

RODENTS AND LAGOMORPHS OF THE CARPINTERIA ASPHALT

Thesis by Robert W. Wilson

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INTRODUCTION

Plant and animal remains were first discovered in the Carpinteria asphalt deposits on the Higgins Ranch near the town of Carpinteria early in 1927. A preliminary announcement of the occurrence was published by Hoffman, Stock, and Chaney.(1927) Since then more detailed work carried on at the locality has furnished additional and larger collections of bird and mammal material. While the bird assemblage has been determined by Loye Miller(1931) and by Alden Miller(1932), no very complete list of the mammals is as yet available. The present study embodies a critical determination of the various rodent and rabbit types occurring in the fauna with a view to establishing evidence of value in an interpretation of the age relationships of the deposits and of the environmental conditions under which the mammalian fauna existed. The problem was suggested by Doctor Chester Stock of the California Institute of Technology to whom the author is indebted for guidance during the course of the investigation and for criticism of the manuscript.

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SIGNIFICANCE AND GENERAL CHARACTERS OF FAUNA

The rodent material from Carpinteria is of very fragmentary character. Due to the incomplete preservation specific identification of the remains was always difficult and for most of the types only a generic determination was possible. The presence of many forms closely similar in structural details to living species now occupying the region of Carpinteria points to an age of the fauna not older than Quaternary. While an age determination of the Carpinteria fauna must, by the nature of the evidence presented by the rodents and the lagomorphs, be far more general than that based on the birds, the former assemblage certainly offers no salient facts mitigating against a late Pleistocene age.

Rodents are in general sensitive indicators of climate and environment. While the fragmentary state of preservation of the material makes an interpretation of the ecologic conditions difficult the evidence presented by these mammals may serve to check, and perhaps amplify, conclusions drawn from studies of the birds and plants.

Presence of the chipmunk (Eutamias) and of the tree-squirrel (Sciurus) suggests rather strongly a region at least partly forested and is thus evidence substantiating conclusions derived from a study of the avifauna and of the flora. The faunal list moreover indicates a mingling of semi-arid and

sylvan types. Associated with Sciurus and Eutamias are Dipodomys and Onychomys?. Doctor Loye Miller (1931, pp 364-365) records evidence for the recognition of two ecologic stages during the period of occurrence of the Carpinteria avifauna but does not regard this difference as necessarily due to a major time interval. Doctor Miller believes both stages show a definite sylvan environment with one faunule exhibiting this character more so than the other. This view does not satisfactorily explain the relationships found in the rodent fauna. The intermingling of semi-arid and sylvan forms in the same deposit may however be accounted for if we assume that the accumulation of the material occurred at a locality situated near the edge of an existing forest.

When compared with the comparable assemblage from Rancho la Brea the Carpinteria rodent fauna shows definite differences. The presence of the chipmunk and tree-squirrel at Carpinteria and their absence at Rancho la Brea support the evidence furnished by the floras and avifaunas that the region was, unlike that in the vicinity of Rancho la Brea, at least partly forested. Further, the relative abundance of individuals representing different genera offers some contrasting features. At Rancho la Brea gophers of the genus Thomomys far exceed all other forms in numerical representation. Among the remains of rodents those relatively abundant are the kangaroo-rat Dipodomys, the pocket-mouse

Perognathus, and the cottontail Sylvilagus audubonii while these less abundant include the meadow-mouse Microtus, the white-footed or deer-mouse Peromyscus, and the ground-squirrel Otospermophilus. Rare forms are represented by the harvest-mouse Reithrodontomys, the jack-rabbit Lepus, the brush-rabbit Sylvilagus bachmani, the wood-rat Neotoma, and the grasshopper-mouse Onychomys. In the Carpinteria asphalt Peromyscus occurs as the most abundant form. The deer-mice are represented by more than twice the number of individuals recorded for the type nearest in abundance. With decreasing representation but still abundant occur the genera Dipodomys, Thomomys, and Microtus. Eutamias and Sylvilagus bachmani are relatively common while Perognathus, Sciurus, Onychomys?, Neotoma and Lepus are rare. The order of abundance may or may not possess significance as a reflection of differences in ecologic conditions presented at the two localities. It is well to remember that the susceptibility of certain forms to capture by the peculiar agencies operative in tar seep accumulations may be responsible for at least some of the difference in numerical representation. The presence of a relatively large number of individuals of the genus Dipodomys is interesting since this form occurs typically on arid and semi-arid plains of the Californian region at the present time. Assuming that the fundamental habits and habitat of the kangaroo-rats have undergone no great

change since late Pleistocene time, the occurrence of these creatures at Carpinteria furnish some of the more striking evidence in support of the view that the forest cover in the region of the asphalt accumulation was broken by areas of sparser vegetation.

A minimum number of 130 individuals is represented in the fauna. Approximate percentages of individuals for particular genera are as follows:

Sciuridae

Eutamias 5%

Sciurus 1%

Geomysidae

Thomomys 16%

Heteromyidae

Perognathus 2%

Dipodomys 17%

Cricetidae

Onychomys? 1%

Peromyscus 39%

Neotoma 1%

Microtus 12%

Leporidae

Lepus 1%

Sylvilagus 5%

ANNOTATED LIST OF RODENTS AND LAGOMORPHS

Eutamius, species

Several lower jaws and portions of palates establish the presence of the chipmunk. Characters in the dentition clearly indicate that the genus represented is Eutamius. The Eastern chipmunk Tamias is at present so far removed in range from the Carpinteria locality as to further preclude the possibility of generic reference other than to Eutamius.

On the basis of size and of geographical distribution the fossil species should apparently be assigned to the townsendii group. The subspecies inhabiting the Carpinteria region today is Eutamius merriami merriami. Whether the fossil form is to be included in this living species and subspecies cannot be satisfactorily determined in view of the range in variation exhibited in the subspecies itself. Skull and jaws of an adult female in the Dickey collection, collected in a Recent fauna at Carpinteria, exhibit characters which are identical with those shown by the Pleistocene form except for slight differences due to varying amounts of wear. Careful examination of numerous specimens of the subspecies Eutamius merriami merriami demonstrates a marked variation in certain features of the dentition of this form and eliminates slight differences which might be regarded as of specific or subspecific value.

Owing to the incompleteness of the fossil material, and the minute morphological differences which distinguish the skulls and teeth of living chipmunks it seems inadvisable to carry the identification of the Pleistocene type beyond the genus.

Sciurus, species

The tree-squirrel Sciurus is represented in the Carpinteria assemblage by only two isolated teeth, $P\bar{4}$ and $M\bar{1}$?. These specimens agree in size and structure with comparable teeth in a Recent specimen of Sciurus griseus anthonyi from Santa Barbara county. The teeth are low crowned and with little or no elevation of the trigonid portion of the crown. The two anterior cusps of $P\bar{4}$ are situated close together, and their position gives a triangular shape to this tooth which is characteristic of Sciurus, Otospermophilus, and Ammospermophilus. The California ground-squirrel Otospermophilus beecheyi approaches the fossil form in size but is distinguished from it by slightly higher cusps and the development of a distinct paraconid-hypoconid ridge.

Thomomys near bottae (Eydoux and Gervais)

Specimens of the gopher Thomomys consist of numerous lower jaws, a portion of the premaxillae bearing the incisors, and the anterior portion of a skull with the complete upper dentition.

In the fossil specimens the posterior enamel plate of the upper premolar is complete. The last upper molar has only two enamel plates, an anterior and a posterior one. The posterior enamel plate is present and complete on the first, second, and third upper molars. Two enamel plates are also present on each of the lower molars. These characters identify the fossil form as Thomomys.

Comparison of the material with Recent species shows that the form from the Carpinteria asphalt is representative of the heavy rostrum group which includes among others the following types: T. bulbivorus, T. townsendi, T. bottae, T. alpinus, T. perpallidus, T. fulvus, T. umbrinus. The following distinctive characters can be observed in the fossil form:

1. heavy rostrum
2. upper incisors with very obscure groove (may be absent)
3. incisors slightly projecting
4. size large
5. nasals apparently spatulate

In view of the enumerated characters the fossil material has been compared with T. bottae. This species has a very wide distribution at the present time and if leucodon is accepted as one of its subspecies its distribution was equally wide during the Pleistocene. No specific characters in the fossil material serve to distinguish the asphalt species from the Recent T. bottae. The two forms correspond

closely in size. An apparently immature individual from the asphalt is characterized by a greater dorso-ventral diameter than in any Recent T. bottae of comparable age. The skull characters of gophers vary so greatly with age that the difference noted above can hardly be regarded as sufficient evidence to distinguish specifically the fossil from the Recent type.

Until more material becomes available the gophers of the Carpinteria asphalt are referred, therefore, to Thomomys bottae.

Perognathus, species

The specimens of the pocket-mouse Perognathus consist of three rami, of which one retains the fourth premolar while the others are without teeth. The paucity of characters presented by this material does not permit positive specific determination.

The size of the lower jaws are within range of variation of jaws of Perognathus californicus californicus, and no characters are present to distinguish the fossil type from this subspecies. The generic determination is all that is advisable for the present.

Dipodomys, species

The Carpinteria material comprises chiefly

lower jaws, with a few maxillary fragments bearing teeth. The teeth of the kangaroo-rat Dipodomys present apparently few noteworthy specific characters for they possess an extremely simple pattern. The expanded bullae and mastoids on which specific identification of skulls is frequently made are unfortunately lost in the fossil specimens.

The specimens available agree in size with the corresponding structures in Dipodomys agilis. This species now lives in the vicinity of Carpinteria. However, no specific determination of the fossil material seems warranted.

Onychomys?, species

A single left lower jaw without teeth is the only available material from Carpinteria which evidently represents the grasshopper-mouse, Onychomys, in the collection. It is possible to distinguish this jaw from Peromyscus on the basis of the well developed coronoid process as well as by the greater angle at which the ascending ramus meets the alveolar portion of the jaw.

The specimen can be distinguished from the lower jaw of Reithrodontomys by the character of the descending ramus. In Reithrodontomys this portion of the ramus is bent into a more horizontal position than in Onychomys and the extreme edge is twisted upward leaving a depression. Moreover the

coronoid process is less strongly developed in Reithrodontomys.

The ramus represents an individual of rather large size but in this character the species lies within the range of size of O. torridus and within that of the subspecies O.t. ramona.

Peromyscus, species

Remains of the deer-mouse Peromyscus consist of lower jaws, usually without teeth, and two maxillary fragments. One of the latter specimens bears M1 and M2 while the other carries only the second molar. Due to the scarcity and incompleteness of the material no specific determination is made.

The pattern of the teeth is very simple and no accessory tubercles are present on any of the molars. On the basis of the latter character the material from the brea deposit may be referred to the subgenus Haplomylomys.

Individuals of the living Carpinteria type, P. californicus californicus and its related subspecies P.c. insignis appear to be distinctly larger than the fossil forms. The subspecies P.c. insignis in contrast to P.c. californicus includes individuals of smaller size, and the fossil forms although deviating somewhat from the norm in this character may represent the latter subspecies. The Carpinteria asphalt species resembles also P. eremicus, another member of the subgenus Haplo-

mylomys. At the present time P. eremicus does not range so far north as Carpinteria.

P. eremicus fraterculus is another subspecies exhibiting characters close to those of the fossil form in so far as the material permits of comparison. However, one or two differences are to be noted. In P.e. fraterculus the median anterior cusp is characterized, in a fairly unworn tooth, by a small infold. This is entirely absent in the fossil species or is only slightly indicated. This character is noted in some specimens of P.e. insignis and is absent in other specimens of the same subspecies.

The fossil specimens show the average angle formed by the anterior border of the ascending ramus and the alveolar border of the mandible to be greater than in Recent individuals of P.e. fraterculus. The reliability of this character is open to question.

Possibly two species of Peromyscus are present in the Carpinteria beds. Of the subgenera Peromyscus has lower molars on which the accessory tubercles are sometimes poorly developed. Possibly some of the lower jaws found in the asphalt represent this subgenus, although no accessory tubercles can be observed on any of the molars. A representative of the subgenus Peromyscus, namely P. maniculatus gambeli, is found in the Carpinteria region today.

The Carpinteria fossil types may not represent any existing species of Peromyscus, and until better

material becomes available there appears to be no special reason for assigning these forms to either a new or to an existing species.

The genus Reithrodontomys may be represented in the collection by numerous small jaws known to belong to cricetine rodents. The rami average smaller than those referred to Peromyscus although a line of division based on size is difficult to establish. The specimens agree closely with jaws of Reithrodontomys megalotis longicauda, a form which inhabits the region about the Carpinteria deposits at the present time.

The principal character of generic importance in the mandible of Reithrodontomys is the shape of the descending process. To quote in part a statement of the characters of this genus given by A.H. Howell(1914, p 14), "Descending process of mandible a broad flattened plate strongly inflected inward, the lower portion twisted into a nearly horizontal position and the inner margin raised, leaving a distinct depression in the ramus...." However, certain species of the deer-mice belonging to the subgenus Haplomyiomys show practically the same character. As members of the subgenus Haplomyiomys are present in the living Carpinteria assemblage this character can only be used tentatively. The character of size appears to be the only stable guide to a generic separation. The fossil jaws can, however, in this case belong to an immature

individual of Peromyscus. Future material may show that these jaws belong to the harvest mice, but for the present they are tentatively referred to Peromyscus.

Among the numerous isolated upper incisors from the deposit none was found which showed the grooved character or a size and shape like that of Reithrodontomys.

Neotoma, species

The material referred to the wood-rat Neotoma consists of one right lower jaw with M1 and M2, and several isolated teeth. On the basis of the small amount of material available an attempt to make more than a generic determination does not appear to be justifiable. Two species of Neotoma are found living in the region of Carpinteria today, namely Neotoma intermedia of the subgenus Neotoma and Neotoma fuscipes of the subgenus Homodontomys. On the basis of size alone the fossil jaw is closer to N. fuscipes. Although differences in tooth pattern separate the three subgenera of Neotoma these characters are variable to the extent that a determination of fossil material based exclusively on tooth pattern may be subject to considerable uncertainty.

It is interesting to note that N. fuscipes builds houses of sticks some distance above the ground. This habit lends further support to the

hypothesis that a forest environment prevailed during the period of existence of the Carpinteria Pleistocene fauna.

Microtus californicus (Peale)

The fossil material representing the California meadow-mouse *Microtus californicus* consists of numerous lower jaws, parts of two palates, and some isolated teeth. Evidence for the specific determination is presented by the shape of the incisive foramina and the occlusal pattern of the teeth. The former character can be determined even in fragmentary specimens. On the basis of the occlusal pattern of the teeth the fossil form resembles most closely the subspecies *M.c. californicus*.

The latter subspecies does not now inhabit the region of Carpinteria and its presence in the Pleistocene would substantiate the view that a forest essentially similar to the Monterey forest of today was present in the region of Carpinteria during the period of existence of the Pleistocene fauna. Possibly certain elements in the mammalian assemblage may have enjoyed a more extended range south of Monterey than prevails at the present time.

The Carpinteria asphalt species has one peculiar character that none of the Recent subspecies possesses. The first internal re-entrant angle of M₁ is wider than in the living species. This character of width

is apparently not due to wear. The character does not warrant subspecific separation for only two specimens of the first upper molar are available in the collection, a number certainly insufficient to demonstrate that the wide re-entrant angle is constant.

Lepus near californicus Grey

A jack-rabbit is represented by a single left ramus, apparently of an old individual. The tooth-row is complete with the exception of $M\bar{3}$. The specimen is evidently referable to the genus Lepus, as indicated by the large size and presence of a long diastema. $P\bar{3}$ has the shape and pattern seen in the existing species.

No difference of structure can be observed between the fossil specimen and L. californicus. The diastema seems long for the size of the individual, but the length is an extremely variable character and apparently has been duplicated in some of the Recent specimens of L. californicus.

The specimen is referred to L. californicus which it resembles in size. L. washingtonii kla-
mathensis is smaller and L. campestris sierrae is much larger than the Carpinteria specimen.

Sylvilagus bachmani (Waterhouse)

Remains of Sylvilagus from Carpinteria are

very fragmentary. The collection comprises several lower jaws, portions of the maxillae, and isolated teeth. In size and length of the diastema between \bar{I} and $P\bar{3}$ these specimens are distinctly more like Sylvilagus than like Lepus.

Two of the species of Sylvilagus, S. bachmani and S. audubonii, are distinguished by their size. The former type is smaller than the latter and is further characterized by the straight anterior wall of the posterior re-entrant angle of $P\bar{3}$ and by the less complex folds in the re-entrant angles of $M\bar{1}$ and $M\bar{2}$. A large number of specimens from the Carpinteria Pleistocene possess the characters peculiar to S. bachmani.

The collection contains several young or immature specimens and the separation of the two species is not simple. In S. bachmani the third lower premolar lacks the plication seen in the posterior re-entrant angle characteristic of S. audubonii. The wall of the re-entrant angle in the Carpinteria species is in some cases slightly wavy. A Recent specimen of S. Audubonii shows a $P\bar{3}$ having this character although the Recent tooth is more of the plicated type. In this connection it may be indicated that the statement by Dice (1925, p 128) that in S. bachmani the enamel is straight or in rare instances simply crenulated cannot be verified. Recent specimens of S. bachmani have been found in which definite plications exist.

The first and second upper molars of the fossil material correspond in pattern to those of the Recent S. bachmani. One specimen from the asphalt having a size larger than the average may represent S. audubonii. Here again the statement by Dice (1925, p 129) that, "The enamel of the anterior edge of the re-entrant angles of the first and second upper molars seems never to be more than slightly wavy in the S. bachmani group, and is usually a nearly straight line" is not supported by all specimens. Several specimens of the Recent S. bachmani are available in which the folding on these teeth can hardly be regarded as only slightly wavy.

In size the fossil specimens are all small and fall readily within the species S. bachmani. The presence of S. audubonii is not certainly indicated. However, a right maxillary with P3, P4, M1, and M2 is characterized by large size and by very well developed plications on the re-entrant angle of M2. In this specimen the enamel forming the re-entrant angle of M2 is more complicated than that forming the angle of M1.

The morphological characters possessed by the Sylvilagus specimens from the Carpinteria deposit, as studied in the light of structural features in the dentition of existing species of Sylvilagus indicate definitely that the former types are to be referred to Sylvilagus bachmani. The presence of S. audubonii cannot be definitely shown but the

sharp distinctions in enamel pattern between this species and S. bachmani is not maintained as a result of comparisons made in the present study.

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