

A NEW SPECIES OF EXTINCT LATE PLEISTOCENE PUFFIN (AVES: ALCIDAE) FROM THE SOUTHERN CALIFORNIA CHANNEL ISLANDS

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ABSTRACT

We describe a new species of extinct late Pleistocene puffin (Aves: Charadriiformes: Alcidae) from the southern California Channel Islands. The new species is intermediate in the extent of dorsoventral expansion of the rostrum and mandible between extant *Cerorhinca monocerata* (rhinoceros auklet) and members of the genus *Fratercula*, and lived between 12,000 and 100,000 BP (Before Present). The presence of eggshells and large numbers of bones, including articulated skeletons of both adult and immature birds that appear to have died in burrows, indicate that breeding colonies of this species once existed on San Miguel and San Nicolas islands.

Keywords: Late Pleistocene, northern Channel Islands, *Fratercula dowi* new species, Aves, Charadriiformes, Alcidae.

INTRODUCTION

In October 1986 G. L. Kennedy and D. R. Muhs discovered an articulated bird skeleton in situ in an upper Pleistocene eolianite unit on the west end of San Nicolas Island (Figure 1). The skeleton as preserved in the outcrop was 14 cm long, with its ventral side downward, legs folded beneath it, and wings at its side. The neck was bent and what remained of the skull was turned to the side. The cranium and dorsal part of the skeleton (several vertebrae, synsacrum, pelvis) and parts of the legs and feet had eroded away. About 1.35 m to the rear the bird a nearly complete egg was found in the eolianite. The skeleton was subsequently briefly examined by Hildegard Howard, who identified it as an alcid near *Cerorhinca monocerata*.

Concurrently, D. A. Guthrie had been studying the late Pleistocene avifauna of San Miguel Island, including spectacularly rich bone beds that have yielded over 6,000 bones of a new alcid that he considered specifically distinct from *C. monocerata*. These specimens from San Nicolas and San Miguel Islands form the basis of this paper.

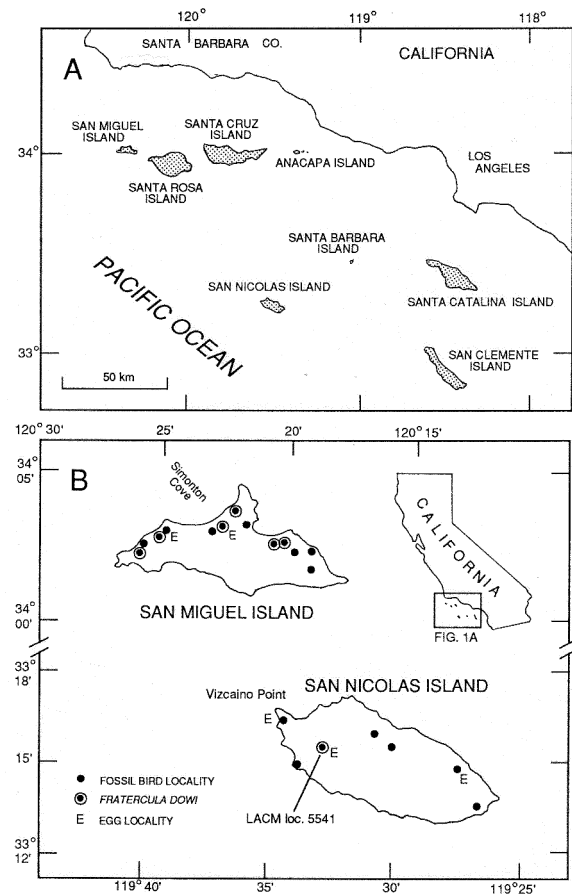


Figure 1. A) Map of Channel Islands of California, and B) Map of San Miguel and San Nicolas islands, showing fossil bird localities.

MATERIALS AND METHODS

Fossil material was compared with skeletons of extant *Cerorhinca monocerata*, *Fratercula cirrhata* (tufted puffin) and *F. corniculata* (horned puffin), and west coast fossil material assigned to these genera. A specimen of *C. monocerata* was dissected for anatomical details. Anatomical terminology is an anglicization of Baumel et al. (1993) or follows Howard (1929). The following institutional abbreviations are used: LACM, Natural History Museum of

Los Angeles County, Los Angeles, California; and SBMNH, Santa Barbara Museum of Natural History, Santa Barbara, California.

SYSTEMATICS

Genus *Fratercula*

Fratercula (including *Lunda*; Olson 1985) and *Cerorhinca* are the only members of the tribe Fraterculini, and as might be expected, the skeletal characteristics of these two genera are very similar. Several authors (Howard 1971; Strauch 1985; Chandler 1990) have noted skeletal differences between these two genera. Some of these, along with additional characteristics, which are useful in separating fossil material and which, upon examination of a large number of skeletons of the three west coast species of Fraterculini, seem valid, are listed below.

1. Condition of hypotarsal sulcus on tarsometatarsus; a deep groove in *Fratercula*, a bony canal in *Cerorhinca* (Strauch 1985).
2. Shape of the procoracoid process on the coracoid; upper border straight in *Cerorhinca*, curved in *Fratercula* (Howard 1971).
3. Condition of dorsal fossal crest of pneumotricipital fossa on head of humerus; extends distal to contact bicipital crest in *Cerorhinca*; does not reach this crest in *Fratercula* (Chandler 1990).
4. Appression of mandibular rami; appressed posterior to symphysis in *Fratercula*, not appressed in *Cerorhinca* (Figure 2-A).
5. Presence or absence of a fenestra at base of the palatine process of the maxilla; fenestra present in *Cerorhinca*, not present in *Fratercula* (Figure 2-B). This fenestra, a prominent feature in *Cerorhinca*, is also found in *Brachyramphus* and *Ptychoramphus*, which share with *Cerorhinca* a basal position in the Alcidae (Strauch 1985).
6. Amount of 'bowing' between minor and major metacarpals on carpometacarpus; minor more bowed in *Fratercula*, more parallel to major metacarpal in *Cerorhinca* (Figure 2-C).
7. Shape of the sternal articular facet on the coracoid; more expanded anteriorly and laterally in *Fratercula*, more rounded in *Cerorhinca* (Figure 2-D).
8. Prominence of tibiofibular crest on distal end of femur; elongate in *Fratercula*, more rounded and shorter in *Cerorhinca* (Figure 2-E).

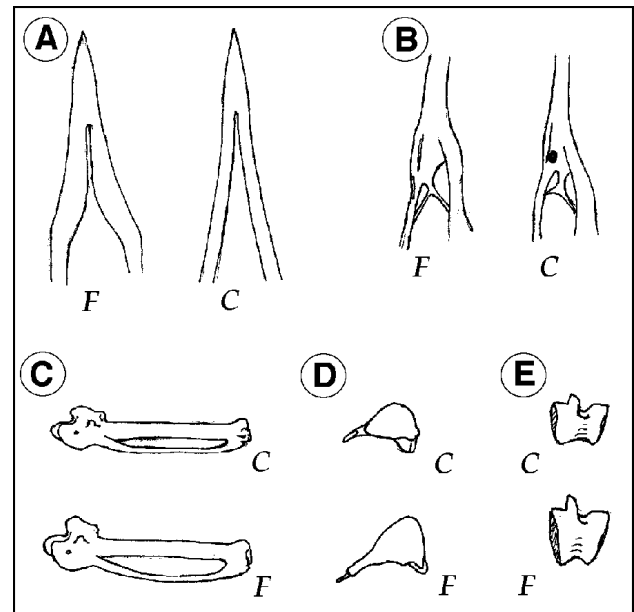


Figure 2. Features differentiating *Cerorhinca* (C) from *Fratercula* (F). Figures based on *Cerorhinca monocerata* and *Fratercula cirrhata*. Distinguishing features discussed in text. A) Ventral view of mandibles, B) Ventral view of left maxilla, C) Lateral view of carpometacarpus, D) View of sternal facet on coracoid, and E) Ventral view of distal end of femur.

The species described below is assigned to *Fratercula* as it is similar to this genus rather than to *Cerorhinca* in all the features listed above.

Fratercula dowi, new species

Fratercula sp. Guthrie 1992

Fratercula sp. nov. Guthrie 1993

Cerorhinca undesc. sp. Guthrie 1998

Holotype

LACM 127813 (Figure 3), originally articulated partial skeleton consisting of rostrum and mandible, six cervical vertebrae, two caudal vertebrae, sternum, left coracoid and proximal end of right coracoid, left ramus and part of right ramus of furcula, glenoid facet of left scapula, left and right rib groups, left humerus and distal end of right humerus, most of left radius except distal end, right radius, left and right ulnae, left and right carpometacarpi, left and right major carpal digits, both proximal and distal parts, most of left femur except proximal end, right femur except distal end, proximal ends of left and right tibiotarsi, proximal end of right fibula, four left and one right tarsal digits. The cranium and dorsal part of the skeleton (several vertebrae, synsacrum, pelvis) and parts of the legs and feet are missing.

Type Locality. LACM locality 5541 (Figure 1), unnamed upper Pleistocene (upper Rancholabrean) eolianite unit exposed near top of bluff overlooking west end of San Nicolas Island, Ventura County, California. The holotype was collected by G. L. Kennedy and D. R. Muhs 20



Figure 3. Disarticulated holotype skeleton of *Fratercula dowi*, LACM 127813.

October, 1986, at an elevation of 186.3 m, latitude 33°15'15.5"N, longitude 119°32' 53.2"W (USGS 1956).

Age. Surficial sediments on the west end of San Nicolas Island overlay Eocene marine sedimentary rocks (Vedder and Norris 1963). At the type locality there are two eolian sand units, an upper one, with a conventional uranium-series date of $16,000 \pm 1,000$ BP (Muhs 1992), and a lower one, the type locality for *F. dowi*. Although open-system conditions (uranium gain) or very recent precipitation of CaCO_3 in a sample from the lower eolianite preclude an unequivocal age assignment for this unit, it is believed to be the same age as a sand layer at nearby Vizcaino Point, dated 31,000 to 46,000 BP (Muhs 1992).

Etymology. We are pleased to name this new species for Ronald J. Dow, in recognition and appreciation of the assistance and logistical support provided G. L. Kennedy and D. R. Muhs during their trips to San Nicolas Island.

Measurements of Holotype (mm). Cranium: Craniofacial hinge to tip of rostrum, 20.7 mm; length of left naris along ventral margin, 14.8 mm; dorsoventral dimension of bill at front edge of naris, 10.22 mm; width of bill at front edge of nares 5.92 mm. Mandible: Depth of mandible below point where tapering towards tip begins, 6.46 mm. Maximum lengths of postcranial elements: ulna, 53.74 mm;

humerus, 66.57 mm; carpometacarpus 35.25 mm; radius, 51.56 mm; coracoid, 38.86 mm.

Paratypes

Several complete skulls and mandibles; SBMNH 142 (Figure 4-C), and SBMNH 367, from Locality 6 (Figure 1), SBMNH 348 from locality 8, and SBMNH 339, 423, 424 from locality 18, all from San Miguel Island, Santa Barbara County, California.

Referred Material. Over 5,000 bones (SBMNH 14 to 144, 147 to 160, 331 to 356) representing most post-cranial elements from deposits on San Miguel Island (Guthrie 1992; 1993; 1998) are referred to *Fratercula dowi*. An Additional 2,000 bones have not yet been cataloged. An egg (LACM 127814) found near the holotype may also represent *F. dowi*. Additional eggs from San Miguel Island (SBMNH 401 to 404) are also of the size to be referable to this species.

Locality of Paratypes and Referred Material. All paratypes and referred material are from upper Pleistocene sands along the north shore of San Miguel Island (Figure 1). Exact locality data is on file at SBMNH and at Channel Islands National Monument Headquarters, Ventura, California.

Age of Paratypes and Referred Material. The age range for specimens from San Miguel Island is based on radiocarbon determinations on bones of *F. dowi* from two localities on the north shore of San Miguel Island. The section at Simonton Cove, from which most material has been obtained (locality 7), is radiocarbon dated between $<38,000$ BP and $25,160 \pm 380$ yrs BP (Guthrie 1992). Material of *F. dowi* from most other localities is considered equivalent to this in age. However, a few specimens of *F. dowi* were recovered from another locality (locality 4) that yielded a radiocarbon age of $11,890 \pm 95$ BP (Guthrie 1992).

Diagnosis

The holotype and paratypes of *Fratercula dowi* are separable from all other extant and fossil west coast puffins by the degree of dorsoventral expansion of the bill and mandible (Table 1; Figure 4). *F. dowi* is smaller than *F. cirrhata*, but is inseparable in size from bones of *Cerorhinca monocerata* and *Fratercula corniculata*. However, all puffin bills and mandibles from San Miguel Island (over 200 specimens) are clearly identifiable as *F. dowi* (Table 1). Further, those elements which can be clearly assigned to *Fratercula* or *Cerorhinca* on the basis of the characteristics listed above (over 3,000 bones; humerus, coracoid, tarsometatarsus, carpometacarpus, femur), are referable to *Fratercula*. As no specimens of *F. corniculata* have ever been found in Pleistocene or Holocene deposits south of Alaska (Brodkorb 1967), all of the approximately 6,000 bones known from these deposits on San Miguel Island, representing all post-cranial skeletal elements, are referred to *Fratercula dowi*.

Most of the material here referred to *F. dowi* comes from several localities dated between 38,000 BP to 25,160

Table 1. Measurements of bills and mandibles of *Fratercula dowi*, compared to extant Pacific puffin.

	Bill ^a			Mandible ^b		
	Number	Observed Range	Mean	Number	Observed Range	Mean
<i>Fratercula dowi</i>						
Holotype (LACM 127813)		10.22				
San Miguel Island	30	9.40-10.56	9.83	18	5.78-7.24	6.49
<i>Cerorhinca monocerata</i>	12	6.23-7.73	7.17	11	4.66-5.44	5.11
<i>Fratercula cirrhata</i>	10	17.14-20.82	18.89	10	9.40-12.85	11.3
<i>Fratercula corniculata</i>	10	17.39-21.17	19.84	10	8.36-9.77	9.35

^aBill measurement; maximum dorso-ventral distance at anterior edge of naris.

^bMandible measurement; maximum dorso-ventral distance at point where bill begins to taper towards the tip.

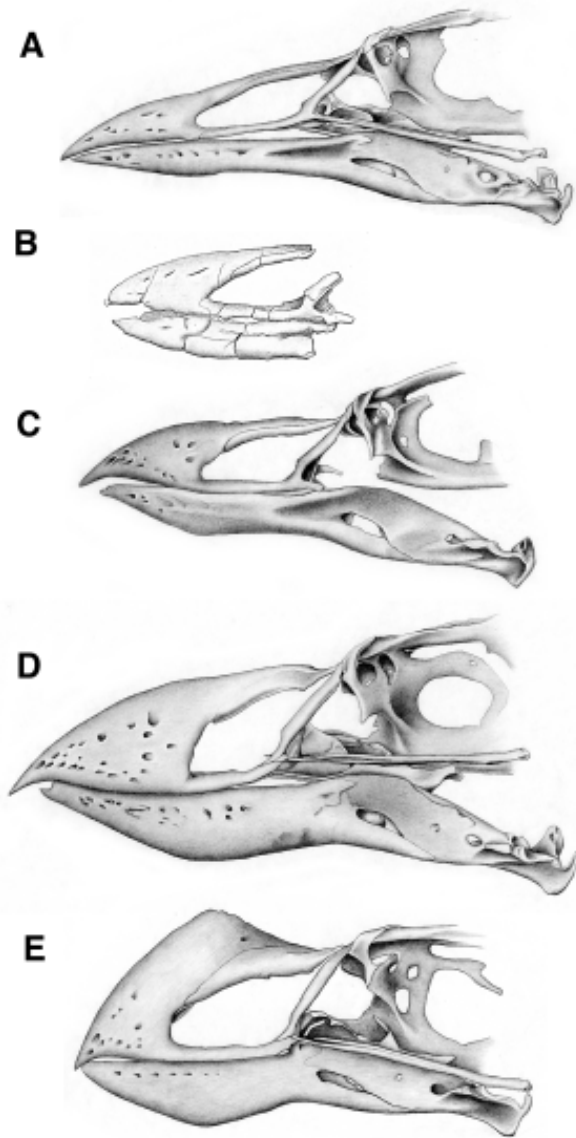


Figure 4. Lateral views of anterior portions of skulls of puffins, showing relative dimensions and shapes of premaxillae, nares and mandibles. A) *Cerorhinca monocerata* (LACM 87319), B) *Fratercula dowi*, Type (LACM 127813), C) *Fratercula dowi*, paratype (SBMNH 142), D) *Fratercula cirrhata* (LACM 90494), and E) *Fratercula corniculata* (LACM 102615).

± 380 yrs BP. Bones of *Fratercula dowi* are rare in younger deposits, but, interestingly, the smallest bill and mandible assigned to *F. dowi* are from the locality dated at 11,890 BP.

Although similar in size to *C. monocerata* and *F. corniculata*, the skull structure of *F. dowi* seems closest to *C. monocerata* and the larger *F. cirrhata* and these species are considered its closest relatives.

DISCUSSION

Quaternary puffin bones are rare, and most reported specimens from the northeastern Pacific are from prehistoric midden sites in Alaska (Brodkorb 1967). On the California Channel Islands, *Cerorhinca monocerata* is present but rare in the Holocene middens on San Nicolas Island (Bleitz-Sanburg 1987; Bleitz 1993). Small numbers of bones of *C. monocerata* and *Fratercula cirrhata* are also present in the middens on San Miguel Island, occurring in levels dating younger than 5,000 BP (Guthrie 1980).

In addition to *Fratercula dowi*, three bones of *F. cirrhata* (SBMNH 389, 390, 413) have been recovered from the late Pleistocene deposits on San Miguel Island. Although puffins are thought to have a Pacific rather than Atlantic origin (Olson 1985) there are no other fossil records of *Fratercula* from the Pacific coast. The earliest fossil puffins assigned to *Fratercula* are from the lower Pliocene (Hemphillian) of North Carolina (Olson 1985).

Howard (1968a) reported a single bone of *Cerorhinca monocerata* from upper Pleistocene deposits on Santa Rosa Island. This bone, a humerus, is referable to *F. dowi*. Howard also identified several bones from Anacapa Island as *C. monocerata* (in Lipps 1964). These bones include two humeri, a femur, and a coracoid, all of which are assignable, on the basis of characters listed in this paper, to *Fratercula*. Although the additional bones, an ulna, pelvis and scapula, cannot be assigned to genus, all these specimens are thought to represent *F. dowi*. Interestingly, these bones, which may date as early as 100,000 BP (Guthrie 1998:190) are at the large end of the size range for *F. dowi*.

Although no other specimens assigned to *Cerorhinca* are known from the Pleistocene of the west coast, several earlier specimens are known. *Cerorhinca minor* (Howard 1971) from the upper Miocene (Hemphillian) Almejas Formation on Isla Cedros, Baja California, Mexico and *Cerorhinca reai* (Chandler 1990) from the upper Pliocene San Diego Formation, seem, on the basis of the skeletal characteristics listed above, to be correctly assigned to *Cerorhinca*. Other puffins from the Pacific include *C. dubia* (Miller 1925), described from the upper Miocene (Clarendonian) Sisquic Formation near Lompoc, California, a bird identified as *Cerorhinca* sp. by Howard (1968b:16) from the upper Miocene Capistrano Formation of southern California and based on the proximal end of an ulna, and two fragmentary humeri, from the upper Miocene Monterey Formation, which Howard (1978:22) could not identify as to genus. Whether these three records should be

assigned to *Fratercula* or *Cerorhinca* cannot be determined from the available material.

The Pleistocene avifauna from San Miguel Island now includes over 70 species (Guthrie 1998), most of which are represented by disarticulated material as might be expected from deposits formed by wind and water erosion. However, articulated material is known for three species; *Fratercula dowi*, *Synthliboramphus antiquus* (ancient murrelet), and *Ptychoramphus aleuticus* (Cassin's auklet). Skeletons of both adult and immature birds of these species were positioned in a sitting position. Although no trace of burrows persist in the deposit, it appears that these birds died in caved-in nesting burrows. Among related forms, *Fratercula corniculata* nests almost exclusively in rock crevices, while both *Cerorhinca monocerata* and *Fratercula cirrhata* nest in burrows excavated in loose soil (Manuwal 1984). Puffins typically lay a single, relatively large egg that is incubated by both parents. The single, well preserved egg found near the holotype of *F. dowi* is approximately 66 mm long (projected length) and 43.2 mm in greatest diameter. This is within the range of modern egg measurements of *C. monocerata* and *F. corniculata*, but smaller than those of the larger *F. cirrhata* (Bent 1919). A radiograph of the egg did not reveal any embryonic bones, and exposure to ultraviolet light failed to reveal any color patterns that might help in its identification.

The eggs from San Miguel Island assigned to *F. dowi* were not clearly associated with skeletons of this species but are the size of the specimen from San Nicolas Island.

Today, puffins are northern birds whose distributional limits are probably controlled by a combination of temperature, water masses and food availability. Although a few puffins are found in southern California in winter (Garrett and Dunn 1981), they have rarely nested further south than the Farallon Islands of San Francisco (Hunt et al. 1980; Manuwal 1984). However, between 60,000 and 30,000 years ago, during interstadials in the mid-Wisconsin (equivalent to State 3 of the marine oxygen isotope record) the marine waters around the southern California Islands were significantly cooler and equivalent to those found today off the Oregon and Washington coasts (Wehmiller et al. 1977; Kennedy et al. 1982). Thus, the existence of a breeding colony of puffins on the Channel Islands is not unexpected.

SUMMARY

Fratercula dowi, a new Upper Pleistocene species of puffin, is described. Although only the type specimen is known from San Nicolas Island, this species was common on San Miguel Island between 25,000 and 40,000 BP, but occurred as recently as 12,000 BP on San Miguel island. Although *Fratercula* was previously known from the Miocene of North Carolina, this paper presents the first record of the genus *Fratercula* in fossil deposits on the west coast. Pleistocene records of the closely related genus *Cerorhinca* from Santa Rosa Island and Anacapa Island are based on *Fratercula dowi* and extend the range of this latter species

back to near 100,000 BP. *Fratercula dowi* appears to have decreased slightly in size between 100,000 BP and 11,000 BP. The genus *Cerorhinca* occurs in the Miocene and Pliocene of California, but is unknown from Pleistocene deposits, reappearing in middens about 5,000 BP. Material assigned to *F. dowi* includes eggshells, bones of immature birds, and articulated skeletons from individuals that appear to have died in burrows, suggesting that nesting colonies of this species once occurred on San Miguel and San Nicolas islands.

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