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LATE PLEISTOCENE ROADRUNNER (*GEOCOCCYX*) FROM KARTCHNER CAVERNS STATE PARK, SOUTHEASTERN ARIZONA

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ABSTRACT—A right femur (KCSP-128) from late Pleistocene deposits (ca. 36,210 yr B.P.; Rancholabrean) in Kartchner Caverns State Park, southeastern Arizona, is identified as the larger-than-modern roadrunner, *Geococcyx californianus conklingi*. This large form is best known from late Pleistocene localities in New Mexico and Nuevo Leon, as well as from assumed mixed late Pleistocene/Holocene deposits from New Mexico, Texas, and Chihuahua. It has never been reported from Arizona. Fossils of the modern-sized form, *Geococcyx californianus californianus,* have been reported from late Pleistocene localities in California and New Mexico, and from mixed late Pleistocene/Holocene deposits in Chihuahua. Comparisons of the Kartchner Caverns specimen to modern *G. c. californianus* specimens, and to published data of fossil *G. c. californianus* and *G. c. conklingi,* indicate KCSP-128 is relatively larger than the *G. c. conklingi* data and notably larger than *G. c. californianus*. KCSP-128 is added to the Rancholabrean record as the first late Pleistocene roadrunner reported from Arizona.

RESUMEN—Un fósil de depósitos tardíos del Pleistoceno (ca. 36,210 años antes de la era presente; Rancholabrean) en el parque estatal de las cavernas Kartchner en el sureste de Arizona ha sido identificado a partir de un fémur derecho (KCSP-128) como un correcaminos *Geococcyx californianus conklingi*. Esta forma extinta de gran tamaño se identifica principalmente en sitios en Nuevo México y Nuevo León, así como de posibles depósitos mezclados Pleistoceno/Holoceno de Nuevo México, Texas y Chihuahua. Nunca ha sido reportado en Arizona. Fósiles de tamaño del moderno *Geococcyx californianus californianus* han sido registrados del Pleistoceno tardío en California y Nuevo México y de depósitos mezclados del Pleistoceno tardío/Holoceno en Chihuahua. Las comparaciones de KCSP-128 a especímenes de *G. c. californianus* modernos y datos publicados sobre fósiles de *G. c. californianus* y *G. c. conklingi* indican que el KCSP-128 es relativamente de mayor tamaño que *G. c. conklingi* y notablemente más grande que *G. c. californianus*. KCSP-128 ha sido añadido al record de Rancholabrean como el primer correcaminos del Pleistoceno tardío reportado en Arizona.

Roadrunners (Aves, Cuculiformes, Cuculidae, *Geococcyx* Wagler) today consist of 2 species of robust, largely terrestrial and carnivorous birds. The greater roadrunner, *Geococcyx californianus,* ranges primarily throughout desert scrub and chaparral habitats of the southwestern United States and northern Mexico (Fig. 1), and east throughout Oklahoma, much of Arkansas, and portions of Louisiana. The lesser roadrunner, *Geococcyx velox,* occurs in tropical deciduous forest from Sonora, Mexico south to Nicaragua (Marshall, 1957; Lougheed, 1999).

Although members of the family Cuculidae are known from Paleogene deposits, the oldest record of *Geococcyx* is Pleistocene (Brodkorb, 1971). As compiled in Table 1 and Figure 1, late Pleistocene (Rancholabrean Land Mammal Age) records of *Geococcyx* are known from Wisconsinan glacial-age deposits in southern California and southern New Mexico, as well as the Sierra Madre Oriental of Nuevo Leon. *Geococcyx* has also been recovered from mixed Pleistocene/Holocene deposits (Table 1, Fig. 1) in southern New Mexico, Texas, and Chihuahua (Larson, 1930; Howard, 1931, 1971; Howard and Miller, 1933; Miller, 1943; Rea, 1980; Harris and Crews, 1983; Harris, 1985*a*,

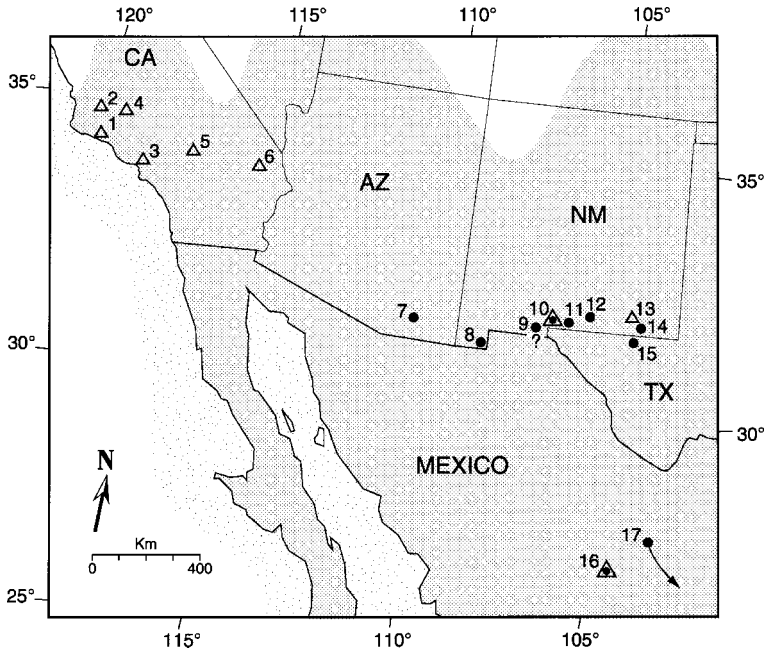

FIG. 1—Southwestern fossil localities (numbers 1 through 17) and partial modern distribution (shaded area) of *Geococcyx californianus californianus*. Numbers correspond to localities listed in Table 1. Kartchner Caverns State Park is number 7. San Josecito Cave (number 17) is located off the map. Open triangle represents *Geococcyx californianus conklingi*; black dot represents *Geococcyx californianus californianus*; black dot within open triangle represents localities with both forms.

1985*b*, 1987, 1991, 1993; Jefferson, 1991; Steadman et al., 1994).

Late Pleistocene *Geococcyx* specimens from the Rancho La Brea, Carpinteria, and McKittrick asphalt seeps of coastal California are within the size range of the modern roadrunner and were described by Larson (1930) as *Geococcyx californianus* (Table 2). Howard (1931) described an extinct species, *Geococcyx conklingi* (Conkling's roadrunner), from Pleistocene cave deposits in New Mexico at Conkling Cavern (type locality) and Shelter Cave that was larger than the living roadrunner and the fossil California specimens of Larson (Table 2). While fossil *G. californianus* forms have been recovered from California localities and some inland southwestern sites, *G. conklingi* forms have never been reported west of New Mexico (Fig. 1; Table 1).

Reported Holocene records for *Geococcyx* are problematic. Remains of *Geococcyx conklingi* from Pratt Cave in Trans-Pecos Texas were originally reported as from Holocene deposits (Gehlbach and Holman, 1974; Rea, 1980), but these deposits might have been mixed with Pleistocene materials (A. Harris, pers. comm., 2002). Harris and Crews (1983) tentatively identified Conkling's roadrunner from Holocene deposits at the Khulo Site in southern New Mexico, but Harris recently stated (pers. comm., 2002) that the identification of the Khulo specimen as this form (versus the greater roadrunner form) is now uncertain. At Shelter Cave, New Mexico, and Jimenez Cave, Chihuahua, mixed deposits bring into question whether the associated *Geococcyx* material is late Wisconsinan or Holocene (Harris and Crews, 1983; Harris, 1985*b*).

Harris and Crews (1983) hypothesized that the size difference between the *G. conklingi* and *G. californianus* forms might be in response to different late Pleistocene/Holocene temperature regimes, such as the warmer, maritime-influenced western coast of California versus cooler, arid inland sites, or perhaps interstadial versus stadial climates at the inland sites themselves. They regard the larger-sized *G. conklingi* as a geographic and temporal subspecies of the

TABLE 1—List of fossil localities for *Geococcyx*. Numbers correspond to localities in Figure 1. Taxa are listed as published in each associated primary reference. [1] = originally published as *G. californianus conklingi,* but now in question (see text). [2] = taken to subspecies level in Harris, 1993.

Site	Taxon	Primary reference
1. Carpenteria	*G. californianus*	Larson, 1930
2. McKittrick	*G. californianus*	Larson, 1930
3. Rancho La Brea	*G. californianus*	Larson, 1930
4. Maricopa (Pentland)	*G. californianus*	Jefferson, 1991
5. Daggett	*G. californianus*	Jefferson, 1991
6. Mitchell Caverns	*G. californianus*	Jefferson, 1991
7. Kartchner Caverns	*G. c. conklingi*	This paper
8. U-Bar Cave	*G. c. conklingi*	Harris, 1985*b*
9. Khulo Site	*G. c. conklingi*[1]	Harris and Crews, 1983
10. Shelter Cave	*G. conklingi*[2]	Howard, 1931
	G. californianus[2]	Howard and Miller, 1933
11. Conkling Cavern	*G. conklingi*[2]	Howard, 1931; Howard and Miller, 1933
12. Pendejo Cave	*G. c.* cf. *conklingi*	Harris, 1991
	G. c. conklingi	Harris, 1993
13. Dry Cave	*G. c. californianus*	Harris and Crews, 1983
14. Dark Canyon Cave	*G. conklingi*[2]	Howard, 1971
15. Pratt Cave	*G. conklingi*	Gehlbach and Holman, 1974; Rea, 1980
16. Jimenez Cave	*G. c. californianus*	Harris and Crews, 1983
	G. c. conklingi	Harris, 1985*b*
17. San Josecito Cave	*G. conklingi*	Miller, 1943
	G. cf. *conklingi*	Steadman et al., 1994

living *G. californianus,* and proposed that *G. conklingi* be recognized as *Geococcyx californianus conklingi,* while the modern-sized fossils and living forms be recognized as *Geococcyx californianus californianus* (Harris and Crews, 1983). In addition, Harris (1993) lists the common name Conkling's greater roadrunner, rather than Conkling's roadrunner, for the *G. c. conklingi* form.

We follow Harris and Crews (1983) and classify all modern-sized specimens as the *Geococcyx californianus californianus* form (greater roadrunner), while specimens determined to be larger than modern in size (regardless of age or geography) will be designated the *Geococcyx californianus conklingi* form (Conkling's greater roadrunner). Here we present the first Pleistocene occurrence of *Geococcyx* from Arizona.

KARTCHNER CAVERNS—Kartchner Caverns State Park (KCSP; permit number 1996-25ps/ext.II; site number AZ E:3:54 ASM) is in the San Pedro River valley at 1,430 m elevation at the base of the Whetstone Mountains in Cochise County, southeastern Arizona (Fig. 1). The plant community outside the cave today includes species characteristic of both the Chihuahuan and Sonoran deserts; oak (*Quercus*), pine (*Pinus*), and juniper (*Juniperus*) woodlands occur immediately upslope.

The cave has over 3 km of passageways, including spacious rooms (Buecher and Hill, 1999; Hill, 1999). Prior to development of the cave as a tourist attraction, it received a thorough assessment of scientific significance, including paleontological remains located in sections to be modified for trails. Abundant faunal remains have been recovered from various Kartchner Caverns deposits. These remains, which include mollusks, amphibians, reptiles, mammals, and birds, are the subjects of future manuscripts. Three major sectors of the cave received extensive paleontological testing (Mud Flats, Tarantula Room Talus, and Bison Room). *Geococcyx* was recovered from sediments deposited in Mud Flats.

CHRONOLOGY—Five test units (typically 30 × 30 cm) were excavated at Mud Flats, in levels to depths ranging from 19 to 32 cm below surface. All recovered sediments were taken to the Laboratory of Quaternary Paleontology, Northern

TABLE 2—Measurements of *Geococcyx* femora (mm). TL = total length of femur; DSAP = diameter of shaft, anterior-posterior; DSML = diameter of shaft, medial-lateral; PEL = proximal end, length; PEMAPD = proximal end, maximum anterior-posterior diameter; PEMMLD = proximal end, maximum medial-lateral diameter; DEL = distal end, length; DEMAPD = distal end, maximum anterior-posterior diameter; DEMMLD = distal end, maximum medial-lateral diameter.

Specimen[1]	TL	DSAP	DSML	PEL	PEMAPD	PEMMLD	DEL	DEMAPD	DEMMLD
KCSP-128	61.34	5.23	5.63	9.17	10.19	12.16	10.11	11.10	12.05
LA #113	57.50	4.70	5.00	—	—	—	—	10.70	11.40
LA # 114	—	5.20	5.10	—	—	—	—	—	—
LA #115	—	5.00	5.10	—	—	—	—	—	—
Shelter Cave	—	—	—	—	11.00	13.20	—	—	—
Larson (1930), Pleistocene									
Range	51.20–58.20	4.30–4.80	4.00–5.10	9.90–11.20	7.70–8.60	10.10–12.10	10.90–12.90	8.40–9.00	9.43–10.90
Mean	52.50	4.57	4.43	10.35	8.13	11.19	11.84	8.74	10.16
QSP 6683	54.39	4.12	4.09	8.74	8.30	10.03	8.93	9.15	9.78
MNA Z8.8442	54.08	4.13	4.03	9.06	8.45	10.53	8.61	9.59	10.36
MNA Z8.1036	54.25	3.93	3.88	8.94	7.88	9.57	8.24	9.09	9.61
H1076	53.06	4.04	4.11	7.92	7.68	9.84	8.31	8.52	9.65
H2664	53.54	4.00	4.16	8.17	9.02	10.49	8.88	9.34	10.06
H2474	53.77	4.05	4.17	8.96	8.26	10.21	8.79	9.19	10.01
H2355	54.27	4.30	4.25	9.62	8.15	10.03	8.73	9.23	9.73
H2348	55.10	4.05	4.03	9.69	8.43	10.14	8.35	8.82	9.87
Z8.1661	51.80	3.84	3.82	8.91	7.80	9.75	7.94	8.60	9.58
H3051	52.47	3.94	4.19	9.04	7.93	9.64	8.65	8.89	9.83
H3468	53.73	3.85	3.90	8.63	7.70	9.84	8.48	8.48	9.41
Z8.1744	54.35	4.04	4.35	8.95	8.51	10.79	8.82	8.96	10.04
H4063	52.11	4.12	3.96	7.91	7.45	9.66	8.10	8.47	9.33
Z8.8331	53.59	3.91	3.82	8.66	7.50	9.70	7.77	8.70	9.61
Z8.1055	54.06	4.50	4.65	9.16	8.56	10.46	8.54	9.27	10.24
H2346	55.09	4.34	4.47	8.46	8.36	10.51	8.53	9.24	9.75
Z8.2330	54.46	4.10	4.16	8.85	8.32	10.06	8.15	8.87	9.72
Larson (1930), modern									
Range	49.34–58.80	3.80–4.50	3.90–4.90	9.40–10.99	5.50–9.20	9.80–11.90	11.00–14.10	8.00–9.70	9.50–10.80
Mean	54.50	4.18	4.26	9.82	7.66	10.40	11.80	8.77	10.09

[1] KCSP-128 = Kartchner Caverns specimen, this paper; LA #113–#115 = Howard (1931), fossil *G. conklingi* specimens from Conkling Cavern, New Mexico; Shelter Cave = Howard (1931), fossil *G. conklingi* specimen from Shelter Cave, New Mexico; Larson(1930), Pleistocene = Larson's fossil *G. californianus* specimens from California; QSP # = modern *G. c. californianus,* Quaternary Sciences Program collection, Northern Arizona University Flagstaff; MNA #, H#, Z# = modern *G. c. californianus,* Museum of Northern Arizona, Flagstaff; Larson (1930), modern = Larson's modern *G. californianus* specimens.

Arizona University for wet sieve washing through 700-μm mesh. Small chunks (<5 mm) of charcoal were present but rare in all test units, being scattered throughout the depth of the excavation units.

One test unit produced enough charcoal between 6 and 14 cm below surface to permit an accelerator mass spectrometer analysis, resulting in a conventional radiocarbon age of 36,210 ± 490 yr B.P. (Beta-109671; $^{13}C/^{12}C$ ratio −27.5‰).

Uranium-series dates on calcite travertine collected from other regions in the cave, and unrelated to the *Geococcyx* remains, range from approximately 200,000 to 40,000 years old (Ford and Hill, 1999).

The stratigraphy of the Mud Flats area seems to indicate no late glacial or Holocene deposition. Sediments and faunal remains entered Mud Flats from the talus slope in the Tarantula Room, approximately 20 m away. Large roof blocks and a series of speleothems that now separate the 2 areas appear to have acted as a dam in the past, as well as the present. Cracks in the ceiling occur above the talus slope, oriented approximately 15 m along the southeastern wall of the Tarantula Room. These cracks must have been open to the surface during the Pleistocene and Holocene, creating small entrances into the cave. Today a portion of a 20-cm iron rebar penetrates a crack, pounded into place from outside the cave. Holocene material is entering the cave today but it is unable to flow off the talus slope and onto Mud Flats, due in part to the roof fall and speleothem dams mentioned above.

Uranium-series (Th) dating of an *Equus* tooth from about 20 cm below the surface at the base of the talus slope produced an age of 37,700 ± 2,700 yr B.P. Preliminary stratigraphic analyses of Mud Flats and Tarantula Room imply that the damming and roof fall might have happened sometime prior to the late glacial, ending any significant deposition in Mud Flats.

A right femur of *Geococcyx* (KCSP-128; Fig. 2) was recovered from the approximately 7-cm depth in the Mud Flats room of Kartchner Caverns. Based on the radiocarbon age and discussion above, we infer that the bone is close to 36,210 years old.

IDENTIFICATION—Skeletal characteristics of *Geococcyx* are described in detail by Shufeldt (1886). One significant characteristic in the identification of *Geococcyx,* and KCSP-128, is the presence of a foramen located on the posterior side of the femur between the trochanter and the femoral head (Fig. 2), rather than on the anterior side below the trochanter, as is usual in Cuculidae (Shufeldt, 1886).

We replicated all measurements of Larson (1930) on the Kartchner Caverns and modern comparative specimens (Table 2), although her illustrations of Proximal End Length (PEL) and Distal End Length (DEL) are vague enough to make us question whether our points of measure for these characters are precisely the same. The measurements of PEL and DEL by Larson (1930) are distinctly larger than our modern specimens, indicating our points of measure differ from hers.

Measurements of femora (Table 2) from late Pleistocene sites and from our modern specimens are graphed in Figures 3 and 4. KCSP-128 is distinctly larger and more robust than the 17 modern specimens in our analysis and the 21 modern specimens of Larson (1930). It is also larger than late Pleistocene *G. c. californianus* from California (Larson, 1930) and the specimens of *G. c. conklingi* from New Mexico (Howard, 1931). One exception is the Shelter Cave specimen of Howard (1931), discussed below, which is slightly larger than KCSP-128 (Fig. 3). Howard (1931) did not use all the measurements presented by Larson (1930) on the 3 *G. c. conklingi* specimens from Conkling Cavern and 1 specimen from Shelter Cave. For this reason, in Figure 3, we could plot only the femur length of the Conkling Cavern specimen LA #113 and only the maximum anterior-posterior diameter of the proximal end of the Shelter Cave specimen. The *G. c. conklingi* specimens graphed in Figure 4 do not include Shelter Cave, because Howard (1931) did not make these particular measurements on the Shelter Cave specimens. KCSP-128 is larger than the extant form, *G. c. californianus,* and seems best described as the *G. c. conklingi* form.

DISCUSSION—Although there are numerous late Pleistocene faunal sites in southern Arizona, the mid-Wisconsinan paleoecology and paleontology of the region are just beginning to be understood. Most localities, such as Lehner Ranch, Escapule, and Murray Springs, are

FIG. 2—Left to right: KCSP-128, anterior view; KCSP-128, posterior view; modern *Geococcyx californianus californianus* femur (QSP 6683), posterior view. Arrow points to the foramen, its location being unique within Cuculidae to *Geococcyx*. Note size difference between KCSP-128 and modern specimen.

terminal Wisconsinan in age, lie in valley-bottom alluvial deposits, and contain predominantly megafaunal remains. The only caves in southern Arizona extensively studied for vertebrates are Deadman Cave (Mead et al., 1984), Papago Springs Cave (Skinner, 1942; Czaplewski et al., 1999), and Ventana Cave (Haury, 1950). Paleoecological reconstructions indicate the biotic habitats surrounding these caves in the Pleistocene were perhaps more grassy and wooded than today (Mead et al., 1984; Czaplewski et al., 1999). Each cave lies in a different physiographic setting and had different modes of fossil accumulation, but no remains of *Geococcyx* are recorded from these deposits.

Paleoenvironmental reconstructions of the Kartchner Caverns area are just beginning. At this time, we can only speculate as to the mid-Wisconsinan habitat and environment in which the roadrunner at Kartchner lived. Kartchner Caverns is situated well above the valley floor that contains megafaunal sites, but below the more densely vegetated woodland areas, such as at Papago Springs Cave. Perhaps the habitat near Kartchner Caverns during the

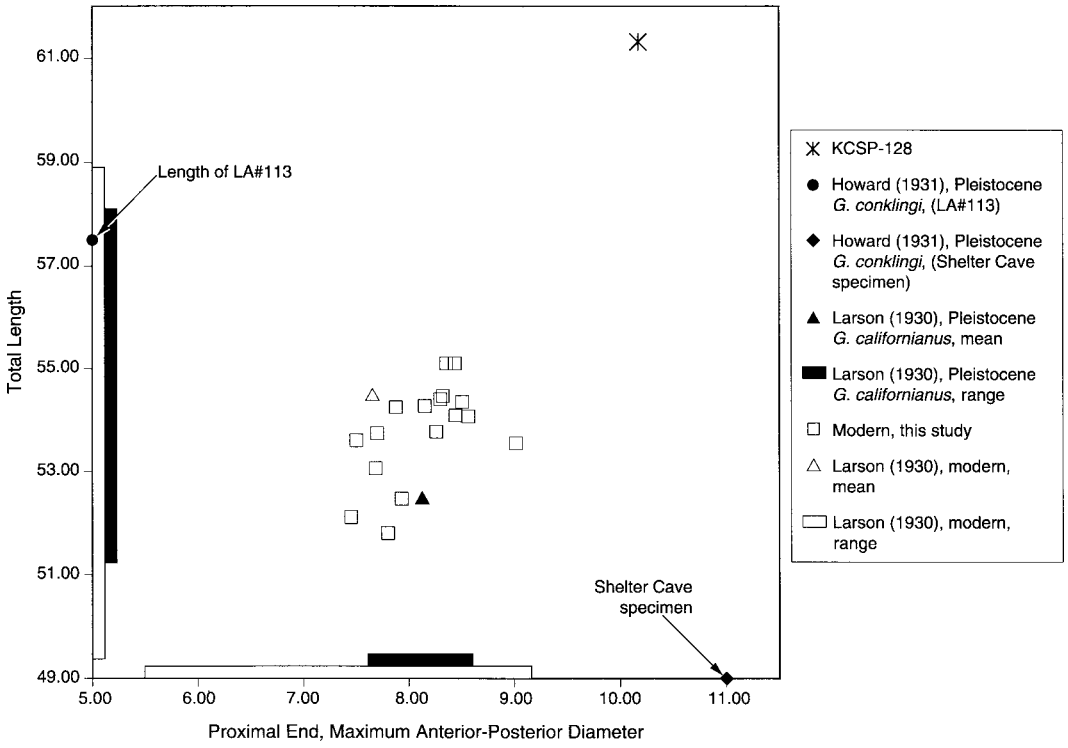

FIG. 3—Comparisons of KCSP-128, modern, and fossil *Geococcyx* femora. The specimens and their measurements are listed in Table 2. LA #113 and Shelter Cave specimens have only a single measurement available for each bone. LA #113 is plotted directly on the Y-axis (Total Length); the X-axis has no bearing on this measurement. Shelter Cave specimen is plotted directly on the X-axis (Proximal End, Maximum Anterior-Posterior Diameter); the Y-axis has no bearing on this measurement.

mid-Wisconsinan was more suitable to *Geococcyx* than at the other sites mentioned above. Alternatively, inadequate sampling could account for the lack of pervious records. Modern roadrunners do occur in the vicinity of Kartchner Caverns today.

Harris and Crews (1983) argued that the size difference between the modern-sized fossil specimens and the larger Conkling's greater roadrunner reflect dissimilar temperature regimes of various late Pleistocene, and possible Holocene, localities. Though the fossil record is sketchy, it does indicate that both the smaller *G. c. californianus* form and larger *G. c. conklingi* form occurred in the Southwest during the late Pleistocene, with *G. c. conklingi* disappearing possibly sometime during the early to middle Holocene (Harris and Crews, 1983).

The *Geococcyx* femur from Kartchner Caverns (ca. 36,210 yr B.P.) is distinctly larger than modern specimens and late Pleistocene *G. c. californianus* specimens from California. However, it is similar to, and relatively larger than, late Pleistocene *G. c. conklingi* specimens presented by Howard (1931) from inland Southwest sites. KCSP-128 represents the *G. c. conklingi* form and is added to the sparse record as the first Pleistocene fossil roadrunner from Arizona.

Our paleontological work in Kartchner Caverns State Park would not have been possible without the special and constant attention of C. Johnson, Arizona State Parks. Other park members of particular help to us include B. Burnett and J. Dexter. Thanks to B. and D. Buecher for their continual help with the Kartchner Caverns project, and to P. Davis, E. Lundelius, and T. Tyrburg for their assistance in our search for specimens and comparative data. Special thanks to A. Harris for helpful dialogue concerning identifications and fossil localities. T. Dallege, P. Gensler, P. Hallman, C. Jass, D. Jolly, E. Larkin, A. Morrison, J. Osterhaudt, and D. Snyder assisted

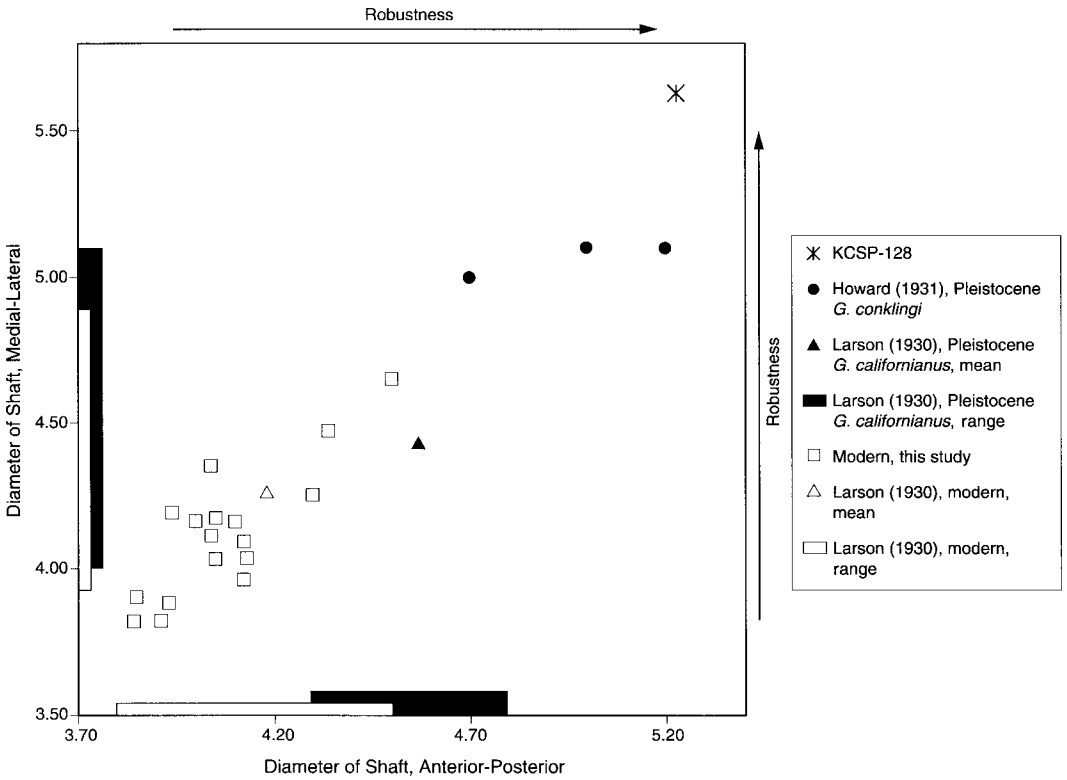

FIG. 4—Comparisons of KCSP-128, modern, and fossil *Geococcyx* femora.

greatly in fieldwork for this portion of the project. Curational assistance from M. Hollenshead and S. L. Swift is greatly appreciated. The Museum of Northern Arizona, Flagstaff, generously loaned modern comparative specimens used in this study. Finally, we thank our reviewers for helpful editing suggestions.

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