A New Teratorn (Aves: Teratornithidae) from the Upper Pleistocene of Oregon, USA

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Abstract

An associated partial skeleton recovered from a paleo-/archaeological test trench in the Willamette Valley is the first record of the family Teratornithidae from the state of Oregon. Recovered elements include both cranial and postcranial bones and a number of vertebrae. The elements fall with the range of size variation of *Teratornis merriami* from Rancho La Brea, California, but they have several unique features that indicate that they represent a new species of teratorns. The inferred age of the specimen is approximately 12,000 yrBP, and it is associated with archaeological and micro- and megafaunal remains. *Teratornis* have not previously been reported from north of central California, although they have been reported from as far east as Florida. Based on their large wingspans, which were in excess of 4 m, teratorns have been interpreted as primarily birds of semi-open terrain where they would not have had trouble maneuvering. From this it may be inferred that such habitats were available in the Willamette Valley 12,000 years ago. The only other reported occurrence of teratorns in proximity to archaeological remains is at Rancho La Brea, California.

Introduction

Buried bogs dating from the late Pleistocene are common in the Willamette Valley of Oregon, and they have been known to produce fossils for over 150 years (Orr and Orr, 1999). The Woodburn Bog is one of these fossiliferous bogs, and it comprises a buried network of ancient wetlands within the City of Woodburn, Oregon. The flood plain of the Mill Creek drainage, a seasonal tributary of the Willamette River, commonly overlies the Woodburn Bog (Balster and Parsons, 1968). Sewer line construction near Mill Creek close to Woodburn High School in the 1950's resulted in the discovery of Pleistocene megafaunal remains, and similar excavations in 1987 produced additional fossils. These finds, along with other reported finds along Mill Creek, prompted the City of Woodburn to initiate the Woodburn Paleo-Archaeology Project in 1996 to ensure minimal impact on other remains by future utility construction. This project was undertaken by the Institute for Archaeological Studies, in conjunction with Oregon State University and the

Condon Museum of Geology, University of Oregon. A completely unexpected discovery in the course of this project was an associated partial skeleton of a new species of teratorn.

Material and Methods

The Woodburn Paleo-Archaeology Project tested four sites in the Mill Creek flood plain, all on undeveloped land and at elevations of 45-50 m above mean sea level. Auger probes to 5± m depth were used to determine site stratigraphy. These tests were then followed by trench excavation at three sites (Mammoth Park, Legion Park, and Stafek; Fig. 1) using a backhoe. Hand excavation and direct inspection of the stratigraphic profiles were prevented by a high water table and slumping. However, expert trenching work and careful separation of stratigraphic horizons did allow for minute scrutiny of all sediments removed from the trenches. The stratigraphy at all of the sites proved to be similar, and all of the sites produced both fossil vertebrates and archaeological remains. The oldest beds producing remains have been ^{14}C dated to >12,000 yrBP.

The Legion Park site produced the teratorn remains reported on here. Field tests at this site were first undertaken in 1999, and included nine auger probes and three trenches. The first two trenches, A and B, were at opposite ends of the site, approximately 226 m apart. Trench C, from which came the teratorn, was

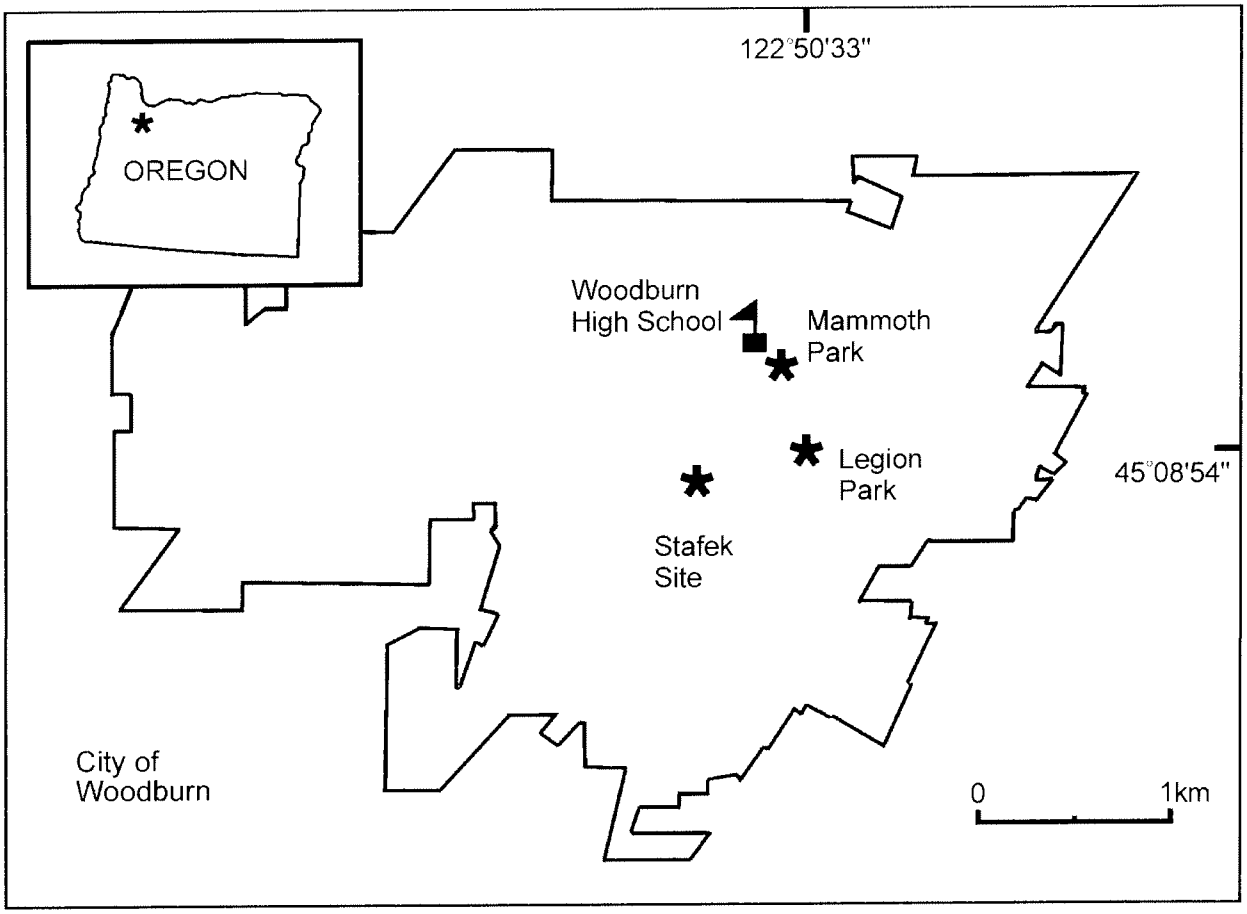

FIGURE 1. Map of the City of Woodburn showing the location of the three sites trenched during the 1999 Woodburn Paleo-Archaeology Project. Inset map shows state of Oregon, with location of City of Woodburn indicated by asterisk.

near the middle of the site, and it was about 2 m long by 1 m wide. This trench collapsed during excavation and was immediately backfilled with non-productive higher-level strata while the samples of extracted older strata were being examined for remains. The collapse was fortuitous because it brought a halt to the backhoe work after enough of the teratorn had been brought up to indicate that there was a good possibility that an entire associated skeleton was present, but before the specimen had actually been detected in the sediment. A return excavation in July 2000, however, failed to recover additional remains.

Except for being broken in excavation, the bones of the Woodburn teratorn are in good condition, with excellent preservation of osteological characters. Elements of the new specimen were compared with those of *Teratornis merriami* Miller, 1909 in the extensive collections from Rancho La Brea housed in the George C. Page Museum of La Brea Discoveries, a branch of the Natural History Museum of Los Angeles County. In the course of this work several specimens in the La Brea collections were identified as belonging to the second, little known teratorn species from that site, *Cathartornis gracilis* Miller, 1910.

Osteological terminology is primarily from Baumel (1993) and Howard (1980). Measurements were taken with dial calipers accurate to 0.05 mm.

Systematic Paleontology

Class Aves

Order Ciconiiformes

Family Teratornithidae Miller, 1909

Genus *Teratornis* Miller, 1909

Teratornis woodburnensis n. sp.

Holotype Partial skeleton of one individual, including right and left quadrates, right pterygoid, right palatine, partial left and right mandibular rami, anterior end of sternum, almost complete left humerus, distal end of right tibiotarsus, and axis, 3rd, 9th-11th, 13th cervical and 3rd thoracic vertebrae; Condon Museum of Geology, University of Oregon, catalogue number F36468.

Diagnosis The specimen is diagnosed as a member of the family Teratornithidae by the enlarged great tuberosity on anterior face of bicipital crest of the humerus and the tall, thin Pars intermediae of the Rami mandibulae that bear anterior suture scars. It agrees with *Teratornis*, and differs from *Cathartornis*, by having humerus with caput humeri more rounded proximally and less set off ventrally, in anterior view; facies bicipitalis more deeply channeled; epicondylus ventralis more pronounced and more angular; tuberculum supracondylare ventrale more prominent, highly elevated, and angular.

The holotypical specimen differs from *Teratornis merriami* by having crista deltopectoralis with prominent ridge on anterior surface of bone, with attachment of M. pectoralis superficialis consisting of two parts: a very long, greatly elevated, proximal portion for insertion of M. pectoralis superficialis, superficial layer; and a shorter, much less elevated, but still prominent distal portion for attachment of M. pectoralis superficialis, deep layer, with elevated ridge narrowing considerably where the attachment scars for deep and superficial layers meet, but with no hiatus between the two (proximal elevated portion shorter and distal elevated portion longer in *Teratornis merriami*, with a hiatus between the attachment scars associated with the two areas); great tuberosity on anterior face of bicipital crest long, at less of an angle to long axis of shaft, in ventral and anterior view; epicondylus ventralis prominent, less rounded, maximum ventral extension positioned distal to tuberculum supracondylare ventrale (not positioned quite as far distally in *T. merriami*); epicondylus dorsalis extending farther dorsad, less rounded. Tibiotarsus with condylus lateralis, in anterior view, at a greater angle to long axis of shaft, with antero-proximal corner protruding more laterad; in distal view, not protruding as far anteriad, giving more flattened appearance. Ossa quadratum with processus oticus with medial portion, or pars squamosum, extending farther dorsad, and with condylus squamosum larger, longer, and more bulbous at medial end.

Type Locality Legion Park, City of Woodburn, Oregon. Lat. 45° 08' 54" N; Long. 122° 50' 33" W; University of Oregon locality number UO3038 (Fig. 1).

Type Horizon and Age Stratum 4 (= uppermost, transitional horizon capping Willamette Silts) of the Woodburn Bog deposits (Fig. 2); at an approximate depth of 2.8-3.0 m below the surface. The stratigraphic record at the three trenched sites in the Mill Creek

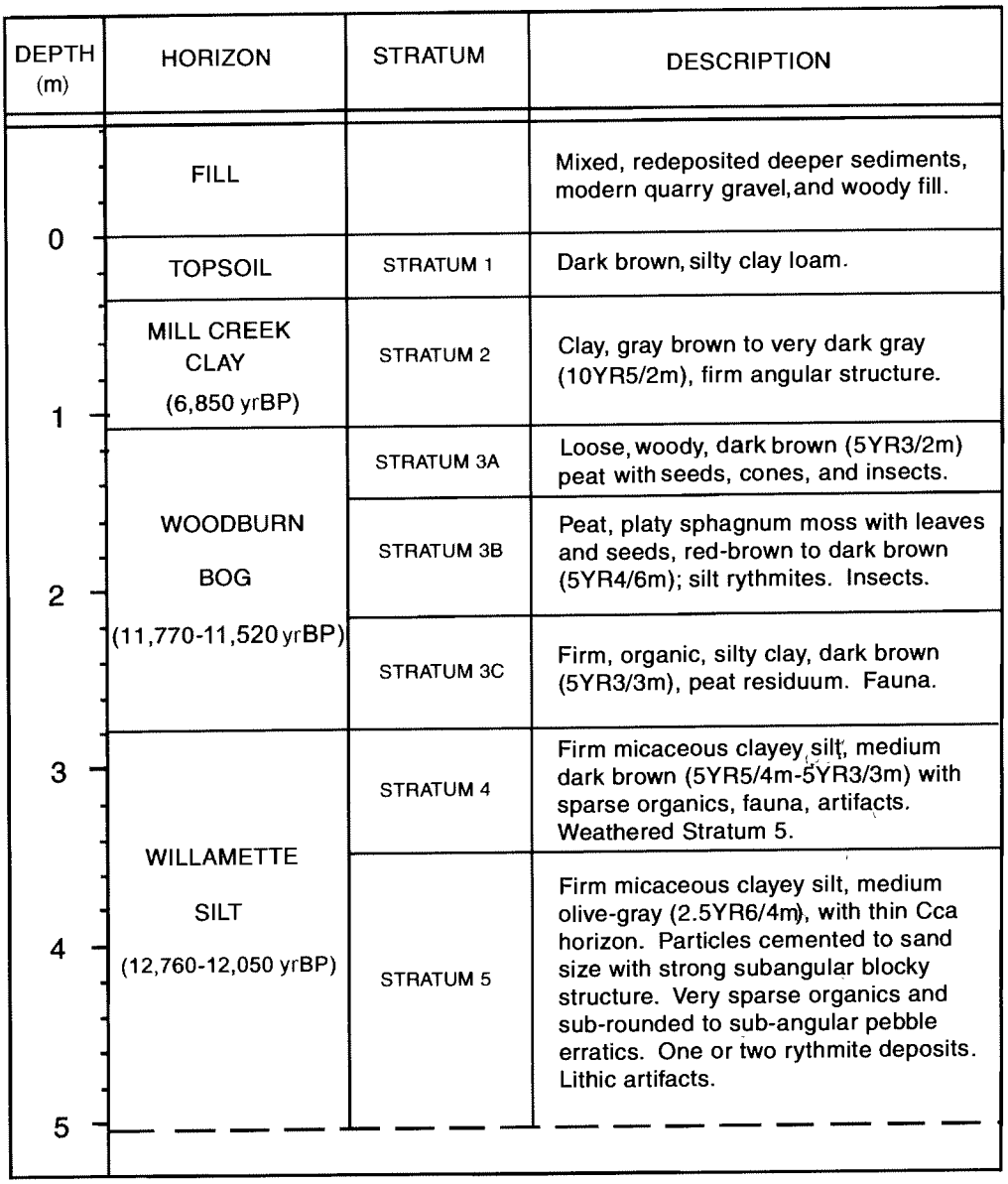

FIGURE 2. Chart showing the interpretation of the stratigraphy at Legion Park, the type locality for *Teratornis woodburnensis* n. sp. The stratigraphy at this site is comparable to that at the other two sites in Woodburn that were trenched in 1999.

floodplain spans the Pleistocene-Holocene boundary (Fig. 2). The Willamette Silts (Stratum 4 and Stratum 5), which were deposited by the last episode of the late Pleistocene Bretz floods (Balster and Parsons, 1968; Allen, 1986), comprise the base of the section exposed. The excavations did not reach the base of these silts. Stratum 4 is the uppermost, transitional horizon of the Willamette Silts. An organic silty clay, it appears to represent a period of weathering of the original deposit, with only light accumulation of sediment.

The teratorn specimen itself has not been dated, but an age of approximately 12,000 yrBP is inferred based on a ^{14}C sediment date from the deep part of Stratum 4 at the Legion Park site (12,050±50; Beta

146470). At the Mammoth Park site, sediment from Stratum 4 has been ^{14}C dated to 12,200±100 yrBP (Beta 96399). Stratum 4 is also bracketed by older dates on Stratum 5 samples from the Mammoth Park (12,310±80 yrBP; Beta 96400) and Stafek (12,760±110 yrBP; Beta 133022) sites and younger dates on Stratum 3 samples at Legion Park (11,520±70 yrBP; Beta 136265) and the Mammoth Park site (11,770±70 yrBP; Beta 96403).

Etymology This species is named for the city in which it was found, Woodburn, Oregon.

Collector Collected by Alison Stenger, Charles Hibbs, and William T. Orr on 29 September 1999.

Description In addition to the diagnostic characters listed above, the following comparative descriptive comments illustrate differences from comparable features in *Teratornis merriami*. The size of the comparative sample is different for each bone because of differential preservation of fossils at Rancho La Brea. For those elements with only a small number of comparative bones the diagnostic value of the characters listed below is unknown.

Ossa quadratum Right and left, complete, except for procesus orbitalis (Fig. 3). Corpus ossis quadrati more lightly built overall. Sulcus pneumaticus less excavated, with small, as opposed to large, foramen pneumaticum. Condylus lateralis narrower antero-posteriorly, with lateral portion extending farther posterolaterad relative to medial portion, in ventral view, and with medial flange at a greater angle to long axis of bone and not extending as far ventrad, in posterior view, which gives a shallower "saddle" between the lateral and medial portions of the condylus lateralis. Condylus oticum shorter along long axis; more bulbous, particularly on external end, where its facies articularis extends farther ventrad. Incisura intercondylus narrower. Condylus pterygoideus slightly convex at anterior end, much more convex at posterior end (variable in *Teratornis merriami*, from slightly concave to moderately convex). Comparative material consisted of 5 left and 5 right quadrates of *T. merriami*.

Measurements (mm; *T. merriami* in parentheses): Right and left quadrates in that order; not separated to side for *T. merriami*. Length through condylus medialis and medial portion of condylus lateralis, 25.7, 25.3 (24.5-27.1, $\bar{x}$ =25.9, n = 8); length through condylus lateralis, 16.4, 16.1 (15.1-17.6, $\bar{x}$= 16.3, n = 7); height through lateral portion of condylus posterior and condylus squamosum, 31.9, 32.0 (31.0-34.0, $\bar{x}$= 32.4, n = 8); width through condylus oticum and condylus squamosum, 18.9, 19.1 (18.1-20.0, $\bar{x}$= 19.1, n = 8).

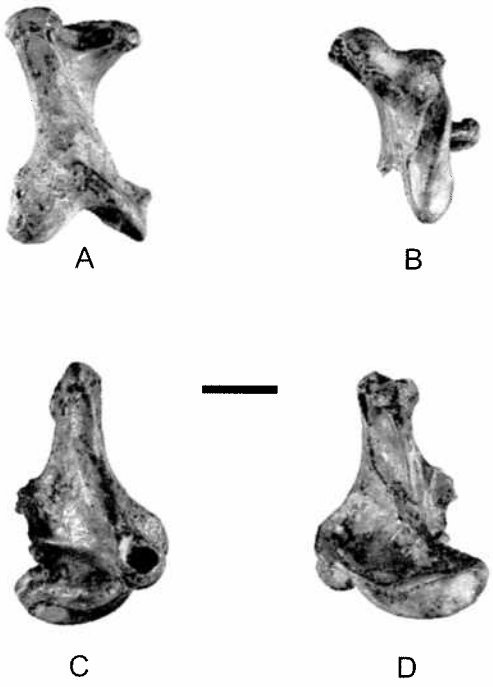

FIGURE 3. Left quadrate of *Teratornis woodburnensis* n. sp. in posterior (A), ventral (B), lateral (C), and medial (D) views. Scale bar = 1 cm.

Ossa mandibulae The mandibles of teratorns are long, thin, and blade-like, with a highly developed flexure zone where the pars posterior joins the pars intermedia. The pars symphysialis of teratorns has yet to be identified.

Ramus mandibulae, pars posterior Left, fragment (Fig. 4). This fragment consists of part of the mandible immediately posterior to the zona flexoria intramandibularis posterior, and it includes the posterior portion of the fenestra rostralis mandibulae. An overall similarity to *T. merriami* can be noted, including the dorsolateral flare of the occusal edge, but this specimen is too fragmentary to provide details. Comparative material included 8 left and 7 right specimens of *T. merriami*.

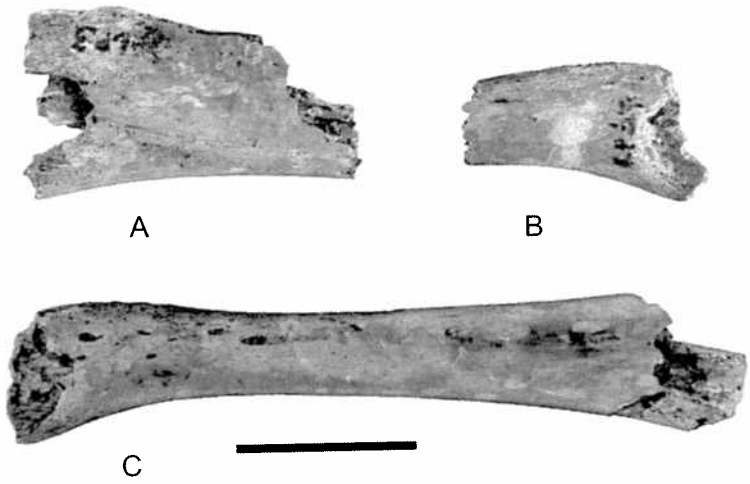

FIGURE 4. Partial mandibular rami of *Teratornis woodburnensis* n. sp. (A), anterior portion of left ramus mandibulae, pars posterior, in lateral view; (B), anterior portion of right ramus mandibulae, pars intermedia, in lateral view; (C), almost complete left ramus mandibulae, pars intermedia, in lateral view. Scale bar = 2 cm.

Measurements (mm; *T. merriami* in parentheses): Height at posterior end of fenestra rostralis, 20.1 (20.4-23.3, $\bar{x}$ = 21.3, *n* = 10); maximum width at posterior end of fenestra rostralis, 5.4 (4.6-6.0, $\bar{x}$ = 5.4, *n* = 11).

Ramus mandibulae, Pars intermedia Left, almost complete, and right, anterior end (Fig. 4). Both fragments display the typical teratorn suture zone at the anterior end. Numerous small foramina occur in the dorsolateral quadrant, and the occusal edge is roughened anteriorly. Dorsoventral depth much greater at proximal suture zone than for some distance posterior to suture zone. No characters can be noted that distinguish the pars intermedia of *Teratornis woodburnensis* from that of *T. merriami*. Comparative material included four pars intermedia of *T. merriami* in good condition and six badly worn or broken specimens.

Measurements of left specimen (mm; *T. merriami* in parentheses): Vertical height at shallowest point distal to anterior suture, 9.4 (8.1-9.1, $\bar{x}$ = 8.6, *n* = 4); width at shallowest point, 3.1 (3.2-4.1,$\bar{x}$ = 3.7, *n* = 4).

Os pterygoideum Right, complete (Fig. 5). Facies articularis quadratica larger, more rectolinear, with broad dorsal extension onto processus quadraticus (extension absent in *Teratornis merriami*, but may be a variable character); at greater angle to long axis of bone, in medial view; and more prominently set off from shaft in medial view. Processus quadraticus much broader, in dorsal view, with larger foramen in distal portion. Facies articularis basipterygoidea a shorter,

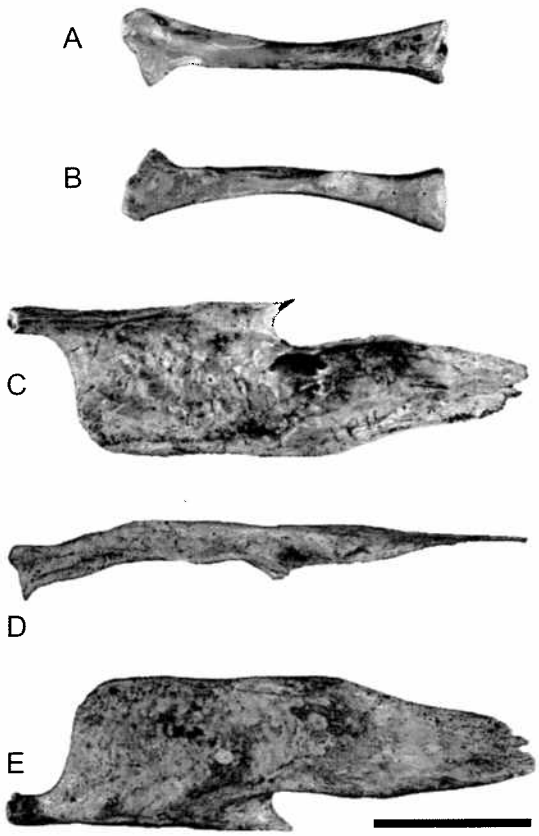

FIGURE 5. Right pterygoid (A, B) and right palatine (C-E) of *Teratornis woodburnensis* n. sp., in ventral (A, C), dorsal (B, E), and medial (D) views. Scale bar = 2 cm.

deeper, elliptical depression, much better demarcated by a prominent rim. Pes pterygoidei deep dorsoventrally, with prominent lateral flange, giving it a triangular appearance, in anterior view (ventral half absent, with lateral extension of bone dorsoventrally deep, not flange-like in *T. merriami*). Facies articularis parasphenoidalis larger, better marked. Facies articularis palatina a triangular-shaped, deeply pitted, rugose surface, as opposed to the rather amorphous structure in *T. merriami*. Only one pterygoid of *T. merriami* was available for comparison.

Measurements (mm; *T. merriami* in parentheses): Length, 40.6 (43.2); proximal depth, 9.4 (9.9); maximum distal depth of pes pterygoidei, 8.1 (6.3); maximum width through pes pterygoidei, 6.4 (4.3).

Os palatinum Right, complete (Fig. 5). The palatine in teratorns is a flattened, blade-like bone without the ridges or flanges projecting significantly dorsad or ventrad as seen in so many groups of birds. Processus pterygoideus shorter, triangular-shaped as opposed to elliptical, with facies articularis pterygoideus a flattened surface, as opposed to a surface sloping anterolaterad with a deep central pit. Processus pterygoideus, in medial view, with posterior end with sharp dorsal projection and moderately developed, rounded, posteroventral projection (slight to moderate, rounded dorsal projection and flat ventral edge in *Teratornis merriami*). Crista dorsalis a high, narrow, sharp-edged ridge that continues anteriad, turning mediad in dorsal view, as opposed to a low, rounded ridge that decreases rapidly in elevation anteriad as in *T. merriami*.

Pars choanalis bordered ventrolaterally by a low, stout ridge of bone. Crista ventralis absent, as in *Teratornis merriami*. Fossa choanalis a wide, smooth groove, with medial projection bordering fossa long and pointed in dorsal view. Dorsal extension of bone bordering fossa a very thin, sharp ridge, with posterolateral corner extending dorsad as sharp point (narrower, less trough-like and more grooved, with less sharp border and no posterolateral extension to bordering dorsal rim in *T. merriami*). Facies articularis parasphenoidalis, in medial view, broader dorsoventrally throughout, with pronounced flexure dorsad midway between facies choanalis and facies articularis pterygoideus (point of flexure positioned farther posterior and amount of flexure less in *T. merriami*).

Pars lateralis broader posteriorly, with prominent, squared-off, as opposed to well rounded, posterolateral corner. Ventral area of attachment of M. pterygoideus faintly crenulated, slightly convex perpendicular to long axis, as opposed to mostly flat or with slight concavity, with better developed ridge bordering area of attachment laterally for length. Dorsal area of attachment of M. pterygoideus well crenulated, moderately concave rather than flat, extending almost to end of bone, with a deep fossa dorsolateral to posterior portion of fossa choanalis. Processus maxillaris wider, thin, flat, and turning more distinctly away from midline anteriorly. Comparative material included two palatines of *T. merriami*.

Measurements (mm; *T. merriami* in parentheses) Overall length as preserved, 66.0 (64.3, 67.0); Facies articularis pterygoideus to posterior end of groove for fossa choanalis, 32.9 (33.0, 31.2); width at posterior end of fossa choanalis, 19.4 (18.2, 20.0); vertical distance through facies articularis pterygoideus, 7.8 (6.2, 4.3).

Sternum Portion of anterior end.

Sulci articularis coracoideus approach the midline in a more ventral position, such that the anterodorsal edges of articular facets do not form anterodorsal edge of the sternum. A low, wide, horizontal ridge, the pila coracoidea, crosses the sternum dorsal to the sulci, in anterior view (ridge less developed in *Teratornis merriami*, which gives the appearance of a broad valley between the dorsal edges of the sulci articularis coracoideus). Anterodorsal part of carina broader and more massive in anterior view, not as concave ventral to sulci articularis coracoideus. Comparative material included more than 30 partial sterni of *T. merriami*.

Humerus Left, almost complete (Fig. 6). Caput humeri, in posterior view, with proximal end narrowly elliptical, less rounded. Condylus ventralis longer, dorsoventrally, with proximoposterior edge less rounded and ventral end extending farther distad. Comparative material included more than 50 complete and partial humeri of *T. merriami*.

Measurements (mm; *T. merriami* in parentheses): Maximum width through epicondyles, 61.7 (56.2-65.8, $\bar{x} = 62.2$, $n = 14$); anteroposterior depth through lateral bounding ridge of sulcus scapulotricipitalis and condylus dorsalis, 31.0 (30.2-36.8, $\bar{x} = 33.1$, $n = 15$);

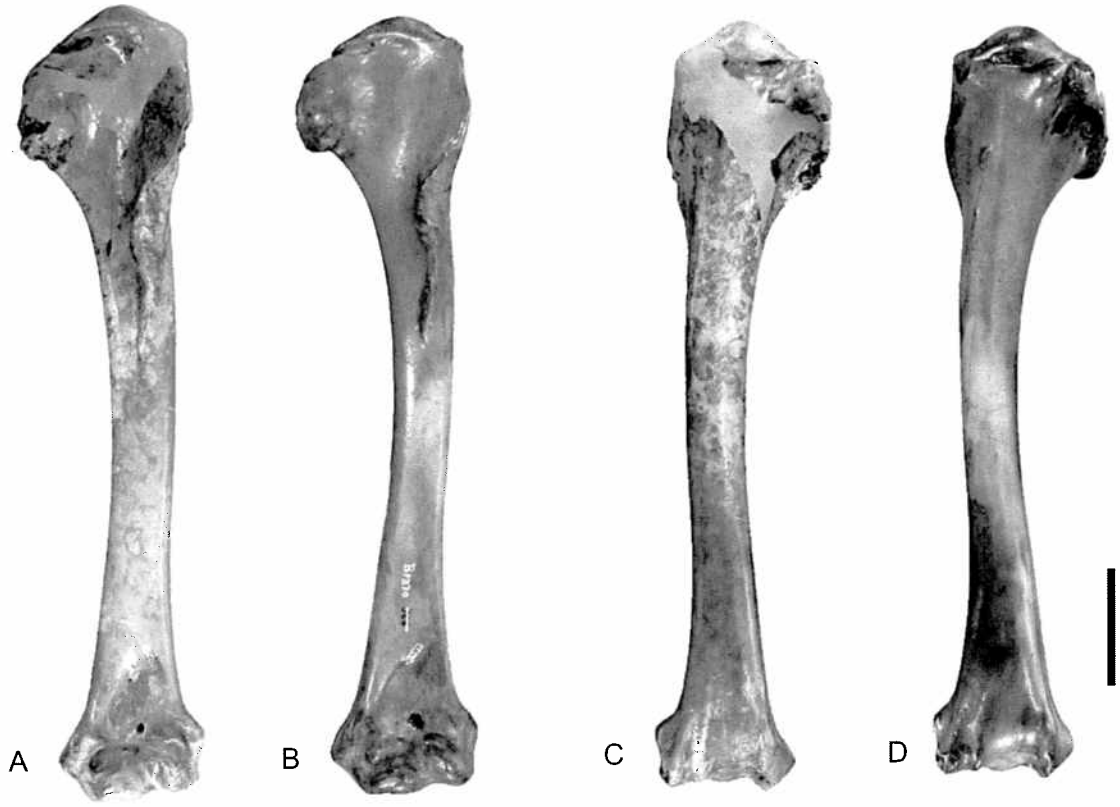

FIGURE 6. Left humerus of *Teratornis woodburnensis* n. sp. (A, C) in comparison with a humerus of *T. merriami* from Rancho La Brea (RLB/Hancock B1370) (B, D), in anterior (A, B) and posterior (C, D) views. The uniform gray color in the proximal end of *T. woodburnensis*, in both views, is clay filling in for parts of missing bone. Scale bar = 5 cm.

shaft width at level of midshaft nutrient foramen, 26.1 (23.6-26.9, $\bar{x}$ = 25.3, *n* = 5).

Tibiotarsus Right, distal end. Condylus medialis with anteroproximal corner curving mediad. Trochlea cartilaginis tibialis shallower, in anterior view. Crista lateralis of trochlea cartilaginis tibialis with proximal corner merging smoothly with shaft, as opposed to being distinctly set off. Comparative material included more than 50 complete and distal tibiotarsi of *Teratornis merriami*.

Measurements (mm; *T. merriami* in parentheses): Width through condyles, 28.4 (25.6-29.5, $\bar{x}$ = 27.7, *n* = 8); anteroposterior depth through condylus lateralis, 25.8 (24.7-29.0, $\bar{x}$ = 25.9, *n* = 8).

Axis Complete (Fig. 7). Facies articularis atlanticus shallower, with ventral portion not protruding as far proximad, and narrower, more rounded in proximal view. Zygapophysis anterioris, facies articularis more oval in shape, oriented more vertically. Dens with proximal end more rounded in dorsal view, and proximal end with greater slope posteroventrally, in lateral view. Corpus vertebrae proportionally narrower, especially proximally, with a much narrower and shorter crista ventralis corporis that does not extend as far ventrad. Zygapophysis posterioris, facies articularis longer than wide, with a fairly straight, as opposed to sub-rounded, medial edge. Zygapophysis posterioris with torus dorsalis less bulky and turning slightly proximad, in lateral view, as opposed to being vertical or tilting slightly posteriad; and with small,

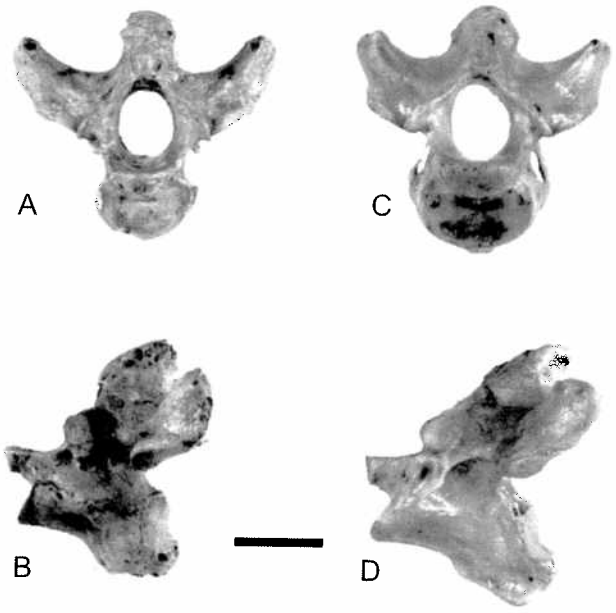

FIGURE 7. Axis (2nd cervical vertebra) of *Teratornis woodburnensis* n. sp. (A, B) in comparison with an axis of *T. merriami* from Rancho La Brea (RLB/Hancock K7392) (C, D). A and C, anterior view; B and D, left lateral view. Scale bar = 1 cm.

sloping shelf running transversely across bone dorsal to distal ends of facies articularis posterioris. Processus spinosus narrower proximally and widening by more than double distally, over a shorter distance. Entire bone compressed anteroposteriorly. Comparative material included 2 axes of *Teratornis merriami*.

Measurements (mm; *T. merriami* in parentheses) Overall length, dens through zygapophysis posterioris, facies articularis, 23.0 (26.6, 24.9); width through zygapophyses posterioris, facies articularis, 27.3 (30.4, 27.9); width, facies articularis atlantica, 10.9 (12.3, 12.0); height through dens, 8.9 (10.4, 10.3).

3rd Cervical Broken, complete only on left side. Overall, more lightly built. Zygapophysis anterioris with foramen ventral to it more bean shaped, in anterior view, concave ventromedially where edge of facies articularis anterioris intrudes, with long axis having lower lateral slope. Zygapophysis posterioris with more clearly defined ridge for crista transverso-obliqua and torus dorsalis considerably less bulky, but similarly protrudent. Zygapophyses without boney projections bridging the gap between them; lateral areas between zygapophysis anterioris and posterioris more open, less closed off by bone, particularly less so from zygapophysis anterioris. Neural canal not as tall, with thinner anterior edge of lamina dorsalis arcus. Trailing edge of lamina dorsalis arcus concave anteriorly in dorsal view, as opposed to being fairly straight from one side to the other. Comparative material included three 3rd cervicals of *Teratornis merriami*.

9th, 10th, 11th, and 13th Cervical (Complete) These four cervicals all differ from their counterparts in *Teratornis merriami* in similar ways. The foramen transversarium has a more elongated, kidney bean shape with concave edge facing ventromediad, in anterior view, with ventral end rotated laterad. The appearance of a concavity is produced by the dorsolateral edge of the facies articularis anterioris. The ansa costotransversaria is bowed laterad to accommodate this rotation, as opposed to being straight or convex laterad. The zygapophysis posterioris, facies articularis is longer, with posterior end rotated lateroventrally, i.e., it faces less directly laterad. The orientation of these articular facets is, of course, reflected in the more horizontal position of the facies articularis of the zygapophysis anterioris. The facies articularis posterioris of the 9th and 10th cervicals are more dorsoventrally constricted at the midline, but taller at each lateral end, giving more of a butterfly appearance. Comparative material included nine 9th, thirteen 13th, seven 11th, and eleven 13th cervicals of *Teratornis merriami*.

3rd Thoracic (Complete) No comparisons with *Teratornis merriami* are possible because only five badly broken specimens from Rancho La Brea can be identified as 3rd thoracic vertebrae.

Discussion There is a fair amount of variability in the osteological characters of *Teratornis merriami*, as might be expected in a bird of such large size. If only a single bone of *T. woodburnensis* had been recovered we could have noted its differences with *T. merriami*, but there probably would not have been sufficient justification to describe a new species. However, with the several elements available, and with the consistent osteological character differences noted between them and their counterparts from *T. merriami*, we find that the Woodburn teratorn represents a new species. This

is in spite of the fact that most of the measurements of *T. woodburnensis* fall very near the mean of comparable measurements of *T. merriami*. The argument for a new species is especially strengthened by the consistent differences observed in the vertebrae, which one might expect to be less variable than elements of the cranial and postcranial skeleton.

There is little that can be noted, based on the available material, that might suggest that the lifestyle of *Teratornis woodburnensis* was any different from that of *T. merriami* (Campbell and Tonni, 1982). That is, *T. woodburnensis* was probably an active predator that secured its prey while on the ground. The only hint that there may be some differences is found in the axis and 3rd cervical vertebra, which are proportionately smaller than those seen in *T. merriami*. This suggests that there may have been some differences in the size of the cranium. Although there is only a very limited sample available for comparable vertebrae of *T. merriami*, the noted differences are more of proportions than strictly of size, which is more indicative of interspecific variation than intraspecific variation. The lighter build of *T. woodburnensis* is also noted in the quadrates.

As a group, all teratorns thus far known are large to very large flying birds. The family includes the world's largest known flying bird, *Argentavis magnificens* Campbell and Tonni, 1980, which had a wingspan of 7-8 m. And there was at least one, and probably more, species of teratorn with a wingspan near 5 m known from southern California and Nevada (Campbell *et al.*, 1999). *Cathartornis gracilis*, known only from Rancho La Brea, is only slightly smaller than *Teratornis merriami*, whose wingspan was about 4 m. The presence of teratorns in a fauna indicates an open, sparsely vegetated habitat because such would be necessary to accommodate birds with such large wingspans. *Teratornis merriami* is also characterized by having a large, heavy body on very short legs, which suggests that getting airborne was dependent upon direct flapping take off, without much of a running start. In the event a running start might have been employed, even more open space would have been required to become airborne.

Associated fauna Analysis of the associated flora and fauna from the sites is still in the preliminary stages, so a detailed list of species is not yet available. Further, because of the limited extent of the excavations it is undoubtedly true that only a small portion of the paleofauna present in the Willamette Silts has been sampled. Nonetheless, taxa identified to date from the upper Willamette Silts (Stratum 4) include mammoths, mastodons, ground sloth, bear, dire wolf, bison, deer, elk, and horse. From the overlying peat deposits of the Woodburn Bog have come large samples of leaves, seeds, cones, and wood. Insects are also very abundant in these peat deposits, as are excellently preserved rodent, rabbit, shrew and small bird bones. Archaeological remains were recovered exclusively from the older Woodburn Bog and Willamette Silt horizons, as opposed to the younger strata. This includes the Legion Park site, where archaeological remains were recovered below Stratum 4 from whence came *Teratornis woodburnensis*. Artifacts include lithic and bone debris, flakes, cut bone, and cut and polished bone. There is no evidence to suggest that the teratorn remains are directly associated with activities attributable to the human occupation(s) at the site. The only other known instance where teratorn bones have been found in proximity to archaeological remains is in Pit 10 at Rancho La Brea (Howard and Miller, 1939). However, because of the natural mixing of the asphalt deposits at Rancho La Brea it is not possible to say for certain whether or not teratorns were actually contemporaries with early human occupations at that site.

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Literature Cited

Allen, J.E., 1986. *Cataclysms on the Columbia*. 213 pages. Portland: Timber Press

Balster, C.A. and R.B. Parsons, 1968. *Geomorphology and Soils, Willamette Valley, Oregon*. Agricultural Experiment Station, Oregon State Univ., Special Report 265: 1-31

Campbell, K.E. and E.P. Tonni, 1980, A new genus of teratorn from the Huayquerian of Argentina (Aves: Teratornithidae). *Natural History Museum of Los Angeles County, Contributions in Science,* 330: 59-68

Campbell, K.E. and E. P. Tonni, 1982. Preliminary observations on the paleobiology and evolution of teratorns (Aves: Teratornithidae). *J. Vert. Paleont.*, 1(3-4): 265-272

Campbell, K.E., E. Scott and K.B. Springer, 1999. A new genus for the Incredible Teratorn (Aves: Teratornithidae). *Smithsonian Contrib. Paleobiol.*, 89: 169-175

Howard, H. and A. Miller, 1939. The avifauna associated with human remains at Rancho La Brea, California. Carnegie Inst. Wash. Publ., 514: 39-48

Miller, L., 1909. *Teratornis*, a new avian genus from Rancho La Brea. *Univ. California Publ., Bull. Dept. Geol.*, 5(21): 305-317

Miller, L., 1910. The condor-like vultures of Rancho La Brea. *Univ. California Publ., Bull. Dept. Geol.*, 6(1): 1-19

Orr, E. and W. N. Orr, 1999. *Oregon Fossils*. 340 pages. Dubuque: Kendall/Hunt Publishing Co.