

**Some birds of prey from the Upper Pliocene of Kansas.**—Although many avian fossils from the local faunas of the Rexroad formation (Upper Pliocene), Meade County, Kansas, have now been reported, several species of birds of prey remain. These fossils, which Dr. C. W. Hibbard of The University of Michigan Museum of Paleontology and his field parties collected, come from the Rexroad and Fox Canyon local faunas of the Rexroad formation. These two localities are described by Hibbard (1950). The two local faunas have been treated as one in the past, but Hibbard's (1967) latest view is that they are distinct. The Fox Canyon local fauna is now considered to be older than the Rexroad and is distinct on the basis of its small mammals (Hibbard, 1967). Birds have been reported previously from these local faunas by Wetmore (1944), Tordoff (1951, 1959), Brodkorb (1964, 1967), Collins (1964), Ford (1966), Murray (1967), and Feduccia (1967, 1968). The birds of prey represented are as follows:

*Accipiter* sp.—Two distal ends of tibiotarsi represent an accipiter approximately the size of the Recent *A. cooperi*, but the elements are not sufficiently diagnostic to warrant the naming of a new species or the definite assignment of the fossils to the Recent form. One bone, a 42-mm piece of the distal end of a left tibiotarsus (UMMP No. V57506, from the Rexroad local fauna, loc. no. 3) measures 10.8 mm in width through condyles. The same measurement for eight specimens of Recent *A. cooperi* females gives a mean of 10.1 mm, with a range of 9.2–10.9 mm. The smaller fossil, a 17.1-mm piece of the distal end of a left tibiotarsus (UMMP No. V45422, from the Rexroad local fauna, loc. UM-K3-53) measures 9.0 mm in width through condyles. The same measurement for five males of Recent *A. cooperi* gives a mean of 8.5 mm, with a range of 8.3–8.8 mm. Whether or not both fossils represent females or one a female and the other a male cannot be determined, but it is probably best to assume that only one species is represented.

*Buteo* sp.—A fragment of a right coracoid (UMMP No. V24767, from the Fox Canyon local fauna, loc. UM-K1-47) represents a large species of *Buteo* close in size and morphology to *B. jamaicensis*, but it is too fragmentary to permit allocation. No useful measurements could be taken.

*Falco* sp.—The considerable size variation in the falconiform birds owing to sexual dimorphism quite often transcends the boundaries of the Recent species and makes the allocation of fossil material very difficult. This is the case for many elements in the Rexroad collections that represent a small falcon, larger than *F. sparverius* and approximately the size of *F. columbarius*. The elements include an almost complete right coracoid (UMMP No. V29107, from the Fox Canyon local fauna, loc. UM-K1-47), which measures 25.7 mm in total length. The mean for total length for seven unsexed specimens of the Recent *F. columbarius* is 29.8 mm, for six females of Recent *F. sparverius*, 23.8 mm. The fossil is therefore intermediate in size between the two Recent species but is somewhat more robust than *F. sparverius*, resembling *F. columbarius* in this character. Three pieces of the distal end of tarsometatarsi (UMMP Nos. V27159, V57509, from the Fox Canyon local fauna, loc. UM-K1-47, and V57510 from the Rexroad local fauna, loc. no. 3) represent a falcon somewhat similar in size and osteological characters to the Recent *F. columbarius*. In width across the trochleae, the fossils V27159, and V57510 measure respectively, 7.3 mm, and 6.5 mm. The mean for the same measurement for three Recent specimens of *F. columbarius* is 6.4 mm. The proximal end of a tarsometatarsus (UMMP No. 57514, from the Fox Canyon local fauna, loc. UM-K1-47) appears to represent the same species as the distal fragments, but is too fragmentary to be of use. A fragment of the proximal end of a left humerus (UMMP No. V57508, from the Fox Canyon local

fauna, loc. UM-K1-47), is also close to the Recent *F. columbarius* and appears to represent the same species as the other fossils. In addition the distal 20 mm of a left tibiotarsus (UMMP No. 57513), from the Fox Canyon local fauna, loc. UM-K1-47) seems to represent the same form. It measures 6.7 mm in width across the condyles. The mean for three specimens of the Recent *F. columbarius* is 6.7 mm. All of these elements indicate that the Fox Canyon local fauna contained a hawk similar in size and morphology to the Recent *F. columbarius*, but whether or not it is conspecific with the Recent species is impossible to determine owing the variation involved.

*Bubo* sp.—Two elements represent a large owl, probably a species of *Bubo* similar in size to the Recent *B. virginianus*, but the elements are not sufficiently diagnostic to permit positive identification. The first, the distal 33 mm of a left tibiotarsus with the condyles badly eroded (UMMP No. V47724, from the Rexrod local fauna, loc. UM-K3-53) is the size of large individuals of *B. virginianus* and *Nyctea scandiaca* and agrees with them in having the ventrolateral portion of the tendinal groove separated from the rest of the depression by an oblique ridge running from above the middle of the lateral rim. This character will not separate all species of *Bubo* from those of *Strix*, but does appear a constant diagnostic character for the modern North American species of these genera. Thus the fossil, which measures 13.4 mm in width of shaft across the tendinal groove and 5.3 mm in thickness of the intercondylar area, probably represents a member of the genus *Bubo* (possibly *Nyctea*) and is not distinguishable from *B. virginianus* on the basis of size. The second element is an incomplete right coracoid (UMMP No. V31030, from the Rexroad local fauna, loc. no. 3), 44 mm in length, which agrees closely in size and morphology with both *Strix nebulosa* and *B. virginianus*. It differs from both these species in having the lateral surface of the shaft above the sterno-coracoidal facet broadly flattened, but as even complete coracoids of *Strix* and *Bubo* cannot be distinguished with certainty and most other genera cannot be identified on the basis of the characters remaining on this fossil, it is not possible to identify it any more precisely than being from a large owl of the size of *S. nebulosa* and *B. virginianus*. The coracoid measures 5.9 mm in least width of shaft, 36.5 mm in the internal distal angle to margin of scapular facet, and the estimated total length is 50–52 mm. The two elements may represent two species of owls, but only one large Rexroad owl can be recorded with certainty.

Previously reported birds of prey from the faunas of the Rexroad formation include *Otus* cf. *asio* (Fox Canyon local fauna), *Speotyto megalopeza* (Rexroad and Fox Canyon local faunas), and *Asio* sp. (Fox Canyon local fauna) (Ford, 1966).

We wish to thank C. W. Hibbard, R. W. Storer, and H. B. Tordoff for their criticism of the manuscript, and Joel Cracraft of The American Museum of Natural History for providing certain measurements. Feduccia's work was supported in part by a grant from the National Science Foundation, GB-6230, to N. G. Hairston, The University of Michigan, for research in Systematic and Evolutionary Biology. Ford's work was supported in part by a grant from the Faculty Research Fund, St. John's University.

#### LITERATURE CITED

- BRODKORB, P. 1964. Notes on fossil turkeys. *Quart. J. Florida Acad. Sci.*, 27: 223–229.
- BRODKORB, P. 1967. Catalogue of fossil birds: part 3 (Ralliformes, Ichthyornithiformes, Charadriiformes). *Bull. Florida State Mus.*, 11: 99–220.
- COLLINS, C. T. 1964. Fossil ibises from the Rexrod fauna of the Upper Pliocene of Kansas. *Wilson Bull.*, 76: 43–49.

- FEDUCCIA, J. A. 1967. A new swallow from the Fox Canyon local fauna (Upper Pliocene) of Kansas. *Condor*, 69: 526-527.
- FEDUCCIA, J. A. 1968. The Pliocene rails of North America. *Auk*, 85: 441-453.
- FORD, N. L. 1966. Fossil owls from the Rexroad fauna of the Upper Pliocene of Kansas. *Condor*, 68: 472-475.
- HIBBARD, C. W. 1950. Mammals of the Rexroad formation from Fox Canyon, Meade County, Kansas. *Contrib. Mus. Paleontol., Univ. Michigan*, 8: 113-192.
- HIBBARD, C. W. 1967. New rodents from the late Cenozoic of Kansas. *Pap. Michigan Acad. Sci., Arts, and Letters*, 52(1966): 115-131.
- MURRAY, B. G., JR. 1967. Grebes from the late Pliocene of North America. *Condor*, 69: 277-288.
- TORDOFF, H. B. 1951. Osteology of *Colinus hibbardii*, a Pliocene quail. *Condor*, 53: 23-30.
- TORDOFF, H. B. 1959. A condor from the Upper Pliocene of Kansas. *Condor*, 61: 338-343.
- WETMORE, A. 1944. Remains of birds from the Rexroad fauna of the Upper Pliocene of Kansas. *Univ. Kansas Sci. Bull.*, 30: 89-105.

J. ALAN FEDUCCIA, *Department of Biology, Southern Methodist University, Dallas, Texas 75222*, and NORMAN L. FORD, *Department of Biology, St. John's University, Collegeville, Minnesota 56321*.

**Comparative orientational and homing performances of single pigeons and small flocks.**—It has long been a question in pigeon orientation studies whether data obtained from flocks (e.g. Griffin, 1952; Hitchcock, 1952) and data obtained from single birds (e.g. Michener and Walcott, 1967a, 1967b) are comparable. Homing pigeons have been selected for many years for their performance in races, but in these races the birds are released in a flock; when the birds are released individually in orientation experiments, their behavior might possibly be significantly different. Indeed, Hamilton (1967) has recently suggested, concerning birds generally, that "The orientation of groups of animals is more accurate than that of individuals." He draws a series of curves that predict decreasing deviation from the goal direction as the flock size increases, the decrease being most rapid as flock size rises from 1 to 5.

In an attempt to answer some of the questions concerning possible behavioral differences between single birds and flocks, and to evaluate Hamilton's ideas, I made a series of test releases designed to compare the performance of single pigeons with that of small flocks. All the pigeons used in these tests were of similar age and training (up to 8 miles in all directions), were housed together in the same loft pen, and were fed and exercised at the same time. It was hoped that this procedure would minimize differences in physical condition or in motivation.

For each test, some birds were randomly selected to be released singly, and others were randomly grouped to form flocks of four birds each. The singles (S) and flocks (F) were then randomly paired, and the tosses followed the sequence S,F,S,F, etc.; this minimized differences in exposure of the two treatments to changes in the weather during the day, or to other temporally varying parameters. The direction in which the birds were pointed at the toss was randomized. Each single bird or flock was watched with 10 × 50 binoculars until it vanished from sight, and a compass bearing for the vanishing point was recorded to the nearest 5 degrees. The interval between toss and disappearance was timed with a stop watch. We waited at least 8 minutes after each