THE CONDOR

A JOURNAL OF AVIAN BIOLOGY

Volume 98 Number 4 November 1996

*The Condor* 98:675–680


# A FOSSIL SCRUB-JAY SUPPORTS A RECENT SYSTEMATIC DECISION[1]

STEVEN D. EMSLIE
*Department of Sciences, Western State College, Gunnison, CO 81231, e-mail: fac_emslie@western.edu*

*Abstract.* Nine fossil premaxillae and mandibles of the Florida Scrub-Jay (*Aphelocoma coerulescens*) are reported from a late Pliocene sinkhole deposit at Inglis 1A, Citrus County, Florida. Vertebrate biochronology places the site within the latest Pliocene (2.0 to 1.6 million years ago, Ma) and more specifically at 2.01–1.87 Ma. The fossils are similar in morphology to living Florida Scrub-Jays in showing a relatively shorter and broader bill compared to western species, a presumed derived character for the Florida species. The recent elevation of the Florida Scrub-Jay to species rank is supported by these fossils by documenting the antiquity of the species and its distinct bill morphology in Florida.

*Key words: Florida; Scrub-Jay; fossil; late Pliocene.*

## INTRODUCTION

Recently, the Florida Scrub-Jay (*Aphelocoma coerulescens*) has been elevated to species rank with the Island Scrub-Jay (*A. insularis*) from Santa Cruz Island, California, and the Western Scrub-Jay (*A. californica*) in the western U. S. and Mexico (AOU 1995). This designation for the Florida species is supported by genetic studies (Peterson 1992) and morphological and behavioral differences (Pitelka 1951, Woolfenden and Fitzpatrick 1984). Such a designation is not new as the Florida Scrub-Jay was first described as a full species (*Corvus floridanus* Bartram 1791 replaced by *C. coerulescens* Bosc 1795), and was only regarded as conspecific with scrub-jays in western North America as late as 1934 (see Pitelka 1951 for a taxonomic history of this species).

Until now, the fossil record for the Florida Scrub-Jay was limited to complete and incomplete postcranial elements from three late Pleistocene localities in Florida (Fig. 1; Brodkorb 1959, Hamon 1964, Ligon 1965). Here I report nine fossil specimens identifiable to this species from the late Pliocene (early Irvingtonian, 2.0–1.6 million years ago, Ma) of Florida. These specimens represent the earliest fossil occurrence of the genus *Aphelocoma* and provide additional support for the recognition of *A. coerulescens* as a distinct, endemic species with a long fossil history in Florida. This record also supports the hypothesis of Pitelka (1951) that living species of *Aphelocoma* arose in the Pliocene.

## METHODS

Comparative measurements of modern scrub-jays were obtained from skeletal specimens at the Florida Museum of Natural History (FLMNH), Gainesville; National Museum of Natural History (USNM), Smithsonian Institution, Washington, DC; Museum of Zoology, University of Michigan, Ann Arbor; Museum of Northern Arizona, Flagstaff; and Southwestern Museum of Biology, University of New Mexico, Albuquerque. All measurements were taken with digital calipers to the nearest 0.1 mm. Measurements of the premaxilla (without rhamphotheca) included length from anterior edge of nares to tip of bill, breadth and depth taken at anterior edge of nares, breadth of nasal bar at anterior end, length of mandibular symphysis, and breadth of mandibular symphysis at posterior edge. Ratio of premaxilla length:breadth was calculated using the mean measurements for each species. All

[1] Received 4 June 1996. Accepted 27 July 1996.

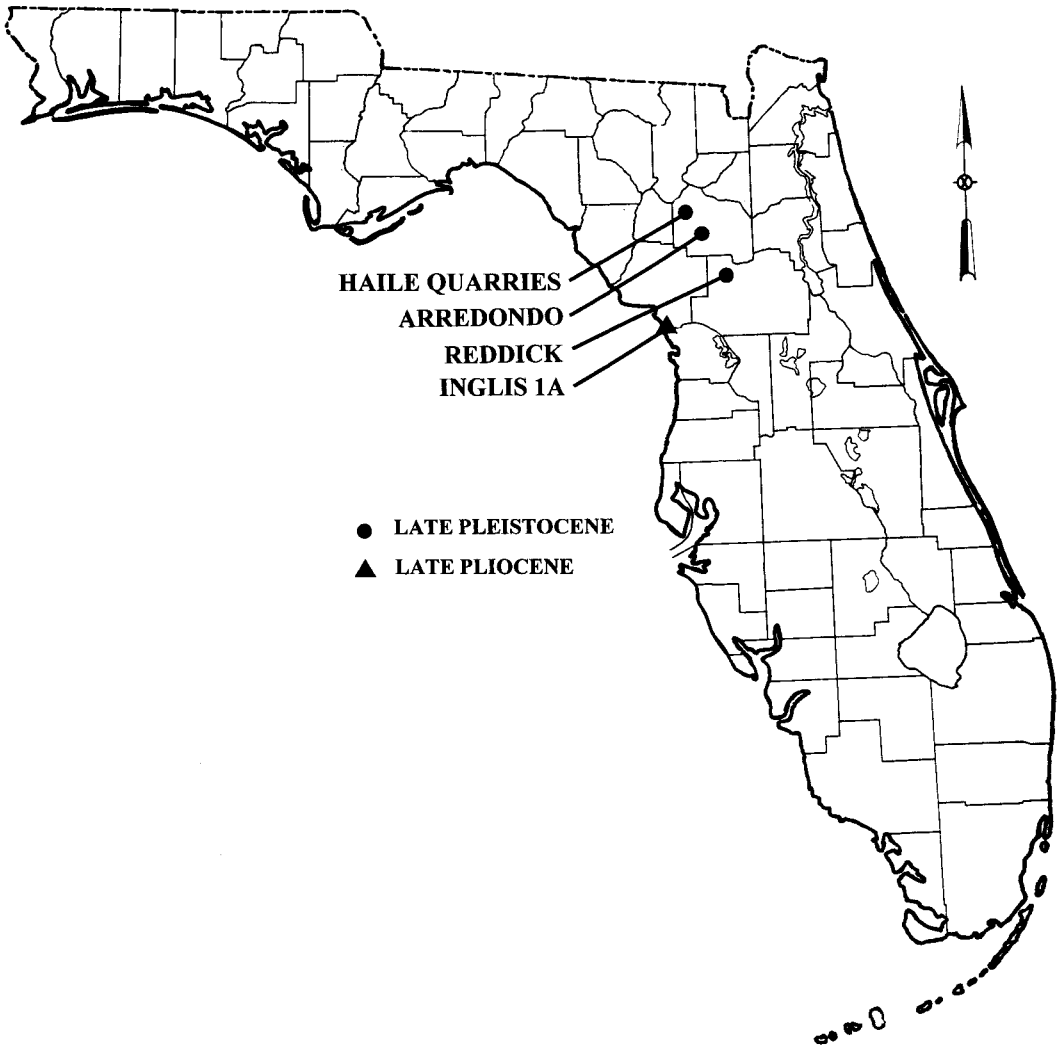


FIGURE 1. Map of Florida showing the locations of the late Pliocene Inglis 1A deposit, Citrus County, and three late Pleistocene localities (Haile 11B, Arredondo, Alachua County; Reddick, Marion County) where fossils of Florida Scrub-Jay (*Aphelocoma coerulescens*) have been recovered.

fossil specimens are housed in the collections at FLMNH and are cataloged with University of Florida (UF) numbers.

## SYSTEMATIC PALEONTOLOGY

### Order Passeriformes
### Family Corvidae
### *Aphelocoma coerulescens* (Bosc 1795)

*Referred material.* Two premaxillae, UF 31436, 31449 (Fig. 2B, C); proximal right mandible, UF 31483; proximal left mandible, UF 31486; five distal mandibular symphyses, UF 31451, 31460-31461, 31468, 31472.

*Locality and age.* Inglis 1A Local Fauna, Citrus County, Florida. This site formed from deposition in a limestone sinkhole and is dated to the late Pliocene (earliest Irvingtonian, 2.0–1.6 Ma) based on mammalian biochronology (see Morgan and Hulbert 1995 for a review of the paleontology and age of this site). More specifically, the vertebrate biochronology correlates with marine oxygen isotope stage 40, dated at 2.01 to 1.87 Ma, or when a glacial interval would have

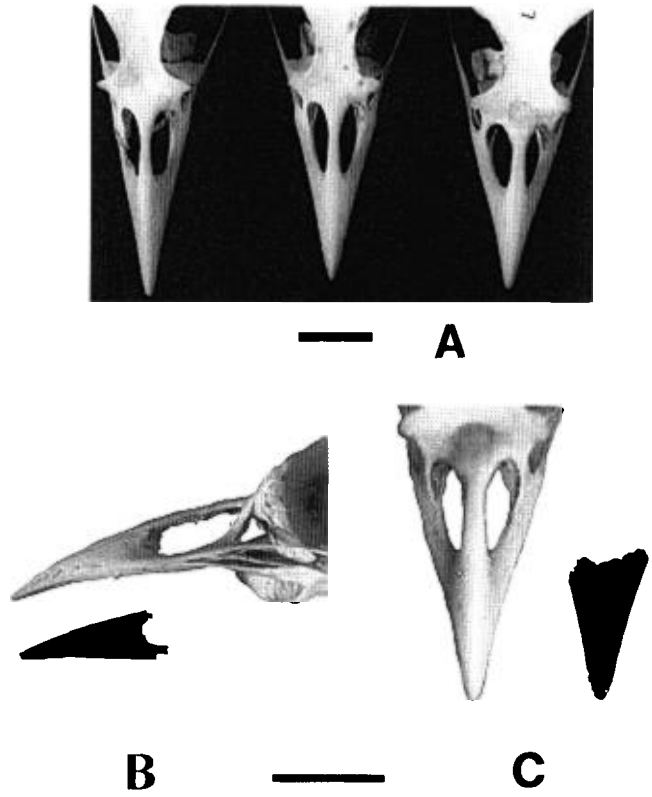


FIGURE 2. (A) dorsal view of premaxillae of male scrub-jays showing variation in bill morphology. Specimens are, left to right, *Aphelocoma californica* (USNM 611084, Nevada, *woodhouseii* group), *A. californica* (USNM 556687, California, *californica* group), and *A. coerulescens* (USNM 489957, Florida). Note the relatively longer and narrower bill in both specimens of *A. californica* compared to the shorter more robust bill in *A. coerulescens*. Also note that the lateral margin of the bill in *A. coerulescens* has a slight concavity at the midpoint compared to the straight margins in *A. californica*. Scale 1×, bar = 1 cm. (B and C) lateral and dorsal view of male *A. coerulescens* (USNM 489957, top and left, respectively) with UF 31449 from Inglis 1A (bottom and right, respectively). Note the slight concavity on the lateral margin of the fossil specimen in (C) that is characteristic of *A. coerulescens*. Scale 1.5×, bar = 1 cm.

caused a sea level lower than today's (see paleoecology below; Webb 1990, Morgan and Hulbert 1995).

*Description.* The fossil material shares characters of the living Florida Scrub-Jay as compared to western species of *Aphelocoma*. The premaxillae (UF 31436 and 31439) are relatively short and broad, as in *A. coerulescens* (Table 1, Fig. 2A) unlike the distinctly longer and narrower premaxillae in *A. californica* (*californica* and *woodhouseii* groups, AOU 1983). No specimens from the *sumichrasti* group were available for comparison, but measurements from skins in Pitelka (1951: 209) indicate that scrub-jays in this group also have a longer and narrower bill compared to *A. coerulescens*. In addition, the margins of the premaxilla form a straight edge from the base to the tip of the bill in *A. californica*; in *A. coerulescens* and UF 31449 a slight concavity exists at the midpoint of this margin caused by a relatively broader base to the bill (Fig. 2A, C). The base of the premaxilla is missing in UF 31436. The premaxillae of the Mexican Jay (*A. ultramarina*) and the Unicolored Jay (*A. unicolor*) are relatively longer than in *A. coerulescens*; *A. unicolor* also has a broader bill and more robust nasal bar than *A. coerulescens* (see measurements in Pitelka 1951). Although UF 31449 measures slightly smaller than modern *A. coerulescens*, its close similarity in characters and proportions (ratio premaxilla length:breadth, Table 1) compared to other scrub-jays allows

TABLE 1. Comparative measurements (mm) giving Mean ± SD and range (in parentheses) of jay premaxillae without rhamphothecae compared to fossil specimens from Inglis 1A. Measurements described in text.

| Species | Length | Breadth | Depth | Breadth nasal bar | Ratio L:B |
|---|---|---|---|---|---|
| *Cyanocitta cristata* | | | | | |
| ($n$ = 11 females) | 14.2 ± 0.9 (12.8–15.9) | 8.6 ± 0.5 (7.4–9.5) | 4.4 ± 0.2 (4.1–4.7) | 2.9 ± 0.3 (2.5–3.3) | 1.66 |
| *Aphelocoma californica* (*woodhouseii* group) | | | | | |
| ($n$ = 13 females) | 14.5 ± 0.7 (13.0–15.5) | 7.1 ± 0.5 (6.2–8.2) | 4.1 ± 0.4 (3.6–5.4) | 2.4 ± 0.3 (2.0–2.9) | 2.05 |
| ($n$ = 11 males) | 15.7 ± 0.9 (14.1–17.1) | 7.4 ± 0.4 (6.8–7.9) | 4.3 ± 0.3 (3.9–4.8) | 2.4 ± 0.3 (2.1–3.2) | 2.11 |
| *Aphelocoma californica* (*californica* group) | | | | | |
| ($n$ = 7 females) | 13.6 ± 0.7 (12.6–14.7) | 7.1 ± 0.3 (6.8–7.5) | 4.1 ± 0.1 (4.0–4.2) | 2.2 ± 0.2 (2.0–2.6) | 1.91 |
| ($n$ = 8 males) | 15.0 ± 0.8 (14.0–16.0) | 7.7 ± 0.5 (6.6–8.3) | 4.4 ± 0.3 (3.9–4.8) | 2.4 ± 0.1 (2.2–2.6) | 1.96 |
| *Aphelocoma coerulescens* | | | | | |
| ($n$ = 14 females) | 13.8 ± 0.7 (12.4–14.7) | 7.9 ± 0.3 (7.4–8.6) | 4.2 ± 0.2 (3.9–4.6) | 2.6 ± 0.2 (2.3–2.9) | 1.75 |
| ($n$ = 15 males) | 14.3 ± 0.9 (12.7–15.6) | 8.0 ± 0.5 (7.2–9.1) | 4.3 ± 0.2 (4.0–4.7) | 2.6 ± 0.3 (2.2–3.2) | 1.78 |
| INGLIS 1A | | | | | |
| UF 31449 | 11.8 | 6.7 | 4.3 | 3.3 | 1.76 |
| UF 31436 | 12.7 | — | — | — | |

referral to this species. The fossil mandibles are too fragmentary for comparative measurements, but they also compare well in relative size and proportions to *A. coerulescens.*

The fossil material also was compared to females of the Blue Jay (*Cyanocitta cristata*), which approach the size of male *Aphelocoma coerulescens.* However, measurements of the premaxilla indicate that *C. cristata* has a relatively longer and broader bill and a more robust nasal bar than in *A. coerulescens* (Table 1). The ratio of premaxilla length:breadth also is smaller in *C. cristata* compared to *A. californica, A. coerulescens* and UF 31449.

*Discussion.* These specimens represent the earliest fossil occurrence of this species and indicate that the distinct bill morphology of *Aphelocoma coerulescens* developed by approximately 2.0 Ma. It is not known whether or not this morphology is primitive or derived for this species. Comparable fossil material of similar age for western species is lacking. Although an analysis of bill shape with diet by Peterson (1993) suggests that the hooked bill of the Florida Scrub-Jay may be a primitive character, the unusually broad base of the premaxilla relative to length (Table 1) is not shared with any other species in this genus and suggests that it is a derived morphology (Pitelka 1951, pers. comm.).

The paleoecology of the Inglis 1A site indicates a habitat not unlike that preferred by the living species. The Florida Scrub-Jay is restricted today to oak-palmetto or sand pine-scrub habitats in coastal regions or on ridges in central peninsular Florida (Woolfenden and Fitzpatrick 1990, Peterson and Vargas-Barajas 1993). The herpetofauna from Inglis 1A suggests that a longleaf pine (*Pinus palustris*) and xeric hammock existed near the site during deposition; the abundance of pocket gophers (*Geomys* sp.) also suggests that the site was a "dune-like sandy terrain well above the water table" (Meylan 1982: 67). The avifauna from Inglis 1A is diverse with over 50 taxa represented that reflect both upland habitats and coastal wetlands. The most abundant remains of birds are those of Northern Bobwhite Quail (*Colinus virginianus*) and an extinct turkey (*Meleagris leopoldi* or *M. anza*) (Steadman 1980, Carr 1981). In addition, the avifauna includes numerous species of herons, egrets, waterfowl, eagles, vultures, and owls including Burrowing Owl (*Speotyto cunicularia*) and two extinct Pygmy-

owls (*Glaucidium* spp.) (Carr 1981, Emslie, unpubl. data). Other passerines in the site include Seaside Sparrow (*Ammodramus maritimus*), Eastern Meadowlark (*Sturnella magna*), and Brown-headed Cowbird (*Molothrus ater*) (Emslie, unpubl. data). All these taxa suggest that the site was located more inland than at present, on drier soils above a karst substrate and with coastal wetlands to the west, during deposition in the late Pliocene. Sinkholes in the region at that time may have held permanent or seasonal water that would have attracted various aquatic vertebrates (Meylan 1982).

## CONCLUSIONS

This fossil material probably was deposited at approximately the time that scrub-jays first colonized Florida. The vertebrate record indicates that numerous species of mammals, birds, reptiles and other taxa first appear in Florida during the late Pliocene, probably in relation to lower sea levels at 2.5 Ma that facilitated the development of a Gulf Coast corridor comprised of savannah and thorn-scrub habitat (Blair 1958, Mares 1985, Webb 1985). This corridor allowed species adapted to these habitats to disperse to and from South America, Central America, Mexico, Florida, and the southwestern U.S. Numerous extinct and extant vertebrate and invertebrate species indicate a formerly extensive common habitat throughout these regions (Stehli and Webb 1985). Although the Plio-Pleistocene record for plant communities in South and Central America is poor, limited evidence suggests a northward expansion of xerophytes and other plants from the south, and southward expansion from the north, that contributed to a dry thorn-scrub community along the Gulf Coast corridor (Axelrod 1979, Simpson and Neff 1985). Subsequent climatic events during the Plio-Pleistocene fragmented this habitat and isolated populations of plants and animals in Florida and the western U.S. (e.g., Mengel 1970). Many of these isolated populations in Florida became extinct by the end of the Pleistocene (Neill 1957). The Florida Scrub-Jay and Burrowing Owl (*S. cunicularia*) are the only two avian species with a disjunct distribution between Florida and the western U.S. today that also have their center of distribution in western North America (Blair 1958). The Crested Caracara (*Caracara plancus*) also has a disjunct distribution between these regions, but occurs in suitable habitat from southern Arizona and Texas and as far south as Tierra del Fuego (AOU 1983); it occurred as far north as Wyoming in the late Pleistocene (Emslie 1985).

The Florida Scrub-Jay, due to its restricted habitat preferences, currently feeds on acorns as its most important plant food, while western species are more catholic in their habitat and diet (Woolfenden and Fitzpatrick 1990, Peterson and Vargas-Barajas 1993). Its restriction to a habitat of oak and pine-scrub habitat may explain why the Florida Scrub-Jay survived in Florida while other avian taxa with southern and western origins became extinct or extirpated there (e.g., California Condor *Gymnogyps californianus,* Merriam's Teratorn *Teratornis merriami,* Great Black Hawk *Buteogallus urubitinga,* an extinct Caracara *Milvago readei,* Northern Jacana *Jacana spinosa,* and Black-billed Magpie *Pica pica*; Emslie, unpubl. data). As sea levels fluctuated considerably in Florida over the past 2.5 Ma, perhaps causing extinctions of lowland and wetland species (Emslie 1992), this habitat may have endured due to its persistence on a substrate of coastal dune features and well-drained sands. Although oak and pine-scrub habitat occurs on the Atlantic and Gulf coasts of Florida today, it also occurs on high, central ridges that extend from north to south through peninsular Florida that formed as coastal dune deposits during high sea levels in the Pliocene and Pleistocene (Woolfenden and Fitzpatrick 1990). These remnant coastal features allowed this habitat to persist, despite relatively frequent fluctuations in sea level since at least the late Pliocene. The three late Pleistocene localities from which *Aphelocoma coerulescens* has been reported are located on the central peninsula near Gainesville, Florida (Fig. 1), the vertebrate faunas of which are not unlike that of Inglis 1A in indicating open prairie, wetlands, and dry scrub habitat (Brodkorb 1959, Hamon 1964, Ligon 1965). Additional records of *A. coerulescens* might be expected from other fossil sites located on these ridges.

## ACKNOWLEDGMENTS

This project was funded by NSF Grant EAR 94-03206. I thank Frank Pitelka for discussion and comments on the manuscript. D. Steadman, S. Olson, and one anonymous reviewer provided many helpful comments as well. Assistance with museum collections was provided

by Phil Angle, Janet Henshaw, Deb Hill, Storrs Olson, Dave Steadman, and Tom Webber.

## LITERATURE CITED

AMERICAN ORNITHOLOGIST'S UNION. 1983. Checklist of North American birds. 6th ed. American Ornithologist's Union, Baltimore, MD.

AMERICAN ORNITHOLOGIST'S UNION. 1995. Fortieth supplement to the American Ornithologist's Union check-list of North American birds. Auk 112:819–830.

AXELROD, D. I. 1979. Age and origin of Sonoran Desert vegetation. Occ. Pap. Calif. Acad. Sci. 132: 1–74.

BARTRAM, W. 1791. Travels through North and South Carolina, Georgia, east and west Florida, etc. James and Johnson, Philadelphia.

BLAIR, W. F. 1958. Distributional patterns of vertebrates in the southern United States in relation to past and present environments, p. 433–468. *In* C. L. Hubbs [ed.], Zoogeography. American Association for the Advancement of Science, Washington, DC.

BOSC, C. 1795. Description de deux nouvelles espèces d'animaux. Bull. Sci., Soc. Philomatique, Paris 1:87.

BRODKORB, P. 1959. The Pleistocene avifauna of Arredondo, Florida. Bull. Florida State Mus. Biol. Sci. 4:269–291.

CARR, G. S. 1981. An early Pleistocene avifauna from Inglis, Florida. Ph.D. diss., Univ. Florida, Gainesville, FL.

EMSLIE, S. D. 1985. The late Pleistocene (Rancholabrean) avifauna of Little Box Elder Cave, Wyoming. Univ. Wyoming Contrib. Geol. 23:63–82.

EMSLIE, S. D. 1992. Two new late Blancan avifaunas from Florida and the extinction of wetland birds in the Plio-Pleistocene. Nat. Hist. Mus. Los Angeles Co., Sci. Ser. 36:249–269.

HAMON, J. H. 1964. Osteology and paleontology of the passerine birds of the Reddick, Florida, Pleistocene. Florida Geol. Sur., Geology Bull.44:1–210.

LIGON, J. D. 1965. A Pleistocene avifauna from Haile, Florida. Bull. Florida State Mus. Biol. Sci. 10:127–158.

MARES, M. A. 1985. Mammal faunas of xeric habitats and the great American interchange, p. 489–520. *In* F. G. Stehli and S. D. Webb [eds.], The great American biotic interchange. Plenum Press, NY.

MENGEL, R. M. 1970. The North American central plains as an isolating agent in bird speciation. Univ. Kansas Dept. Geology, Spec. Publ. 3:279–340.

MEYLAN, P. A. 1982. The squamate reptiles of the Inglis 1A fauna (Irvingtonian), Citrus County, Florida. Bull. Florida State Mus. Biol. Sci. 27:1–85.

MORGAN, G. S., AND R. HULBERT, JR. 1995. Overview of the geology and vertebrate paleontology of the Leisey Shell Pit Local Fauna, Hillsborough County, Florida. Bull. Florida Mus. Nat. Hist. 37 (Part I):1–92.

NEILL, W. T. 1957. Historical biogeography of present-day Florida. Bull. Florida State Mus. Biol. Sci. 2:175–220.

PETERSON, A. T. 1992. Phylogeny and rates of molecular evolution in the *Aphelocoma* jays. Auk 109: 133–147.

PETERSON, A. T. 1993. Adaptive geographical variation in bill shape of Scrub-Jays (*Aphelocoma coerulescens*). Am. Nat.142:508–527.

PETERSON, A. T., AND N. VARGAS-BARAJAS. 1993. Ecological diversity in Scrub-Jays (*Aphelocoma coerulescens*), p. 309–317. *In* T. P. Ramamoorthy, R. Bye, and A. Lot [eds.], Biological diversity of Mexico: origins and distribution. Oxford Univ. Press, NY.

PITELKA, F. A. 1951. Speciation and ecologic distribution in American jays of the genus *Aphelocoma.* Univ. Calif. Publ. Zool. 50:195–464.

SIMPSON, B. B., AND J. L. NEFF. 1985. Plants, their pollinating bees, and the great American interchange, p. 427–452. *In* F. G. Stehli and S. D. Webb, [eds.], The great American biotic interchange. Plenum Press, NY.

STEADMAN, D. W. 1980. A review of the osteology and paleontology of turkeys (Aves: Meleagridinae). Nat. Hist. Mus. Los Angeles Co., Contrib. Sci. 330:131–207.

STEHLI, F. G., AND S. D. WEBB. 1985. The great American biotic interchange. Plenum Press, NY.

WEBB, S. D. 1985. Late Cenozoic mammal dispersals between the Americas, p. 357–386. *In* F. G. Stehli and S. D. Webb, [eds.], The great American biotic interchange. Plenum Press, NY.

WEBB, S. D. 1990. Historical biogeography, p. 70–100. *In* R. L. Myers and J. J. Ewel [eds.], Ecosystems of Florida. Univ. of Central Florida Press, Orlando, FL.

WOOLFENDEN, G. E., AND J. W. FITZPATRICK. 1984. The Florida Scrub-Jay: demography of a cooperative-breeding bird. Princeton Univ. Press, Princeton, NJ.

WOOLFENDEN, G. E., AND J. W. FITZPATRICK. 1990. Florida Scrub-Jays: a synopsis after 18 years of study, p. 239–266. *In* P. B. Stacey and W. D. Koenig [eds.], Cooperative breeding in birds. Cambridge Univ. Press, Cambridge.