Raising Questions in the Central Mojave Desert

Robert E. Reynolds, editor

California State University Desert Studies Center
2013 Desert Symposium

April 2013

Table of contents

Raising questions in the central Mojave: the field trip 5
David M. Miller, Peter Sadler, Kevin Schmidt, and Robert E. Reynolds, trip leaders

Paleogeographic insights based on new U-Pb dates for altered tuffs in the Miocene Barstow Formation, California 31
D. M. Miller, J. E. Rosario, S. R. Leslie, and J. A. Vazquez

The Rainbow Loop Flora from the Mud Hills, Mojave Desert, California 39
Robert E. Reynolds and Thomas A. Schweich

Global warming and fluctuating adult body size in the oreodont *Brachycrus* (Mammalia, Artiodactyla, Oreodondontdae) during the Middle Miocene climatic optimum 49
E. Bruce Lander

Nonmarine gastropods from the Temblor and Barstow formations of California 68
Austin S. Plyley, Don L. Lofgren, and Andrew A. Farke

History of the Barstow Formation cricetid record 73
Everett H. Lindsay and David P. Whistler

Review of *Megahippus* and *Hypohippus* from the Middle Miocene Barstow Formation of California 78
Bobby Gonzalez and Don L. Lofgren

Calico—a brief overview of mining history 90
Larry M. Vredenburgh

The High Road to Borate 95
Robert E. Reynolds

Non-vertebrate fossils in the Miocene Barstow Formation, central Mojave Desert, California 99
R. E. Reynolds

Iron ore deposits of the Johnson Valley 103
Douglas C. Shumway and Dinah O. Shumway

Rock avalanche setting of the Cave Mountain (Baxter Mine) iron deposits, Afton Canyon, California 107
Kim M. Bishop

***Parapliohippus carrizoensis* (Perissodactyla: Equidae) from early Miocene (Hemingfordian NALMA) Barstow Formation outcrops in the southwestern Cady Mountains, Mojave Desert, California** 114
Robert E. Reynolds

New mammal tracks and invertebrate ichnites from Early Miocene Barstow Formation sediments on Daggett Ridge, Mojave Desert, California 117
Robert E. Reynolds

Recognized, zoned, active and potentially active faulting in the Mojave Desert 121
Frank F. Jordan, Jr

Vegetation lineaments near Pearblossom, CA: possible indicators of secondary faulting subparallel to the San Andreas Fault 138
David K. Lynch and Frank Jordan

Population dynamics of the Joshua tree (*Yucca brevifolia*): twenty-three-year analysis, Queen Valley, Joshua Tree National Park 146
James W. Cornett

Kelso Dunes mining claim validity examination 147
Gregg Wilkerson

Dinosaur and arthropod tracks in the Aztec Sandstone of Valley of Fire State Park, Nevada 159
Heather M. Stoller, Stephen M. Rowland, and Frankie D. Jackson

New records of fish from southern exposures of the Imperial Formation of San Diego County, California 165
Mark A. Roeder

Hydrographic significance of fishes from the Early Pliocene White Narrows Beds, Clark County, Nevada 171
Gerald R. Smith, Robert E. Reynolds, and Joseph D. Stewart

The terror bird, *Titanis* (Phorusrhacidae), from Pliocene Olla Formation, Anza-Borrego Desert State Park, southern California 181
Robert M. Chandler, George T. Jefferson, Lowell Lindsay, and Susan P. Vescera

Persistent drought lowers estimated survival in adult Agassiz's desert tortoises (*Gopherus agassizii*) in Joshua Tree National Park: a multi-decadal perspective 184
Jeffrey Lovich, Charles B. Yackulic, Jerry Freilich, Mickey Agha, Meaghan Meulblok, Kathie Meyer, . Terence R. Arundel, Jered Hansen, Michael Vamstad, and Stephanie Root

Changes in the paleogeographic distribution of *Mammut* in the southwestern United States and northwestern Mexico during the Pliocene and Pleistocene epochs 186
George T. Jefferson

Halloran Springs and pre-Columbian turquoise trade 198
Sharon Hull and Mostafa Fayek

Weathering climatic change: signs of prehistoric peoples 206
Amy Leska

Sites I would like to see: historic Native American refugee sites in southern California 209
Frederick W. Lange, Ph.D., RPA

Owlshead GPS Project 216
Randy Banis

Recent meteorite falls in California 221
R. S. Verish

Abstracts from the 2013 Desert Symposium 226
Robert E. Reynolds, editor

Front cover: Mule Canyon

Back cover: Folded sediments in Big Borate Canyon

Title page: Mule team hauling borax ore in Mule Canyon

The terror bird, *Titanis* (Phorusrhacidae), from Pliocene Olla Formation, Anza-Borrego Desert State Park, southern California

Robert M. Chandler,[1] George T. Jefferson,[2] Lowell Lindsay,[2] and Susan P. Vescera[2]
[1] *Biological and Environmental Science, Georgia College, Milledgeville, Georgia 31061*
[2] *Department of Parks and Recreation, Colorado Desert District Stout Research Center, Borrego Springs, California 92004*

ABSTRACT—During the Great American Biotic Interchange that took place after the formation of the Panamanian Land Bridge, *Titanis walleri* (family Phorusrhacidae, known as terror birds) entered southern-most North America during the mid-Pliocene. Specimens of these 2 m-tall, 150 kg flightless birds are known from Florida, and a single specimen from the gulf coast of Texas. Unfortunately, most are postcranial remains and no premaxillae are known. The anterior-most part of a premaxilla (beak), ABDSP(LACM) 6747/V26697, from the Olla Formation, 3.7 Ma, Anza-Borrego Desert State Park, was recently re-identified as *Titanis* and is comparable to the South American *Patagornis marshi*. The specimen was previously assigned to *Aiolornis incredibilis*. This new identification is important for several reasons: 1) it represents a significant geographic range extension for the genus; 2) it may represent the oldest know *Titanis* remains from the US; and 3) it reinforces the tropical aspect of the paleoenvironment of the Pliocene Epoch ancestral Colorado River deltaic deposits within the Salton Trough, California.

Introduction

Titanis is a member of the family Phorusrhacidae, commonly called terror birds. The family includes numerous genera and species (de Alvarenga and Höfling 2003) that range through a major part of the Cenozoic Era, 62 to about 2 Ma. All are South American in distribution except for a single taxon *Titanis walleri* (Brodkorb 1963) from North America. *T. walleri* is considered a valid genus distinguished from other taxa on the slender character of the tarsometatarsus (de Alvarenga and Höfling 2003).

The Phorusrhacidae entered North America via the Panamanian Land Bridge as part of the Great American Biotic Interchange (Webb 1985).

The first phorusrhacid fossils were found in Florida by scuba diver Ben Waller in 1962, hence the specific nomen *Titanus walleri* (Brodkorb 1963). While diving in the Santa Fe River, Gilchrist County, Florida, Waller recovered a tarsometatarsus and Digit III, proximal phalanx. A comparable Digit III, proximal phalanx, was found later in a gravel pit along the Nueces River, San Patricio County near Corpus Christi, Texas (Baskin 1995). Fewer than 50 specimens of *T. walleri* have been reported from the US, and all but the Texas specimen are from four localities in Florida. Most are post cranial elements, and no premaxillae are known (Chandler 1994; de Alvarenga and Höfling 2003; Gould and Quitmyer 2005). The age and identity of these materials have been the subject of discussion and controversy (Gould and Quitmyer 2005), and have an estimated age range from <5 to 2.2–1.8 Ma (McFadden et al. 2007).

The *Titanis* sp. from ABDSP represents a significant range extension from the previously known paleogeographic distribution on the Texas gulf coast and Florida. And, it better constrains the age range of *Titanis* in North America.

Abbreviations are: ABDSP = Anza-Borrego Desert State Park; LACM = Los Angeles County Museum of Natural History. We thank Lyn Murray for his critical review and helpful comments.

Material and occurrence

The *Titanis* sp. premaxilla, ABDSP(LACM) 6747/V26697 (field locality TD 1073), was found by G. Davidson Woodard in 1961. Woodard worked as a geologist with Ted Downs of the Los Angeles County Museum. The specimen was recovered from the lower part of the Olla Formation (Cassiliano 2002) exposed in the Fish Creek/Vallecito Creek Basin of the southern part of ABDSP. The Olla Formation is typified by packages of ancestral Colorado River, well sorted, medium-grained quartzose deltaic sandstone that are interbedded with apparently locally derived packages of poorly sorted, feldspathic fluvial sandstone (Winker 1987). The specimen was recovered from the fluvial part of the formation. It was mapped within the stratigraphic section by Downs as within CZ 23.7 (collecting zone, or CU collecting units of Cassiliano 1999). This horizon falls within reversed subchron C2Ar (4.18-3.58 Ma), and based on the magnetostratigraphy of Dorsey et al. (2011) the interpolated age is 3.7 Ma.

The phorusrhacid identity of the ABDSP specimen was first recognized by Chandler (pers. comm. 2009,

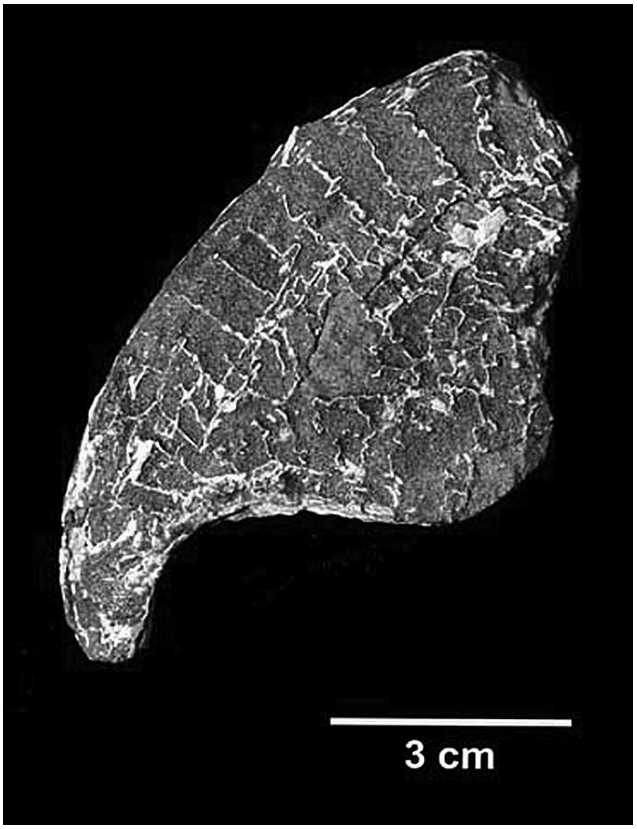

Figure 1. Left lateral view of the anterior portion of premaxilla ABDSP(LACM) 6747/V26697 (image from Jefferson 2006, Jefferson et al. 2012, photographed by B. Marrs).

Jefferson et al. 2012). The specimen (Fig. 1) represents only the anterior-most portion of the premaxilla, and was described in detail by Howard (1972) who placed it the genus *Teratornis*. The specimen largely consists of the permineralized internal portion of the premaxilla with culmen and exposed trabecullae, lacking much cortical bone which apparently has been weathered away. ABDSP (LACM) 6747/V26697 measures 90.8 mm in length, 55.4 mm in height, and 27.5 mm in maximum width across the palate. The specimen is triangular in vertical cross section, with a relatively sharp dorsal crest and flat sides. It exhibits a chord (arc) of the partial culmen (exposed premaxilla) that is identical to that in *Patagornis marshi* (previously *Phororhacos inflatus*, Andrews 1899). ABDSP (LACM) 6747/V26697 has a complete bony palate, not an open, vaulted premaxilla like *Aiolornis*, to which it was referred by Campbell (1999). The specimen has an internal morphology, as revealed in coronal scan (L. Witmer pers. comm. 2009), that is identical in construction to a beak like *Patagornis* with an open space or chamber inside.

The premaxilla, ABDSP (LACM) 6747/V26697, and a wing bone, ABDSP (LACM) 1318/V3803 that was recovered from the Pleistocene Hueso Formation, were both placed in the genus *Teratornis* by Howard (1963, 1972). An additional *Teratornis* specimen, ABDSP(IVCM) 519/V5660, was reported by Jefferson (1995). In 1999 the genus *Teratornis* was divided into two genera and all specimens from ABDSP that were previously assigned to *Teratornis* (Howard 1963, 1972; Jefferson 1995, 2006) were placed in the new genus *Aiolornis* by Campbell et al. (1999). It should be noted that the premaxilla is about 2.5 Ma older than other materials assigned to *Aiolornis* from ABDSP. All of the above specimens except ABDSP (LACM) 6747/V26697 remain assigned to *Aiolornis incredibilis*.

Discussion

The ABDSP specimen at 3.7 Ma falls within the estimated temporal range for Titanis, <5 to 2.2–1.8 Ma (McFadden et al. 2007). The estimate for a maximum age of <5 Ma is based on the Texas specimen, which was recovered from late Pleistocene sediments, ca. 13 ka BP. However, it has a rare-earth-element signature of early Pliocene materials and may have been re-worked from older deposits transported from upstream and mixed with the Pleistocene deposit (McFadden et al. 2007). The materials from Florida sites are estimated to be between 2.2 and 1.8 Ma (McFadden et al 2007). Most of those specimens were recovered from a mid-channel accumulation, SF1A, but are traceable to inplace sediments of SF1B. The proximal humerus, UF 137839, was found at SFB1 and is Blancan NALMA in age. ABDSP (LACM) 6747/V26697 is the only specimen from North America that has a well supported date, and may be the oldest record.

The Arroyo Diablo and Olla formations, which are stratigraphically lateral equivalents (Winker 1987; Cassiliano 2002), yield a fossil wood assemblage that includes tropical taxa such as *Persea podadenia* (avocado) and *Washingtonia* sp. (fan palm) (Remeika 2006). Although vertebrate remains from these stratigraphic units are rare, they include tropical wetland forms such as Gomphotheriidae (elephant-like gomphothere) and subtropical taxa such as *Hesperotestudo* (giant tortoise) and *Pumelia novaceki* (iguana). These and *Titanis* reinforce the idea that the Pliocene fossil record from ABDSP exhibits a tropical to subtropical paleoenviornment not unlike the southern-most US, proximal to the Gulf of Mexico and Mexico at that time.

References

Andrews, C. W. 1899. On the extinct birds of Patagonia, I. The skull and skeleton of *Phorohacos inflatus* Ameghino. Transactions of the Zoological Society of London 15(3):55-86.

Baskin, J. A. 1995. The giant flightless bird *Titanis walleri* (Aves: Phorusrhacidae) from the Pleistocene coastal plain of south Texas. Journal of Vertebrate Paleontology 15 (4): 842–844.

Brodkorb, P. 1963. A giant flightless bird from the Pleistocene of Florida. Auk 80(2):111-115.

Campbell, K. E., Jr., E. Scott, and K. B. Springer 1999. A new genus for the incredible teratorn (Aves: Teratornithidae). In Avian Paleontology at the Close of the 20th Century: Proceedings of the 4th International Meeting of the Society of Avian Paleontology and Evolution, edited by S.L. Olson, Smithsonian Contributions to Paleobiology 89:169-175.

Cassiliano, M. 2002. Revision of the stratigraphic nomenclature of the Plio-Pleistocene Palm Spring Group (new rank),

Anza-Borrego Desert, southern California. Proceedings of the San Diego Society of Natural History 38:1-30.

Chandler, R. M. (1994). The wing of *Titanis walleri* (Aves: Phorusrhacidae) from the late Blancan of Florida. Bulletin of the Florida Museum of Natural History, Biological Sciences, 36: 175-180.

de Alvarenga, H., and E. Höfling 2003. Systematic revision of the Phorusrhacidae (Aves: Ralliformes). Papeis Avulsos de Zoologica 43(4):55-91.

Dorsey, R. J., B. A. Housen, S. U. Janecke, C. M. Fanning, and A. L. F. Spears 2011. Stratigraphic record of basin development within the San Andreas fault system: Late Cenozoic Fish Creek-Vallecito basin, southern California. Geological Society of America Bulletin 123(5,6):771-793.

Gould, G. C., and I. R. Quitymer 2005. *Titanis walleri*: bones of contention. Bulletin of the Florida Museum of Natural History 45(4):201-229.

Howard, H. H. 1963. Fossil birds from the Anza-Borrego Desert. Los Angeles County Museum Contributions in Science 73:1-33.

Howard, H. H. 1972. The incredible teratorn again. The Condor 74(3):341-344.

Jefferson, G. T. 1995. An additional avian specimen referable to *Teratornis incredibilis* from the early Irvingtonian, Vallecito-Fish Creek Basin, Anza-Borrego Desert State Park, California. In Paleontology and Geology of the western Salton Trough Detachment, Anza-Borrego Desert State Park, California, edited by P. Remeika and A. Sturz, Field Trip Guidebook and volume for the 1995 San Diego Association of Geologist's field trip to Anza-Borrego Desert State Park, Volume 1:94-96.

Jefferson, G. T. 2006. The fossil birds of Anza-Borrego. In The Fossil Treasures of the Anza-Borrego Desert, edited by G.T. Jefferson and L. Lindsay, Sunbelt Publications, San Diego, California p. 151-158.

Jefferson, G. T., L. K. Murray, and S. D. Keeley 2012. The Pliocene fossil record of Anza-Borrego Desert State Park, western Salton Trough, California. In Search for the Pliocene: the Southern Exposures, edited by R.E. Reynolds, California State University Desert Studies Consortium, The 2012 Desert Research Symposium pp. 77-87.

McFadden, B., Labs-Hochstein, J. Hulbert, and J. Baskin 2007. Revised age of the late Neogene terror bird (*Titanis*) in North America during the Great American Interchange. Geology 35(2):123-126.

Webb, S. D. 1985. Late Cenozoic mammal dispersals between the Americas. In The Great American Biotic Interchange, Topics in Geobiology, Plenum Press, 4:357-386.

Witmer, L. (pers. comm.) 2009. Department of Biomedical Sciences, College of Osteopathic Medicine, Ohio University, Athens, Ohio.

Winker, C. D. 1987. Neogene stratigraphy of the Fish Creek-Vallecito section, southern California: implications for early history of the northern Gulf of California and Colorado delta. Doctoral Dissertation, University of Arizona, Tucson 494 p.