A CENSUS OF THE ABUNDANT LARGE PLEISTOCENE MAMMALS FROM RANCHO LA BREA

By Leslie F. Marcus

INTRODUCTION

The Pleistocene fossil deposits at Rancho La Brea, now famous throughout the world, are chiefly represented by specimens in the Los Angeles County Museum. This large assemblage of materials makes possible the taking of a census of the representations from the several different pits.

Early excavators observed apparent differences in the faunas and characteristics of the separate pits of Rancho La Brea, and critical study has subsequently underscored several of these features. For example, the abundance of Proboscidea in Pit 9 (Fig. 1) compared to their near exclusion in other pits has been pointed out (Stock, 1956) as well as the presence of human remains in Pit 10. Such observations have indicated the desirability of thoroughgoing pit censuses, since small differences between the several individual pits may be detected by comparing the numbers of individuals of various species that are preserved. Thus far, only two reports have appeared in which comparisons of vertebrate remains from separate pits have been made: Howard & Miller's (1939) bird census of the Los Angeles County Museum pits 3, 4 and 10; Brattstrom's (1953) comparison of the lower vertebrate faunas.

The present census was undertaken to discover whether there are detectable differences, among the major pits, in the faunas of the most

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abundant large mammals. The results have indicated that faunal differences from pit to pit do exist. Furthermore, the differences appear too large to be accounted for by chance, and may more reasonably be explained as the result of differences between pit activities, such as temporal differences or pit preferences by certain species. More complete censuses of the separate pits for all elements of the faunas, as well as detailed studies of the faunas and their component species, will be necessary before a realistic mathematical model can be proposed to explain the pit differences.

Dr. Theodore Downs and Dr. Hildegarde Howard kindly made available to me for study the Rancho La Brea collection and records of the Los Angeles County Museum. I am indebted to them for many helpful suggestions.

**Available Data**

The present census is based entirely on the collection of the Los Angeles County Museum. Only the more abundant species, represented by 18 or more individuals, were usable in this comparative analysis of the separate pits. These species, all of them extinct, are Paramylodon harlani, Nothrotherium shastense, Canis dirus, Canis orecuttii, Panthera atrox, Smilodon californicus, Camelops hesternus, Breameryx minor, Bison antiquus, and Equus occidentalis. Canis furlongi, the extinct timber wolf, is distinguishable with difficulty on other than cranial characters, and only eight skull specimens are known (Stock, 1956 and Nigra and Lance, 1947). The numbers of individuals of the rarer large species, not included here, are given by Stock (1929). The numbers of individuals of Tremarctotherium simum and Mammut americanus may exceed 18 individuals, but they are most abundant in pits other than those from which the more abundant materials were collected (see below). About half of the species of large Rancho La Brea mammals are catalogued in a series of permanent ledgers, which indicate catalogue number, species identification, skeletal element, pit number and coordinates within pit for each specimen. Some of the rarer large mammals are catalogued in an older, card-catalogue. Both catalogues were used to make the pit censuses. A direct count of bones was made only for Bison, which is incompletely catalogued, and for Camelops as a verification of the catalogue. Paramylodon, Nothrotherium, and Breameryx are listed only in the older catalogue. It would be a prodigious task to count the numbers of individuals for every species using the collection itself. Stock (1929) did this for his total census, except that the numbers of the individuals for the two largest groups, the dire wolves and the sabre tooth cats, were only approximated. In Stock's census only adult animals, in general, were considered; in the present census, juveniles may have been included, since the catalogue

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*The University of California collection is incompletely catalogued, and a portion of it has been sent to other institutions.*
does not distinguish them from adults. The census figures were also compared to the field notes where, in most cases, the number of skulls discovered in each separate pit was recorded. In only a few cases is there a discrepancy towards a higher number in the field notes. In some cases, specimens were recorded in the notes as being discovered, but were not collected because of poor preservation.

The term pit, as used in this report, refers to the 96 numbered excavations made by the Los Angeles County Museum from July, 1913, to September, 1915. Over fifty of these excavations were mere test holes, completely unproductive; others, such as Pits 1, 2, and 90 were pockets in the walls of the earlier excavations made by the University of California; Pits 61 and 67 were found to unite into one large pit, and several numbered areas represented test digs at different spots in previously tested outcrops. Only fourteen to sixteen of the ninety-six excavations, according to the field notes, appear to have been actual self-contained deposits which probably represented tar traps for the larger mammals.

Fig. 1. Topographic map of Rancho La Brea showing location of principal excavations. Diagram modified after Stock.
sometime in the past (see Fig. 1). In seven of these, Pits 9, 17, 43, 44, 57, 65 and 72, the bone was of such poor preservation, much of it water soaked and rotten, that collecting was unsatisfactory and only a few specimens were taken. A complete record of the species from these pits is not indicated in the catalogue. Pits 81 and 91 were kept intact for display purposes and no complete count was made of the contained animals. Pit 36 was a rather special, shallow deposit measuring only 2 ft. × 4 ft. at a depth of 6 feet. Its fauna is so small that its inclusion in the discussion was considered impractical. Pit 10 is also excluded from the discussion because, for the most part, it contained small forms suggesting Recent age. Only the birds of Pit 10 have been studied in detail (Howard and Miller, 1939); the few isolated bones of large mammals (bear, wolf, horse and deer) need further study for accurate identification (see Merriam, 1914, and Stock, 1956).

It may now be recognized that only Pits 3, 4, 13, 16, 60, 61-67, and 77 are useful for comparison of census figures. These seven pits, here to be analyzed, will hereafter be referred to as the "major pits" by reason of the abundance of material contained. In some of these pits, the upper few feet of material was discarded before complete collection was attempted. During excavation the bones were segregated as to depth and position below a three-foot grid at the surface. Accordingly, the deposit may be reconstructed in detail from the catalogue or the museum collection, and more detailed census studies of the fauna may be made utilizing these data. Depths in these major pits ranged from 17 feet in Pit 13, to 27 feet in Pit 3; in Pits 16, 60, and 61-67 the greatest depth was 20 feet, in Pit 77, 21 feet, and in Pit 4, 25 feet.

**Procedure**

The present census was made in the following way. For each species in each pit, a tally was made of one skeletal element, for example, the right calcaneum. This count was repeated for all other elements for which there seemed to have been a good chance of preservation and collection and a small chance of loss or breakage in accumulation. The tallies for the separate elements, or bones, were reviewed and the total number of individuals in a pit was estimated from the number of specimens of the most frequently preserved element in that pit. For example, for Smilodon in Pit 3, there were 339 atlases and 254 right calcanea, whereas in Pit 4 there were 94 atlases and 105 right calcanea. Thus, the estimates for the total number of individuals collected from Pits 3 and 4 were taken

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*a*Total census, using most common element per pit as explained in text.  
*b*Total number of most common element over all excavations.  
(Numbers in field notes.  
*Old catalogue.  
**Actual counts.
<table>
<thead>
<tr>
<th>SPECIES</th>
<th>INDIVIDUALS FROM MAJOR NUMBERED PITS</th>
<th>ALL EXCAVATIONS&lt;sup&gt;a&lt;/sup&gt;</th>
<th>MOST COMMON ELEMENT&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>#3</td>
<td>#61-67</td>
<td>#4</td>
</tr>
<tr>
<td><em>Paramylodon harlani</em></td>
<td>16</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td><em>Nothrotherium shastense</em></td>
<td>3</td>
<td>13</td>
<td>-</td>
</tr>
<tr>
<td><em>Canis dirus</em></td>
<td>526</td>
<td>361</td>
<td>266</td>
</tr>
<tr>
<td><em>Canis orcuttis</em></td>
<td>31</td>
<td>50</td>
<td>48</td>
</tr>
<tr>
<td><em>Panthera atrox</em></td>
<td>19</td>
<td>27</td>
<td>9</td>
</tr>
<tr>
<td><em>Smilodon californicus</em></td>
<td>339</td>
<td>279</td>
<td>105</td>
</tr>
<tr>
<td><em>Camelops hesternus</em></td>
<td>8</td>
<td>8</td>
<td>5(8)</td>
</tr>
<tr>
<td><em>Breameryx minor</em></td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td><em>Bison antiquus</em></td>
<td>53</td>
<td>22</td>
<td>28</td>
</tr>
<tr>
<td><em>Equus occidentalis</em></td>
<td>43</td>
<td>24</td>
<td>15</td>
</tr>
<tr>
<td>Total individuals</td>
<td>1040</td>
<td>798</td>
<td>495</td>
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as 339 and 105, respectively. Such inconsistencies between different elements of a species within a pit were noted in several cases and may, perhaps, be accounted for by incomplete preservation of individuals or by breakage or loss in collection. The method used, however, should provide a dependable count of the number of individuals actually preserved in a pit, provided that one individual did not have parts of its skeleton preserved in more than one pit. The census for each species in each major pit, using this method, is given in Table 1. These are the estimates used in the discussion to follow. As a matter of interest, the total census of each species for all the seven selected pits (using the same method) is given in the column “All Excavations, Total”, and may be compared (in the column “Most Common Element, Total”) with the census of each species for all pits based on the most frequent element throughout the pits. These latter estimates are not affected by the preservation of individuals in more than one pit, and, in most instances, give a lower total census figure. Stock’s (1929) total estimates were made in this way.

**Results**

For a meaningful comparison of the numbers of individuals from different pits, it must be assumed either that estimated numbers of individuals collected, housed, and catalogued in the Museum are very near the actual numbers of individuals trapped and preserved in the pits, or that they faithfully represent the relative abundance of species. This assumption implies that after entrapment there was no selective loss of individuals, and that in collection and curation there was no selection of specimens of one species over those of another in different pits. Counts based on less obvious elements such as carpals, tarsals, metapodials, and vertebrae should be less subject to such selection if it existed.

In Table 1, the estimated total number of individuals of the abundant species of large mammals is entered for the seven major pits. Counts based on field notes are entered in parentheses.

The predominance of *Canis dirus* over *Smilodon californicus* is evident in each of the major pits, though the relative proportions of these two to each other and to the rest of the fauna are quite variable. These two species, plus *Panthera atrox*, outnumber the herbivores from 5.5 to 1 (in Pit 4) to 7.8 to 1 (in Pit 61-67). *Canis dirus* outnumbers *Smilodon californicus* by ratios from 1.1 to 1 (in Pit 77) to 3.0 to 1 (in Pit 16). *Canis orcuss* is especially abundant in Pit 16, and *Nothrotherium* is relatively abundant in Pit 61-67. Other comparisons can be made by examining Table 1 and figure 2.

A map of the area is given in figure 1. No consistent pattern of relationship between pit faunas has been discovered that can be correlated with pit location. The seven separate major pits are considered as individual locations of accumulation in the discussion which follows.
DISCUSSION

Merriam, Stock, and others viewed the tar traps as places where unwary herbivores, especially the very young and the very old, were trapped while in search of water in the open pits, or while crossing innocuous looking, dust-covered pits. Once an animal was trapped, its cries attracted carnivores. These in turn were trapped in greater numbers than their prey. Later, carrion feeders came on the scene, and they, too, fell victim to the deceptive pits.

The above is the only reasonable explanation that has been offered for the preponderance of carnivorous animals in the pits. Before the present census counts were made, this explanation was elaborated into a mathematical model, which, it was hoped, could be used to explain the results of the census and permit estimates of the relationships between predators and prey. The testing of the model had to be abandoned when the present study revealed that of the 96 excavations, only five, or at most seven, were useful for the purpose. Instead, the hypothesis of similar proportional faunal composition among the several pits was tested using the $X^2$ test for deviation, corresponding to the test of association in Simpson and Roe (1939, p. 290). If all pits attracted all species equally, we would expect to find approximately the same proportional relationship of the separate species in each pit, and a consequent low factor of deviation ($X^2$). For example, Canis dirus should be in nearly the same dominant proportion in each pit. The pits with the greater numbers of individuals would be expected to be more similar in proportions. The large observed deviations from equal proportionality, however, lead one to favor alternative hypotheses, such as preferential attraction of some species to certain pits, or differences in times of activity for the different pits. A large number of one species in a pit might be correlated with its abundance in the area during the time of major activity of the pit.

The observed value of $X^2$ for the ten most abundant large species in the seven major pits is 349.2. A deviation value as large as this, under the hypothesis of similar proportionality, would be expected rarely ($P < .00001$, Hartley and E. S. Pearson, 1950*), and reflects considerable dissimilarity in accumulation of the faunas of the separate pits. Similarities of proportions for the herbivores and carnivores were tested separately. The six herbivores gave a $X^2$ equal to 55.7 for the seven major pits, again a large deviation under the hypothesis of similarity ($P = .003$). When Nothrotherium is removed from the analysis, however, $X^2$ is equal to 27.4 which is not significant ($P = .29$). Therefore, the proportions of large herbivores other than Nothrotherium are not significantly different, which may mean that abundance and entrapment of these species were not different during the times of activity of the several pits. The presence or absence of Nothrotherium is probably significant in itself, considering

*The lowest probability figure used statistically.
Fig. 2. Pie diagrams giving the proportions of the ten most abundant species for the seven major pits. The number below each pie indicates the total number
of individuals of these species from that pit. The areas of the pies are proportional to these total pit numbers. (see Table 1).
the size of the faunas of the large pits. The four carnivores give a $X^2$ equal to 281.3 for the seven major pits, and this is highly significant ($P < .00001$). Even when *Canis orecutti* is removed from the analysis a highly significant $X^2$ value of 65.3 is obtained (still $P < .00001$). The carnivores contribute a major part to the deviation from the expected numbers under the hypothesis of similarity. They do not seem to follow the variation in the herbivores in any systematic manner, except for a possible association of dire wolves and bison.

**Summary and Conclusions**

The present census does not alter the general picture of accumulation at Rancho La Brea. It does indicate that the separate pits had nearly the same fauna, but differed significantly in numbers of individuals of some of the species. The proportion of carnivores to herbivores is consistently greater, but varies from pit to pit. In no instance, however, do the present figures indicate as great a predominance of carnivores over herbivores as noted by Stock (1929), even allowing for the fact that several of the small carnivores used in Stock’s totals, are not included here.

Differences in physical characteristics of the pits are probably insufficient to explain the census differences pointed out here, although the associated plant life might have influenced the variable abundance of *Nothotherium*. Rather, I favor the hypothesis that the pits were not all continuously active for the same period of time. Either each pit was continuously active for a different interval of time, or the separate pits’ periods of quiescence and entrapment were not coincident even though their total times of activity may have been roughly equivalent. Complete censuses of all faunal and floral elements for all pits will cast more light on this subject. The smaller mammals, the birds and the reptiles should be particularly useful. The majority of them have not become extinct as have the larger mammals. The value of a bird census has already been pointed out by Howard and Miller (1939) in supporting a younger age for Pit 10, which contains human remains. At the same time, these authors presented avian census differences between Pits 3 and 4 (op. cit., figs. 1 and 2) that indicate probably significant differences between these pits. Herpetological material has not been studied in the major pits other than Pit 3 (Brattstrom, 1953). Brattstrom did, however, suggest an age difference in the pits he studied, placing Pit 3 and two other lesser Los Angeles Museum excavations together with the University of California excavation no. 2051 as probably older than L. A. Museum Pits A and B and Univ. of Calif. excavation no. 2052.

The work of Nigra and Lance (1947) and Menard (1947) on measurements of length of the metapodials of the dire wolf and sabre tooth cat, respectively, contributes another interesting facet to the evidence for inter-pit differences. These authors show that in average length of
metapodials, the animals from Pits 4 and 13 show consistent separation, with noticeable, though less consistent, differences between the individuals of Pits 77, 61-67 and 3. If the time differences between the pits can be determined, the collection from Rancho La Brea will provide a unique opportunity for the study of evolution in several species over a relatively short time.

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No. 4. Botany: The Lichens, by Carroll W. Dodge.
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