE BIRD FAUNAS

From the viewpoint of quantity of specimens, the Jones avifauna cannot be compared with other larger Pleistocene bird assemblages such as those reported from Florida (Wetmore, 1931), from México in the San Josecito Cavern (Miller, 1943), Fossil Lake, Oregon (reviewed by Howard, 1946), the Carpinteria and McKittrick asphalt in California (DeMay, 1941*a*, 1941*b*), Hawver, Potter Creek and Samwell caves (sum-

marized by Miller and DeMay, 1942), and the large accumulation of bones from the Rancho La Brea (summarized by Miller and DeMay, 1942). Comparisons can be made, however, between these faunas and the Jones fauna with regard to kinds of birds represented. The content of the Jones fauna bird assemblage is distinctly different from any of the above-mentioned faunas because of the presence of the specific upland, plains types of birds—*Bartramia*, *Calamospiza* and *Calcarius*. The great plains or prairie aspect of the environment of the Jones fauna thus sets it apart from the other Pleistocene assemblages in North America.

#### GEOLOGIC AGE

The similarity of the identified birds with modern species and genera suggests that the avifauna is probably not older than late Pleistocene. The presence of certain other animals in the fauna such as *Lymnaea* (a snail), *Sorex cinereus* (masked shrew), *Citellus richardsonii* (Richardson ground squirrel) and *Microtus pennsylvanicus* (meadow vole) all suggest inhabitants of areas with a cooler climate. In addition the occurrence of the now extinct genera *Platygonus* (a peccary) and *Camelops* indicate that the fauna, including the birds, is not younger than late Pleistocene age.

#### SUMMARY

The Jones avifauna of southwestern Kansas is the first to be studied from the Pleistocene of that state. Over a hundred avian fossil elements have been recorded; these represent ten genera of birds, six of which have been identified as to species; six additional forms are indeterminate as to genus within their designated groups.

*Bartramia longicauda*, *Calamospiza melanocorys*, and the genus *Calcarius* are reported for the first time as fossils.

Observations made on recent bird skeletons during the process of identification of the fossils have provided some data on relationships in the Anatidae on the basis of the structure of the coracoid, and in the Charadriiformes on the basis of the structure of the coracoid and humerus.

The avian fossils identified suggest that near the Jones locality there was a marshy lake or pond with surrounding upland plains or prairies. The climate may have been more humid than it is today. The content of the avifauna suggests probable late Pleistocene dating, an age further verified in previous studies of the mammals from the same deposit.

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An unusually placed nest of the Black Phoebe built on a length of loosely hanging wire. Photographed by Ray Quigley, Jr.