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Odocoileus salinae and
Mazama sp. from the
Talara tar seeps, Peru

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S. CHURCHER *Odocoileus salinae* and *Mazama* sp.
from the
Talara tar seeps, Peru

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ABSTRACT. Two cervids have been recognized from the tar seeps of Talara, Peru. One has been identified as *Odocoileus salinae* (Frick, 1937) on the basis of dental and skeletal characteristics. The remains of this species are relatively abundant and form the majority of the specimens recovered. An isolated small detached tine, and a single atlas smaller than any recorded for *Odocoileus* are assigned to the genus *Mazama*.

Odocoileus salinae (Frick 1937)

INTRODUCTION

A representative of the genus *Odocoileus* has inhabited the South American western equatorial littoral region since Upper Pleistocene times. The first remains of this form were described by Frick (1937) as *Palaeoodocoileus salinae* n. sp., the locality being given as "the coastal oilfields about Salinas", Ecuador. This faunal horizon is called the Carolinian, after La Carolina, Ecuador. The type specimen described was an incomplete mandibular ramus (Frick Collection. American Museum of Natural History no. 28284) which is illustrated (Frick, 1937, Fig. 21, p. 207) to show the dentition, but no measurements are given. Six other elements are reported from the same site, four of them (a left antler, a fragmental left frontal and antler base, a left maxilla with M^2-M^3 , and a right mandible with P_4-M_3) are referred to *P. salinae*, while two (a left radius and a juvenile right metatarsus) are said to be "of *P. gracilis* size" (syn. *Odocoileus peruvianus*). However, Frick says "This (species) which may be equivalent to the Spillmann *P. antonii*, does not much exceed in dimensions the Recent *Pudu*. Several of the Equadorian dentitions are characterized in unworn to moderately worn specimens by the detached antero-inner and posterior lophs of the p_4 (P_4) (see fig. 21), the latter condition being partially reminiscent of that in *Rangifer*. The anterior p_4 (P_4) fossette is closed only in certain worn teeth." Frick indicates the fourth lower permanent premolar by " p_4 " using a lower case "p", rather than " P_4 ", using an upper case "P", as will be done in this paper.

Hoffstetter (1952) comments upon Frick's remarks "Mais la contradiction entre cette observation et les faits est évidente: elle apparaît d'abord dans les dimensions de la série dentaire figurée, qui dépasse de beaucoup celle du *Pudu* andin; d'autre part Ch. Frick lui-même signale (p. 213) qu'un radius et un métatarsien immature, trouvés dans la même gisement, ont la même taille que ceux de "*P. gracilis*" (c'est-à-dire *Odocoileus peruvianus* cf. *ustus*).". He considers the original description inadequate in defining a new species, but as only a single cervid species is found in the deposits of La Carolina and as this species conforms in the other characters described by Frick, he is able to place his material from the same horizon (Carolinian of Ecuador) within Frick's Upper Pleistocene species *Palaeoodocoileus salinae*. The genus *Palaeoodocoileus* Spillmann (1931) is placed in synonymy with *Odocoileus* Rafinesque 1872 by Simpson (1945) and, therefore, *P. salinae* will be referred to as *Odocoileus salinae* (Frick 1937).

Remains of Cervidae were obtained from the Talara tar-seeps by an

expedition from the Division of Zoology and Palaeontology, Royal Ontario Museum, Toronto, during January and February, 1958. This material was tentatively identified as a small representative of the genus *Odocoileus* (Churcher, 1959; Lemon and Churcher, 1961). Sufficient material has now been prepared for a more accurate diagnosis and for comparisons with *O. salinae*, as described by Frick and Hoffstetter, to be made. Remains of *Mazama* have also been identified, but most of the material can be ascribed to a single form *Odocoileus*.

DESCRIPTION OF THE MATERIAL

Skeletal elements from all parts of the body have been found, including well-preserved mandibular, vertebral, podial, metapodial and phalangeal specimens. Cranial and proximal appendicular specimens are either absent or very badly damaged and fragmentary. Much of the material derives from young and immature animals, the epiphyses of vertebral centra and appendicular shafts being frequently missing or separate, and 14 of the 29 premolar specimens show milk teeth.

No complete skull or mandible has been found; incomplete specimens of antlers and frontal bones, premaxillae, maxillae, jugals and mandibles only being recovered. Specimens of the antlers and frontal bones show the region from the orbit to the frontal-parietal suture, but are broken medially before the sagittal suture. Portions of the interior of the orbit and cranium are also visible. The antlers possessed three tines, the first tine pointing posteriorly and dorsally from the shaft, the second posteriorly and horizontally, and the terminal dorsally and slightly posteriorly, the shaft curving backwards from the frontal boss and changing direction upwards and outwards. The presence of three tines is usual in Neotropical *Odocoileus* (Cabrera and Yepes, 1940); a restoration of the antler is shown in Fig. 1.

The milk and permanent dentitions are well preserved. Table I gives the numbers available and the lengths of the crowns of the teeth. Cranial fragments other than of the maxillae and antler-bosses are too small for measurement and no conclusions can be reached from their study, other than that they are from a small cervid. Mandibular specimens show the whole of the lower jaw and its dentitions (Fig. 5), with the exception of the anterior symphyseal region bearing the incisors and canines, although two lower right third incisors have been recovered.

Vertebrae recovered included atlas, axis, posterior cervical, thoracic, lumbar and sacral specimens in varying conditions of preservation. Rib and sternal fragments have also been found, but no certain caudal vertebrae.

Elements of the forelimb recovered include damaged scapulae, shafts and distal articulations of humeri, proximal fragments of ulnae, entire and fragmental radii, trapezoid-magna, scaphoids, lunars, pyramidals, unciforms, metacarpi and phalanges I, II, and III of digits III and IV. No qualitative distinctions could be made between the phalanges of the manus and pes, nor did quantitative analysis indicate size differentiation. No remains of the vestigial digits II and V have been found.

Elements of the hindlimb recovered include parts of the pelvis, epiphysal regions of the femora, and tibiae, shafts of the tibiae, one fibula, calcanea,

TABLE I. Measurements of crown lengths of *Odocoileus salinae* and *Odocoileus* sp. X (after Hoffstetter, 1952) compared with those from the fossil cervids ascribed to *Odocoileus salinae* from Talara. 'e' after a figure indicates an estimated or unreliable measurement. All measurements are in millimetres.

TALARA SPECIMENS													
Lower Dentition	2004	2512	2726	2728	2734	2813	2796	2812	2848	Single or loose teeth	Min. M.v. X̄ N		
											Odocoileus salinae (Hoffstetter)		
Milk Teeth													
		6.8				6.1	7.0	6.4		6.6	6	7.0 ₂	1
	p ₂	10.1	10.3		10.6	9.6	10.0	9.5		6.6	6	10.2	1
	p ₃	15.1	15.5e		15.7e		16.6	14.9	13.1	9.7	11	15.3	2
p ₂ -p ₄		32.2					32.8	29.0		17.3	3	31.7	2
										16.1	3	31.1	2
2004 2071 2418 2513 2514 2726 2728 2734 2777 2796 2842 2848													
Permanent Teeth													
	P ₂		7.8			8.4				8.6	3		1
	P ₃		9.8	10.5		10.1				10.1	6	10.0	4
	P ₄		11.5	10.8	10.7	11.4				12.5	5	11.5	—
	P ₂ -P ₄		30.0			28.9				28.9	2	31.5	—
	M ₁	12.9	12.0e	12.2	11.9	11.8	13.0	12.8	13.1	12.9	15	12.0	—
	M ₂	15.2	14.1	14.1	14.2	13.5	14.9	15.0	15.1	13.7	15	13.9	—
	M ₃		19.1	18.6	19.1					13.1	7	19.0	—
	M ₁ -M ₃		45.5	45.0	43.9	45.5				43.9	4	41.0	—
	P ₃ -M ₃		74.0							74.0	1	—	—
												8.7	17.0
Upper Dentition													
Milk Teeth													
	p ₂	11.5	11.7	12.0						10.7	1	10.2	2
p ₂ -p ₄		12.0	12.2	13.0						11.8	4	—	1
										12.5	6	12.0	—
2069 3421 3421 3421													
Permanent Teeth													
	P ₂												
	P ₃												
	P ₄												
	P ₂ -P ₄												
	M ₁	12.1	13.1	13.0						13.0	5	12.1	—
	M ₂		14.5	14.2						13.5	6	13.8	—
	M ₃		13.5							13.5	2	13.8	—
	M ₁ -M ₃		39.3							39.3	1	39.5	—
	P ₂ -M ₃										0	—	—
												11.0	12.5
2069 2511 2584													
Permanent Teeth													
	P ₂												
	P ₃												
	P ₄												
	P ₂ -P ₄												
	M ₁	10.4	9.8										
	M ₂												
	M ₃												
	M ₁ -M ₃												
	P ₂ -M ₃												

astragali, navicular-cuboids, one cuneiform, one malleolus, metatarsi and phalanges I, II, and III of digits III and IV. No remains of vestigial digits II and V have been recovered.

COMPARISON OF THE TALARA CERVID MATERIAL WITH
Odocoileus salinae RECOVERED FROM LA CAROLINA,
ECUADOR, BY FRICK AND HOFFSTETTER, AND WITH THE
LIVING LOCAL FORM

The status of the living local species of *Odocoileus* is in some doubt. Hoffstetter, in comparing the local extant form of *Odocoileus* ranging throughout the littoral region from the island of Puña to the Santa Elena Peninsula, mentions that this form has been neither described nor named, although he considers that it shows affinities to the *Odocoileus gymnotis* (included in *O. virginianus cariacou*; Herskovitz, 1958) from Venezuela, Northern Brazil, Colombia and the Guianas. Hoffstetter refers to the living littoral form as "*Odocoileus* sp. X", Spillmann (1948) refers to it as *O. punensis* n. sp., but gives an inadequate description. Hoffstetter further considers that *O. sp. X* and *O. salinae* might not be specifically different and separate from *O. gymnotis*, but might be a subspecies of the latter. Herskovitz (1958) considers all the South American forms of *Odocoileus* conspecific with *O. virginianus*, and says (*pers. comm.*) "The teeth and mandibles of your (fossil) South American deer can be matched closely with those of our specimens of South American *Odocoileus virginianus*. On the basis of this evidence alone, I would regard the fossil (from Talara) as conspecific with Recent whitetails." It may be, therefore, that *O. salinae* is but a subspecies of *O. virginianus*, but in this paper the name *O. salinae* will be retained for the fossil form, while the living local species will be referred to as *O. sp. X* in conformity with Hoffstetter's usage.

CRANIAL MATERIAL

The cranial material includes fragments of antlers, incomplete dental series and isolated teeth, both milk and permanent, fragments of the skull, e.g. premaxillae, supraorbital ridges, parts of the braincase, occipital condyles and other less identifiable fragments. Only the antler and dental specimens are complete enough for comparisons to be made.

Six antler fragments have been recovered from the Talara tar-seeps, Royal Ontario Museum Palaeontological Specimens number 2080, 2104, and 2711 showing the portion from the orbital margin and braincase to the shaft distal to the junction with the first tine, 2710 from the region of the bony boss, past the first tine to where the rack broadens out to give rise to the second tine, 2714 showing the shaft between the two tines, the junction with tine two and the continuation towards the tip of the rack, and 2808 showing the tip of the antler or terminal tine almost complete. Thus all except the tip of the second tine is known from at least one specimen. (Throughout this paper the specimen numbers of the material in the Royal Ontario Museum will be given without prefixes and all are four-figure numbers.)

Hoffstetter (Fig. 109a) illustrates a fossil antler (V. 1431) of *O. salinae*,

which is similar to specimens 2104, 2710, and 2711, from Talara. When the distance from the rugose base of the antler to the fork of the first tine is compared for the four specimens, those from Talara measure 50.5, 46.3, and 50.3 mm. respectively, while V. 1431 measures 73.5 mm. (Hoffstetter, *pers. comm.*). It seems therefore that the antlers of the Talara *Odocoileus* population were less developed than those from La Carolina, being approximately $\frac{1}{3}$ smaller. Additional measurements on the Talara specimens are, from the base of the antler to the fork of the second tine, 129.4 (2710), and the total length of the antler along the outside of the curve, estimated 165.0 mm. (2710). The length of the first tines measured from the fork to the tip is 19.1 (2104), 20.0 (2710), and 21.4 mm. (2711). (Throughout this paper all measurements will be given in millimetres and estimated figures followed by 'e'.)

The antler bases all show a well-developed ring of rugosities, but these are much less strongly developed in the littoral form. Both fossil series show a marked ring (Fig. 1, and Hoffstetter, Fig. 109a and b, p. 358) while the living *Odocoileus* sp. X shows a rugose thickening of the basal section of the shaft. The angle between the first tine and the shaft in all three Talaran specimens appears to be greater than in *O. salinae* of Hoffstetter or either of the living species. The angle of the frontal bosses and the bases of the antlers to the skull shows a strong posterior inclination, and the antlers arise from elongated bony peduncles of the frontals, which agrees with the characters ascribed to *O. salinae* by Hoffstetter.

The dentitions of the Talara specimens agree in general with those of *O. salinae* as described by Frick and elaborated by Hoffstetter. Specimens 2418 and 2728 containing a moderately worn full P_2-M_3 and M_1-M_3 dentition respectively and 2513 with a slightly less worn P_3-M_3 row, agree in size and most details of external styles, cingula, etc., with the lateral occlusal view illustrated by Frick (Fig. 21, p. 207). The characters of P_4 quoted from Frick (*vide supra*) and also illustrated (Frick, Fig. 21, p. 207) hold in general for the Talara specimens, although some variation in the continuity of the protoconid-metaconid lophid is apparent. The paraconid (antero-internal cusp) is free from the protoconid in three of the four specimens recovered, although in some cases a medial projection of the protoconid meets the paraconid at the base of the cusp within the fossette and posterior to the maximum height of the paraconid cusp (Fig. 5). As wear proceeds this medial projection joins the paraconid to the protoconid by a posterior transverse ridge. The hypoconid (posterior loph) is always free in unworn P_4 's, but with wear becomes attached to the posterior extremity of the protoconid, forming a continuous W-shaped ectolophid. The metaconid-protoconid lophid is continuous in all four P_4 specimens, and the anterior P_4 fossette is closed anteriorly, but opens posteriorly to the lingual side between the paraconid and metaconid in three of the four specimens.

Some variation in the position and development of the lateral styles is noted, particularly of the buccal style lying between the protoconid and hypoconid of P_4 . This style may or may not be present, or may show varying degrees of development.

The lower and upper milk dentitions and permanent lower and upper

molar dentitions exhibit no qualitative peculiarities that can be observed (Figs. 3, 4, 5, and 6).

Table I gives measurements of the length of the crowns of the upper and lower milk and permanent dentitions. Comparison of these measurements with those for *O. salinae* (after Hoffstetter) and with the local living *Odocoileus* sp. X (after Hoffstetter), shows marked similarity between the ranges of variation and the means given for all three populations. Agreement between the measurements of *O. salinae* and the Talara specimens is seen in 16 of the dimensions given in Table I; in M^2 and M_3 there is approximate agreement, but since the posterior molars are subject to a wide degree of variation, this is not considered significant, and the variation in the crown length of M^1 – M^3 is probably partly due to the variation in the length of M^3 .

The conclusion may therefore be drawn from the dental evidence that the Talaran cervid is identical with *Odocoileus salinae* (Frick 1937), such differences as can be observed lying within the possible range of variation for a single species.

The postcranial material from Talara is more abundant than that reported by either Frick or Hoffstetter.

VERTEBRAL COLUMN

The vertebrae are similar to those of the species of *Odocoileus*, but are smaller than those of any of the species with which they have been compared.

Cervical

Thirteen specimens of cervical vertebrae have been recovered, including four partial atlases, two broken axes, two Cervical III's, two Cervical IV's, one Cervical V, two Cervical VI's, and one Cervical VII. Plate I, Figs. 2 and 7, illustrate the most entire atlas, 2565, and the most complete axis, 2585. Measurements of the atlases 2565, 2564, and 2724 are: length along the dorsal midline 26.0, 24.5e, and 23.0; length along the ventral midline 26.1, 24.9, and 24.6; width across the posterior wings 65.2, 57.6e, and —; width across the condylar articulations 45.4, 43.6, and 44.1; dorsoventral depth 32.4, 29.8, and 30.0 respectively. Measurements of the axes 2585 and 2082 are: length along the dorsal midline 47.2, —; width of the odontoid spout 19.1, 21.6; and width of the odontoid collar 42.1 and 43.8 respectively. Measurements of Cervical III 2602 are: length along the dorsal midline 29.3; length from pre- to post-zygapophyses 50.7; width across the prezygapophyses 29.2; width across the postzygapophyses 29.2; and dorsoventral maximum depth 34.2. Similar measurements of Cervical IV 2603 are: 30.2, 50.1, 33.4, 32.1, and 34.5; for Cervical V 2604 are: 28.1e, 53.8, 40.2e, 38.2, and 40.8; no measurements could be obtained from Cervicals VI and VII.

Thoracic

Ninety-seven specimens of entire or partial adult or juvenile thoracic vertebrae are present. These specimens represent all the thoracic vertebral elements when compared with a column from living *Odocoileus*, but are smaller than any of the elements with which they have been compared. A small Thoracic VII or VIII 2607 is illustrated in Plate I (Fig. 8), the measure-

ments for which are: length along the dorsal midline 28.6, proximal length of the neural spine 62.0e, width across the prezygapophyses 40.8, and width across postzygapophyses 10.8.

Lumbar

Eleven specimens of entire or partial adult or juvenile lumbar vertebrae are present. These are mainly from young individuals, as are all the vertebral elements, since most of the vertebrae lack their central discs. Measurements for Lumbar V? 2083 (Fig. 24) and Lumbar VI? 2084 are: length along the dorsal midline 25.8, —; length from pre- to post-zygapophysis 47.0, —; width across prezygapophyses 36.4, —; width across postzygapophyses 31.5, 40.5; and length of centrum 37.0e, 33.7 respectively.

Sacrum

A single example of an adult sacrum has been recovered, 2085 which is illustrated in Plate III (Fig. 25). Measurements for this specimen are: length along the dorsal midline 55.0e, width across the prezygapophyses 53.5, length from prezygapophysis to distal lateral margin on the right side 75.6, and depth from dorsum of prezygapophysis to ventrum of centrum 36.6.

Caudal

Only two fragmentary and juvenile vertebrae that may be caudals have been recovered.

Ribs

Fragments of many ribs have been recovered, but none of them was entire or adult so far as can be judged.

Other fragments of vertebrae or ribs have also been recovered but were too damaged or fragmentary to be identified in any respect.

FORELIMB

Scapula

The scapulae are mainly represented by the glenoid, coracoid and spinal regions and again are similar to those of living *Odocoileus* except for a reduced size. Measurements of eight scapular specimens, 2153, 2383, 2384, 2721, 2744, 2745, 2746, and 3438 are: dorso-ventral diameter of the glenoid fossa 16.8, 20.3, 21.3, 21.9, 16.6, 22.9, 20.5, and 20.4; coracoid process-glenoid fossa diameter —, 31.5e, —, 31.4, —, 34.2, 33.2, and 31.5; maximum width of the neck of the scapula at the level of the spine 14.1, 15.5, —, 17.8, 13.6, 20.4, 18.8, and 18.7 respectively. No further measurements were possible as the blades of the scapulae are incomplete; specimens 2153 and 2744 are probably from immature animals as the absence of coracoid processes may indicate an unfused condition at the time of death.

Humerus

Entire humeri have not been recovered. The remains of humeri are mainly of the distal articulation with varying lengths of attached shaft (Fig. 9).

Specimens 2767, 2768, 2770, 3434, and 3435 measure 29.6, 31.8, 35.4, 31.4, and 32.5 across the articulation and 2767, 2768, and 3434, 12.8, 14.4, and 15.5 by 15.5, 16.8, and 18.6 for the minimum width and depth of the shaft respectively.

Radius

One entire adult radius, 2762, four almost adult radii lacking only the distal epiphyses, 2764, 2896, 3422, and 3438, two entire juvenile radii lacking both epiphyses, 2765 and 3424, ten fragmentary specimens of both adult and juvenile radii, six distal and one proximal detached radial epiphysis have been recovered. Measurements of the proximal ends of the fragmentary or nearly adult specimens, 2896, 3422, 3438, and 2510, 2713, 2763, 3427 are: maximum width 31.6, 29.6, 29.6, 28.2, 27.2, 26.5, 27.7 and maximum depth 18.0, 17.4, 17.4, 16.9, 16.4, 16.9, 16.7 respectively. The entire specimen 2762 (Fig. 15) measures 28.5, 18.3, for the proximal width and depth respectively, 17.1 and 10.9 for the width and depth of the middle of the shaft, 26.2 and 17.6 for the width and depth of the distal end respectively and the total length of the shaft is 158.1. The largest detached distal epiphysis, 2725, measures 28.7 by 22.6 for its width and depth respectively. The only detached proximal epiphysis, 3432, measures 41.9 by 41.3 for the same respective dimensions.

Ulna

Only proximal ends of ulnae have been recovered. Adult specimens 2729 (Fig. 23) and 3428 measure 32.2 and 33.2 in maximum depth, 37.6 and 40.0 in dorsal length, and 46.4 and 46.5 in the length from the middle of the articulation to the extremity of the olecranon process; the depth of the shaft of the ulnae anterior to the radial facets is 15.5 and 15.4, and, at the centre of the articulation, 21.3 and 20.7, respectively.

Carpalia

Five trapezoid-magna, four scaphoids, two lunars, three pyramidals, five unciforms and three sesamoid carpals have been recovered. A left scaphoid, 2775 (Fig. 14), and a right lunar, 2774 (Fig. 20), are illustrated in Plate II. The scaphoids, 2775, 3445A and B, measure 14.4, 13.6, and 15.6 in dorso-plantar depth, compared with 11.6, 12.3, and 13.7 reported by Hoffstetter (1952) for *O. salinae*. Measurements for the other elements are given in Table II.

Metacarpus

The metacarpal is represented by three entire and one fragmentary adult specimen and by six entire juvenile specimens all of which, except one, lack the distal epiphyses, and by five fragmentary juvenile specimens. Comparison of the adult metacarpals, 2560 (Fig. 13), 2414, and 2845, with that shown by Hoffstetter (Fig. 106d, V. 683, p. 353) shows them to be similarly built, and to most nearly resemble *O. salinae* rather than *O. peruvianus*, either fossil or living. Measurements of the metacarpals are given in Table II

TABLE 11. Measurements of various dimensions of the Carpalia and Metacarpal of the Talara cervid together with some measurements for *Odocoileus salinae* (after Hoffstetter, 1952). All measurements are given in millimetres.

TALARA SPECIMENS										<i>O. salinae</i> (Hoffstetter)		
Dimension		Min.	Max.	N	Min.	Max.	N	Min.	Max.	N		
CARPALIA Trapezoid-magnum	Anteroposterior length	3440A	3440B	3440C	3440D	3447						
	Lateral width	14.1	14.1	13.9	14.3	14.6	14.2	5				
	Dorso-plantar depth	11.8	11.8	11.9	12.0	13.0	12.1	5				
		9.1	10.2	8.7	8.8	10.1	9.4	5				
Scaphoid	Anteroposterior length	2775	3445A	3445B	3445C							
	Lateral width	16.0	16.2	18.1	15.0		16.3	4				
	Dorso-plantar depth	9.2	8.5	11.0	8.6		9.3	4				
		14.4	13.6	15.6	13.2		14.2	4	11.6	13.7	12.5	3
Lunar	Anteroposterior length	2774	3443									
	Lateral width	14.1	14.9				14.5	2				1
	Dorso-plantar depth	10.4	11.1				10.8	2				
		12.0	11.3				11.7	2				
Pyramidal	Anteroposterior length	3442A	3442B	3444								
	Lateral width	14.7	13.3	13.7			13.9	3				
	Dorso-plantar depth	8.4	7.9	7.3			7.9	3				
		14.0	14.0	14.3			14.1	3				
Unciform	Anteroposterior length	3441A	3441B	3441C	3441D	3446						
	Lateral width	14.6	13.6	12.3	11.4	12.3	12.8	5				
	Dorso-plantar depth	12.0	11.2	10.3	10.0	11.1	11.1	5				
		10.1	10.0	9.8	8.5	9.5	9.6	5				
METACARPI	Total length	2414	2518	2560	2845							
	Proximal width	147.5	—	153.5	153.8		151.6	3	—	171.0	—	1
	Median width	21.2	22.2	22.6	22.7		22.2	4	—	24.5	—	1
	Distal width	12.5	14.1	15.1	15.3		14.8	4	—	15.0	—	1
	Distal condylar width	23.2	—	25.2	25.0		24.5	3	—	—	—	—
		21.8	—	24.9	24.9		23.9	3	24.0	26.3	25.1	3

also, but no comparison is really possible with *O. salinae* as few measurements are recorded.

PHALANGES OF THE MANUS AND PÆS

Hoffstetter (1952) gives some dimensions and measurements for the phalanges of both feet of *O. salinae*, but does not indicate whether the phalanges of the manus differ qualitatively from those of the pes. Since he cites measurements for only seven specimens, two phalanx I's, four phalanx II's and one phalanx III, his problem of deciding from which foot they were derived was relatively easy. As the phalanges of the manus are generally considered to be smaller than those of the pes, the seven recovered were in all probability divided into large and small groups.

The Talara tar-seeps have yielded 28 adult phalanx I's (Fig. 18), 28 adult phalanx II's (Fig. 17), and 18 adult phalanx III's (Fig. 16) from adult animals. They have all been examined for possible qualitative differences that would enable a separation into manus or pes, but without success. They have all been measured for their maximum length, maximum proximal width and maximum proximal depth, and these figures plotted for a bimodal distribution. In all nine distributions there is no absolute indication of a bimodal curve, the curves approximating normal distributions in all cases. All the specimens may be considered to be fully adult as the proximal epiphyses are well fused to the shafts in all cases. In addition to the adult phalanges discussed here, 19 juvenile shafts and nine detached epiphyses of phalanx I's, 15 juvenile shafts and one detached epiphysis of phalanx II's and one juvenile phalanx III have been recovered.

Table III gives the comparable figures for the Talara specimens and those for *O. salinae* and *O. peruvianus* (= *O. virginianus*) *ustus* (after Hoffstetter, 1952). The figures given by Hoffstetter for *O. salinae* lie closer to those for the Talara specimens than do those for *O. peruvianus*, and, in fact, in all but one case fall within the range of variation of the Talara specimens. There is thus no method of distinguishing between the Talara phalanges and those of *O. salinae* recorded by Hoffstetter, and it is not possible to support Hoffstetter's identification of manus and pes elements, as his figures lie close to one another or to the upper limit of the range, and therefore should be considered to be possibly from the same foot and possibly from the pes, though such conclusions are speculative.

HIND LIMB

Pelvis

Portions of 13 halves of pelves have been recovered but only specimens 2151 (Fig. 21), 2730, and 2731 are sufficiently complete for measurement. The maximum width of the iliac process is 24.0, 22.4, and 23.5, the maximum width of the ischial process is 24.6 (2151 only), the iliac-ischial diameter of the acetabulum is 28.6, 30.0, and 29.0, and the maximum width of the pubic process is 13.8, —, and 13.4 respectively.

TABLE III. Comparative measurements of the phalanges of the manus and pes of *Odocoileus salinae* and *O. peruvianus* (= *O. virginianus*) (after Hoffstetter, 1952) with those of the Talara cervid similar to *O. salinae*. The phalanges for the Talara cervid (opposite the 'Forelimb' figures). Some uncertainty consequently the figures for all the Talaran cervid phalanges are given as a single group (opposite the 'Forelimb' figures). Some uncertainty exists for some of Hoffstetter's figures, these are indicated by '?' following the figure. In the case of the only phalanx III reported by Hoffstetter, it is given twice under both 'Forelimb' and 'Hindlimb' as he does not assign it to either limb. All measurements are given in millimetres.

	<i>Odocoileus salinae</i> (Hoffstetter)				<i>Odocoileus peruvianus</i> (Hoffstetter)				Talara Specimens			
	Min.	Max.	$\bar{X}$	N	Min.	Max.	$\bar{X}$	N	Min.	Max.	$\bar{X}$	N
FORELIMB												
Phalanx I	—	—	39.5	1	39.4	42.7	40.2	6	33.3	40.7	35.8	28
	—	—	12.3	1	13.8	15.2	14.5	6	10.8	13.4	12.2	28
	—	—	15.3	1	17.1	19.0	17.9	6	14.2	18.5	15.8	28
	—	—	—	3	28.0	31.5	29.4	10	21.0	28.2	24.8	28
Phalanx II	26.3	27.0	—	3	11.7	13.5	12.5	10	9.8	12.7	11.5	28
	10.2	11.7	—	3	16.5	19.0	17.7	10	13.6	18.9	16.0	28
	16.5	19.0	—	3	33.0	35.3	34.3	5	21.8	28.5	25.8	18
Phalanx III	—	—	31.0	1?	—	—	—	—	7.0	11.8	9.7	18
	—	—	—	—	—	—	—	—	12.8	18.3	17.0	18
	—	—	—	—	—	—	—	—	—	—	—	—
HINDLIMB												
Phalanx I	—	—	42.0	1	41.8	48.0	44.2	9	—	—	—	—
	—	—	12.5	1	14.8	16.0	15.5	9	—	—	—	—
	—	—	16.7	1	18.5	20.0	19.6	9	—	—	—	—
	—	—	29.5	1	32.3	33.0	32.9	5	—	—	—	—
Phalanx II	—	—	12.4	1	14.2	15.8	14.9	5	—	—	—	—
	—	—	17.1	1	19.3	20.7	19.9	5	—	—	—	—
Phalanx III	—	—	31.0	1?	35.0?	36.5?	—	3	—	—	—	—

Femora

No entire femora have been recovered, although a number of ends and detached epiphyses are represented in the collection. The distal epiphyses of the femora are represented by five entire and two fragmentary specimens and four chips. The three largest, 2748B, D, and E, measure 41.8, 46.3, and 41.0 respectively across the condyles and 53.3, 55.0, and 53.1 respectively on the anteroposterior diameter. No other measurements of femoral fragments are available.

Tibiae

The tibiae are represented by five proximal and eleven distal epiphyses, one adult proximal fragment with part of the shaft attached, 2751, three fragmentary immature shafts lacking the distal epiphyses and much of the proximal regions, two adult distal fragments, three adult shaft fragments, one with the distal end, and two adult specimens lacking only the proximal articular regions, 2081 (Fig. 22) and 2753 and one immature shaft lacking both epiphyses. From specimens 2081, 2751, and 2753 the following dimensions were measured: Total length 230.0e, —, 237.0e, proximal width 45.0e, 51.6, —, proximal depth 45.0e, 45.7, —, maximum diameter in the middle of the shaft 16.5, —, 20.1, minimum diameter in the middle of the shaft 12.6, —, 15.6, maximum width of the distal articulations 28.5, 31.2, 31.2 and, minimum depth of the distal articulations 20.8, 22.6, 22.5 respectively.

Fibula

Three proximal fragments of fibulae have been recovered. The largest, 3439 (Fig. 34) measures 111.6 in total length, 15.5 anteroposterior diameter of the proximal end and 8.7 width of the proximal end.

TARSALIA

Twenty-seven whole or fragmentary specimens of adult and juvenile calcanea, 35 astragali, 18 navicular-cuboids to one of which the cuneiform is fused, three free cuneiforms, and one malleolus, have been recovered from the Talara tar-seeps, but few undoubted mature bones can be recognized.

Calcaneum

The calcanea are variable in development, 22 of them are undoubtedly immature, and only three, 3100J, 3099A and G of the entire specimens and four fragmentary specimens, 3099M, 3100C, K and M have the posterior tuber calcis region coossified with the body of the calcaneum. Comparison of the certainly adult calcanea, e.g. 2799 (Fig. 10), with that illustrated by Hoffstetter (Fig. 108 c, V. 690, p. 356) shows that the Talara specimens are similarly slim and similarly shaped to his *O. salinae* specimen. Measurements for this tarsal bone and for the other tarsalia are given in Table IV.

Astragalus

Only nine of the 35 astragali recovered can be considered to be adult and fully developed (Fig. 11). Measurements for these adult specimens only are given in Table IV.

TABLE IV. Measurements of the Tarsalia and Metatarsi of the Talaran cervid. The comparative figures for *Odocoileus salinae* are available only for the calcaneum and the astragalus (after Hoffstetter, 1952). All measurements are in millimetres.

TALARA SPECIMENS										<i>Odocoileus salinae</i> (Hoffstetter)			
TARSALIA										Min.	Max.	$\bar{X}$	N
Calcaneum	Total length	3100C	3100J	3100K	3100M	3099A	3099C	3099M		69.6	74.4	71.2	3
	Maximum depth	—	74.4	—	—	69.6	69.6	—		22.6	25.6	23.9	3
	Length of the tuber calcis	49.2	54.2	52.6	52.3	51.3	50.7	49.2		49.2	54.2	51.4	7
Astragalus	Proximal distal length	2804A	2804C	2804D	2804K	2804L	2804G	2828C		31.2	34.5	33.2	10
	Distal width	20.3	20.9	22.9	20.3	33.6	33.2	31.2		20.0	22.9	21.0	10
	Maximum width	2805	2812B	2812D	2812E	2812F	2816C	2816G		25.3	28.8	26.6	8
Navicular-cuboid	Dorso-plantar depth	17.9	18.8	18.7	17.2	17.8	16.1	17.7		16.1	18.8	17.7	8
	Anteroposterior length	23.6	22.6	21.4	21.2	20.8	21.1	22.5		20.8	23.6	21.9	8
Cuneiform (fused with cuboid)	Maximum width	2805	—	—	—	—	—	—		—	—	—	1
	Anteroposterior length	9.8	—	—	—	—	—	—		—	—	—	1
Malleolus	Anteroposterior length	14.4	—	—	—	—	—	—		—	—	—	1
	Dorsoplantar depth	2838	—	—	—	—	—	—		—	—	—	1
	Lateral width	14.1	—	—	—	—	—	—		—	—	—	1
METATARS-I	Total length	1980	2712	2715	3455	3457	3458	3462	3463	181.6	182.9	182.2	2
	Proximal width	181.6	—	—	182.9	—	—	—	—	21.0	23.2	21.6	4
	Proximal depth	21.4	21.1	—	21.0	—	21.3	—	—	21.7	22.8	22.3	4
	Median width	21.7	21.7	—	22.6	—	22.7	—	—	12.2	14.1	13.3	6
	Distal width	12.2	13.4	12.7	14.1	13.8	14.1	—	—	23.1	26.4	24.9	5
	Distal condylar width	24.4	—	23.1	—	25.5	—	25.2	26.4	23.2	25.8	25.3	6

Navicular-cuboid

Of the 18 navicular-cuboids recovered, ten are undoubtedly juvenile and eight seemingly adult. One of the probable adult specimens is fused with its neighbouring cuneiform (Fig. 19), which supports its identification as adult since such abnormalities are more common in old (or injured) animals. Measurements for the navicular-cuboids and for the single fused cuneiform are given in Table IV.

Cuneiform

The three free cuneiforms are small and probably immature. No measurements for these are given.

Metatarsus

The metatarsal is represented by two entire and six fragmentary adult specimens and by three entire almost adult specimens lacking the distal epiphyses, by three smaller entire juvenile shafts also lacking the distal epiphyses and by some 14 fragmentary specimens of various ages. The metatarsal elements are longer than the metacarpal elements as is expected. An adult metatarsus 1980, is illustrated in Plate II (Fig. 12) in comparison with an adult metacarpus, 2560 (Fig. 13). Measurements for the adult metatarsi are given in Table IV.

The measurements given in Tables II, III, and IV support the qualitative conclusions, for the appendicular skeleton as a whole, although the few measurements given by Hoffstetter suggest that the Talaran cervid may be slightly shorter in the leg than that from La Carolina. Hoffstetter mentions that his material is scarce and that some of his specimens are undoubtedly from a large adult. The discrepancy in the proportions of the limb-bones may be, therefore, a partial result of too small a sample, together with the accident of a large specimen on the one hand compared with two younger or smaller specimens on the other, perhaps respectively male and female.

Mazama sp.

A single entire atlas, 2703 (Fig. 35), and a detached right antler, 3151 (Fig. 36), have been recovered from the Talara tar-seeps. These remains do not fit the characters of *Odocoileus salinae* and consequently are described here separately and ascribed to *Mazama* sp., possibly *M. gouazoubia*.

The atlas is almost entire, lacking only the posterior portion of the left wing. It has been compared with the atlas from an individual of *Mazama gouazoubia*, (American Museum of Natural History Specimen no. 130459) and found to resemble it both morphologically and quantitatively. Comparative measurements for the various dimensions of the Talara atlas and that of *M. gouazoubia* are respectively: width across the wings—44.9 and 44.7; length of the wings—39.8 and 35.8; width of the condylar articulations—38.5 and 33.7; width of the axial articulations—33.1e and 30.6; dorsoventral depth—25.5 and 27.7. While these figures are not in absolute agreement, it is evident that the Talara specimen is of approximately the same size and proportions as is the Recent specimen.

The detached right antler is almost entire also, having been split off at the base just distal to the bony boss. The curvature and cross-sectional proportions are similar to that found in many specimens of *Mazama* from South America, while the rugosities on the surface indicate that the antler had been but recently renewed and probably the velvet had not yet been rubbed off. The specimen measures 56.6 in total length.

DISCUSSION AND CONCLUSION

The more abundant form from Talara numbers some 18 or 20 individuals as the minimum number of juvenile and adult animals from which the recovered elements could be derived. The uncertainty as to the actual minimum number exists because of the difficulty in matching partial juvenile specimens of nearly similar ages. The remains of the less abundant form could have been derived from a single individual.

The more abundant fossil form from Talara strongly resembles *Odocoileus salinae* in its dental characters and measurements. In its post-cranial measurements there is less agreement, perhaps because of too small samples and too many juvenile specimens recovered. The characters of the antlers agree qualitatively, but there is a disagreement in the size, those of *O. salinae* reported by Hoffstetter being about 50 per cent larger than those from Talara (73.5 cf. 46.3–50.5). This difference would indicate a different population at Talara, similar in general appearance with *O. salinae* from the Carolinian of Ecuador, but with smaller antlers and a slightly reduced stature, and with otherwise similar proportions. Since variation in the antlers of deer is known to be great, dependent upon age and nutritional factors, especially within the tropics, it is probable that this divergence is not significant at the specific or subspecific level. The Talaran *Odocoileus* may be considered conspecific with *Odocoileus salinae* (Frick), though differences in the skeletal and antler measurements may indicate some separation at the population or subspecific level. The larger antlers in the Carolinian population may indicate a more easily available source of calcium, and possibly a cooler climate, and thus the divergence between the two populations may reflect differing environmental factors rather than genetic differences. The larger size of *O. salinae* reported by Hoffstetter, may be considered tentatively unrepresentative of the population, as Hoffstetter considers it to be a large adult.

The less abundant form is assigned to *Mazama* (Rafinesque 1817) cf. *gouazoubia* on the basis of the similarity in size and shape of the atlas, which is the only reliable skeletal element recovered which gives some indication of the size of the animal, and this identification is supported by the antler specimen which bears a strong likeness to the antlers of some living individuals of *Mazama*.

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PLATE 1 Cranial and Axial Skeletal Elements of *Odocoileus salinae*.

- 1 Right Antler, anterior aspect; restored from 2710 and 2711.
- 2 Atlas, right lateral aspect; 2565.
- 3 Upper milk dentition, left p^3 - p^4 ; a —above, in buccal aspect and b —below, in occlusal aspect; 2069.
- 4 Lower milk dentition, right p_2 - p_4 ; a —above, in occlusal aspect and b —below, in buccal aspect; 2004 and 2512.
- 5 Lower permanent dentition and mandible; a —above, left P_2 - M_3 in occlusal aspect and b —below, left P_2 - M_3 in buccal aspect in situ in mandible. Dentition and ramus from 2418, symphyseal region from 2733 and condyle from 2513.
- 6 Upper permanent dentition, left P^4 - M^3 ; a —above, in buccal aspect and b —below, in occlusal aspect; 2511.
- 7 Axis lacking neural spine, left lateral aspect; 2585.
- 8 Thoracic Vertebra VII or VIII, left lateral aspect; 2607.

Fig. 2, 2565

Fig. 7, 2585

3a.

p³ p⁴

3b.

Fig. 3, 2069

Scale - cms

PLATE I

6a.

P⁴ M¹ M² M³

6b

Fig. 6, 2511

4a

Fig. 4

2004+2512

4b

p₄ p₃ p₂

5a

P₂ P₃ P₄ M₁ M₂ M₃

5b

Fig. 5, 2418, 2513 + 2733

Fig. 8, 2607

Fig. 1
2710 +
2711

PLATE II Appendicular Skeletal Elements of *Odocoileus salinae*.

- 9 Right humerus, distal half, posterior aspect; 2768.
- 10 Right calcaneum, medial aspect; 2799.
- 11 Right astragalus, dorsal aspect; 2804.
- 12 Right metatarsus, anterior aspect; 1980.
- 13 Right metacarpus, anterior aspect; 2560.
- 14 Left scaphoid; *a*—left, lateral aspect and *b*—right, medial aspect; 2775.
- 15 Right radius, anterior aspect; 2762.
- 16 Phalanx III, external aspect; 2800.
- 17 Phalanx II, external aspect; 2784.
- 18 Phalanx I, external aspect; 2802.
- 19 Right navicular-cuboid with fused cuneiform, anterior aspect; 2805.
- 20 Right lunar; *a*—left, proximal aspect and *b*—right, lateral aspect; 2774.
- 21 Right innominate, fragmentary, lateral aspect; 2151.

Fig. 11, 2804

Fig. 12, 1980

Scale - cms

PLATE 2

Fig. 13, 2560

Fig. 15, 2762

Fig. 14, 2775

Fig. 10, 2799

Fig. 16, 2800

Fig. 17, 2784

Fig. 18, 2802

Fig. 19, 2805

Fig. 21, 2151

Fig. 20, 2774

PLATE III Postcranial Skeletal Elements of *Odocoileus salinae*.

- 22 Left tibia lacking proximal epiphysis; anterior aspect; 2081.
- 23 Left ulna, medial aspect of proximal portion only; 2729.
- 24 Lumbar Vertebra V?, lacking neural and lateral processes, right lateral aspect; 2083.
- 25 Sacrum in damaged condition, dorsal aspect; 2085.
- 26 Left unciform; *a*—left, proximal aspect and *b*—right, lateral aspect; 3441.
- 27 Left trapezoid-magnum; *a*—left, proximal aspect and *b*—right, medial aspect; 3440.
- 28 Left pyramidal; *a*—left, lateral aspect and *b*—right, medial aspect; 3442.
- 29 Left navicular-cuboid, lateral aspect; 2816.
- 30 Right cuneiform, proximal aspect; 3234.
- 31 Right humerus, proximal articulation; 3436.
- 32 Left tibia, distal articulation; 2081.
- 33 Left malleolus, lateral aspect; 2838.
- 34 Right fibula, lateral aspect; 3439.

Skeletal Elements of *Mazama* sp.

- 35 Atlas, right lateral aspect; 2703.
- 36 Antler fragment, lateral aspect; 3151.

Fig. 36
3151

Fig. 26, 3441

Fig. 27, 3440

Fig. 28, 3442

Scale - cms

PLATE 3

PLATE IV Photographs of Selected Skeletal Elements of *Odocoileus salinae* and *Mazama* sp.

- 37-38 *Odocoileus salinae*. Right forefoot assembled from individual elements, anterior aspect. Wrist composed of pyramidal 3444A, lunar 2774A, scaphoid 3445B, trapezoid-magnum 3447A and manus of metacarpal 2560, Phalanx I's 2358N and 3793Q, Phalanx II's 2364C and 2737D and Phalanx III's 2413B and 2930H.
- 39 *O. salinae*. Damaged atlas, ventral aspect; 2565.
- 40 *O. salinae*. Right antler lacking tip of tine 1 and all of tines 2 and 3, anterior aspect; 2710.
- 41 *O. salinae*. Right radius, anterior aspect; 2762.
- 42 *Mazama* sp. Damaged atlas, ventral aspect; 2703.
- 43 *Mazama* sp. Damaged antler broken distal to the boss; 3151.
- 44 *Odocoileus salinae*. Damaged right innominate lacking ends of iliac, ischial and pubic radii, acetabular aspect; 2151.
- 45 *O. salinae*. Immature left tibia lacking proximal epiphysis and damaged in that region, anterior aspect; 2081.
- 46 *O. salinae*. Left ulna lacking shaft, medial aspect; 2729.
- 47 *O. salinae*. Left antler boss showing complete tine 1 and superior orbital margin, anterior aspect; 2711.
- 48 *O. salinae*. Assembled mandible with P₂-M₃ and damaged incise and coronoid regions, lateral aspect; 2733 (mesial element) and 2513 (distal element).
- 49-50 *O. salinae*. Left hindfoot assembled from individual elements, anterior aspect. Phalanges of pes omitted as those of manus shown in Fig. 37-38. Left metatarsus 3462; ankle composed of calcaneum 3100J, astragalus 2804L, navicular-cuboid 2816I and cuneiform 3234A.

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