

considered, San Miguel specimens are the grayest and those from Santa Cruz the brownest. In other words, those from Santa Cruz most closely resemble the Ventura County coastal birds. In matter of size, they are practically as large as *clementae*, except for the middle toe, and, as before stated, are in general decidedly closer to that form. Were it not for the fact that they are larger than either, they might well be classed as intermediates between *graminea* and *cooperi*.

Whether or not the northern and southern "colonies" of *clementae* are actually related as closely as the general resemblance indicates is a question. At any rate the characters exhibited make the one name applicable to both.

Summary.—Three races of song sparrows inhabit the Santa Barbara and Los Coronados islands. *Melospiza melodia coronatorum* is confined to the four small islands of Los Coronados group. *Melospiza melodia graminea* is confined to Santa Barbara Island. *Melospiza melodia clementae* is found on San Clemente, Santa Cruz, Santa Rosa, San Miguel, and probably Anacapa islands. The colonies inhabiting the last four named islands may or may not be as closely related to the San Clemente "colony" as their resemblances indicate.

Clementae and *graminea* were not improbably derived from the *cooperi* stock now inhabiting the littoral association of Ventura County. *Coronatorum* probably is most closely related to *cooperi* of that portion of the mainland nearest Los Coronados Islands.

Pasadena, California, September 26, 1924.

VARIABILITY IN *BUBO VIRGINIANUS* FROM RANCHO LA BREA WITH FIVE GRAPHS

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(Contribution from the Los Angeles Museum of History, Science and Art)

B*BUBO VIRGINIANUS* has already been recorded from Rancho La Brea by Dr. L. H. Miller in his paper "The Owl Remains from Rancho La Brea" (Univ. Calif. Publ. Bull. Geol., vol. 9, 1916, pp. 97-104). Since the appearance of this publication, however, more material has become available for study, and further research made possible. This work has been carried on at the Los Angeles Museum of History, Science, and Art, where the assembled material included the large collection of fossil bones from Rancho La Brea, several modern specimens belonging to the museum, others from the Miller collection, and a number of skeletons and skins kindly loaned by the Smithsonian Institution.

The fossil specimens were taken from a number of excavations in the Rancho La Brea formation, the greatest number coming from Pit 16. Of the three limb elements selected for study, the tarsi were the most numerous, being represented by 201 specimens, the tibiae following with 24, and the humeri with 15 specimens. This more frequent preservation of the tarsus was, perhaps, partially due to the fact that it is a small and dense bone with practically no flesh, making it unattractive to Carnivora. The tibiae and the humeri, on the other hand, suggest by their broken state of preservation that they have more frequently been subject to the depredations of the flesh-eaters.

The statement by Dr. Miller that "the fossil species is distinguished from the Recent by a character not held in common, i. e., great variability in a fixed locality,"

(*ibidem*, p. 100) has been further verified by these studies, as will be shown below. Two possible explanations of this variability have been advanced. Dr. Miller has suggested a common stock from which developed the widely diversified subspecies of the present period. The other theory, suggested by Mr. L. E. Wyman of the Los Angeles Museum, deals with the effect of climatic change on the evolution of the bird. The asphalt pools were probably open for thousands of years, and there seems to be evidence that during that time the climate slowly and gradually changed from moist,

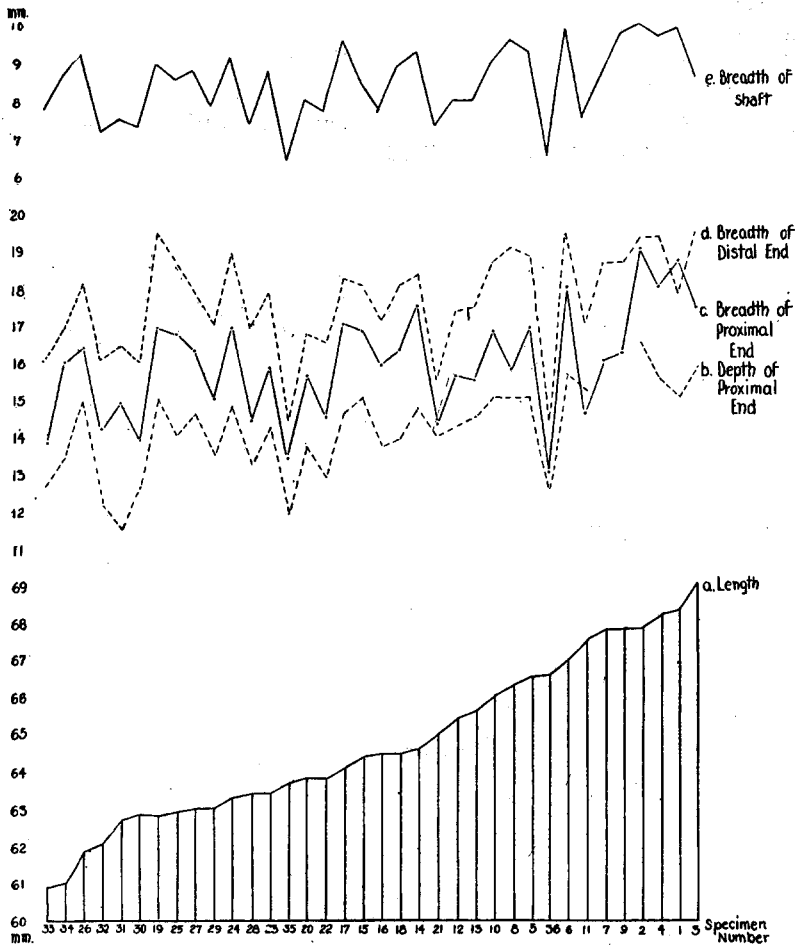


Fig. 54. *Bubo virginianus*. TARSOMETATARSUS. GRAPH SHOWING COMPARATIVE MEASUREMENTS OF A GROUP OF 36 SPECIMENS FROM PIT 16. X 5.

warm-temperate to semi-arid conditions. At the present time, the *Bubo* which occupies the moist northern areas is of a greater size than that of the dry southern regions. The change towards aridity may have had one of two effects: a direct influence on the evolution of the bird, resulting in the dwarfing of a large species; or the migration of the larger species, perhaps first to the mountains, then following the receding moist climate towards the north.

The purpose of this paper is to add, to the information already published, the results of this research, and to draw certain conclusions therefrom. The writer desires to express her thanks for the loan of material to Dr. L. H. Miller, and to the authorities of the Smithsonian Institution. She is also greatly indebted to Dr. Miller, at whose instance this paper was undertaken, for his critical oversight and many helpful suggestions; and to Dr. Wm. A. Bryan and Mr. L. E. Wyman for their aid and encouragement.

TARSOMETATARSUS

The series of tarsi is beautifully preserved, and is large enough to cover all probable variations, due to age, sex, or individuality. Variation is great, the range in length including the smallest, and exceeding the largest, Recent tarsi studied. The one locality covers the present size variation of *Bubo* in the whole of North America. Careful study was made and measurements taken of the series as a whole, and of a picked series of thirty-six tarsi from Pit 16.

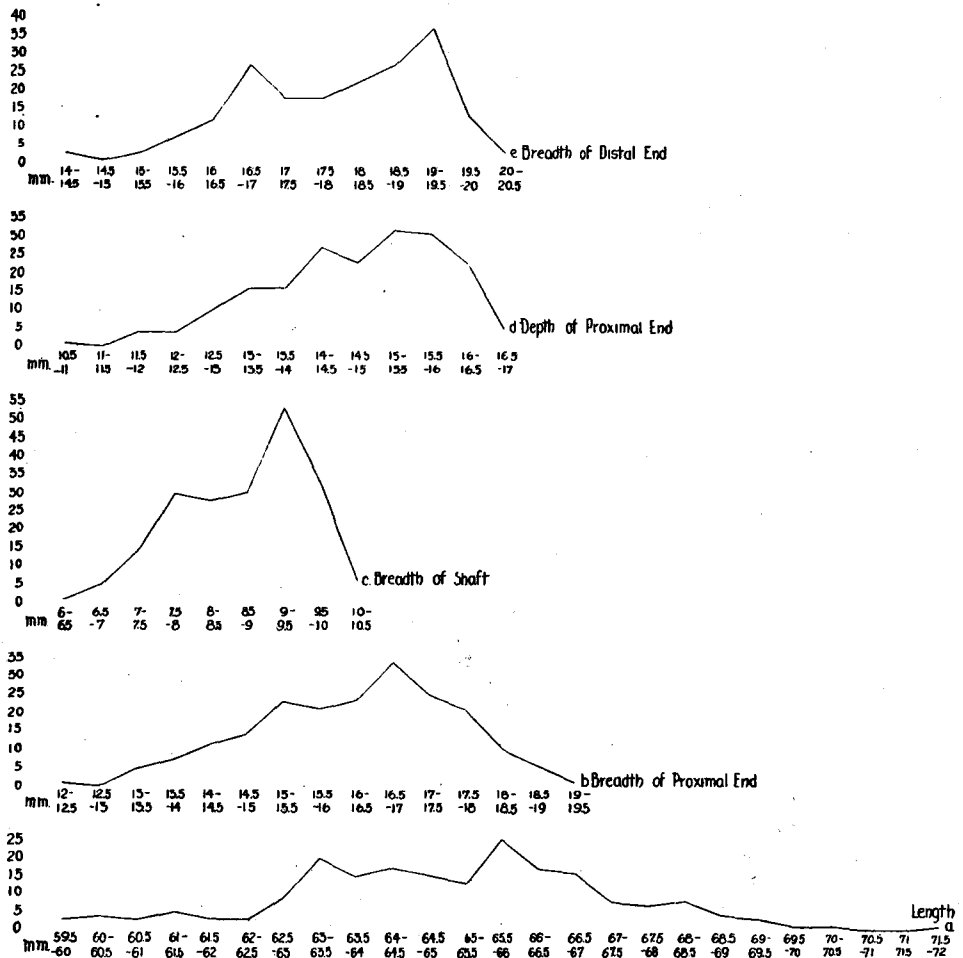


Fig. 55. *Bubo virginianus*. TARSOMETATARSUS. FREQUENCY CURVES OF THE FIVE MEASUREMENTS ON APPROXIMATELY 201 SPECIMENS. THE HORIZONTAL ROWS OF FIGURES REPRESENT THE DIMENSIONS IN MILLIMETERS; WHILE THE VERTICAL ROWS REPRESENT THE ACTUAL NUMBER OF SPECIMENS OF THE VARIOUS SIZES.

The comparative measurements of the latter group are shown in the accompanying graph, fig. 54. The lengths, being arranged in order of increase in size, make this curve a fairly regular one. The other four curves do not follow the length curve, but in general follow one another. This is to be expected, from the fact that length of bone is a character which is apparently determined early in the life of the bird; while stoutness of shaft and diameter of ends vary with age and, perhaps, with sex.

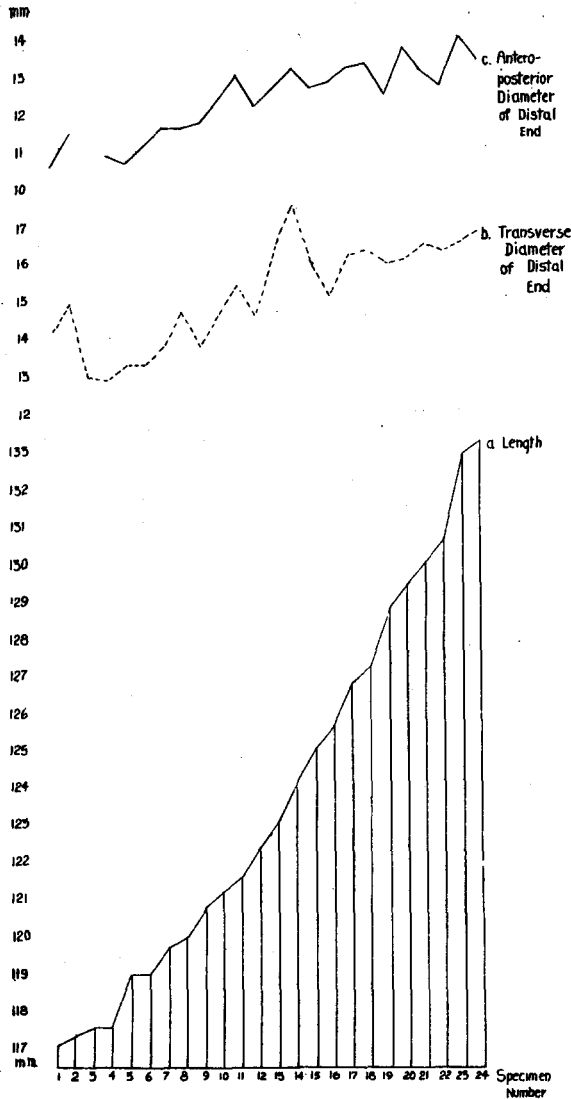


Fig. 56. *Bubo virginianus*. TIBIOTARSUS. GRAPH SHOWING COMPARATIVE MEASUREMENTS OF 24 FOSSIL SPECIMENS. $\times 5$.

Frequency curves were plotted for the five measurements in the series of 201 specimens (see fig. 55). These are interesting in their parallelism. Each curve has its individual characteristics; but each displays two high points, the first being lower than the last. These two apices probably represent the two sexes, the female attaining the greater size.

The following table shows the average length, range of variation, and percentage of variation, prepared from the measurements of the four groups, Recent and fossil, which were studied.

	Fossil 201 specimens	Recent 15 specimens
Average length tarsi	64.96 mm.	62.153 mm.
Range of variation	12.4 mm.	4.466 mm.
Percentage of variation	.1908	.07123

TIBIOTARSUS

As stated above, the series of tibiae is not as extensive as that of tarsi, numbering only 24 perfect specimens. In length there is a considerable variation; but the frequency curve does not show the sex difference as plainly as does the corresponding curve for the tarsi. This character would probably be apparent if the number of specimens were greater.

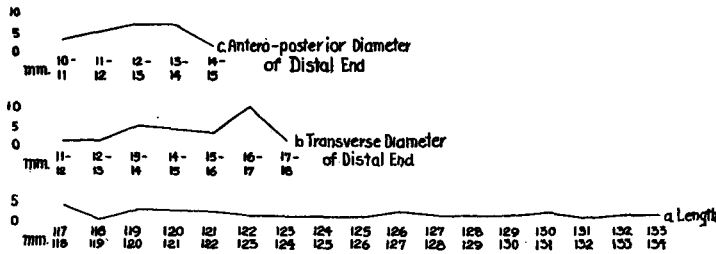


Fig. 57. *Bubo virginianus*. TIBIOTARSUS. FREQUENCY CURVES OF THE THREE MEASUREMENTS ON 24 SPECIMENS. THE HORIZONTAL ROWS OF FIGURES REPRESENT THE DIMENSIONS IN MILLIMETERS; WHILE THE VERTICAL ROWS REPRESENT THE ACTUAL NUMBER OF SPECIMENS OF THE VARIOUS SIZES.

Three measurements of this element were taken, the curves being plotted in the same manner as for the tarsus (see figs. 56, 57). The table of variation, also prepared as for the tarsus, shows a smaller percentage of variation, both for the Recent and fossil groups, than is found for the tarsus.

	Fossil 24 specimens	Recent 21 specimens
Average length tibiae	123.808 mm.	120.326 mm.
Range of variation	16.1 mm.	8.266 mm.
Percentage of variation	.13	.06853

HUMERUS

The series of humeri is the smallest, being represented by only fifteen specimens. In spite of this fact, the length variation is much greater than in the other two elements. This is shown by a comparison of the three tables. The longest fossil specimen exceeds the longest Recent specimen by more than three millimeters, while the smallest is over two millimeters shorter than any Recent one available. The accompanying graph (fig. 58) shows the comparative measurements. The frequency curve was not plotted, being indecisive because the number of specimens is not sufficiently large.

	Fossil 15 specimens	Recent 17 specimens
Average length humeri	129.84 mm.	128.4 mm.
Range of variation	25.4 mm.	12.76 mm.
Percentage of variation	.2033	.0991

COMPARISONS

An interesting comparative study may be made of the length variation in the three elements. The tarsi, with the greatest number of specimens, show the smallest actual variation, only 12.4 mm.; the tibiae have a range of 16.1 mm.; while the

humeri, represented by the smallest number of specimens, have, as stated above, the greatest range, amounting to 25.4 mm. On comparing the percentage of variation between the fossil and Recent groups of a single element, however, it is seen that the variation of the fossil tarsi is approximately three times that of the Recent, while in the case of the tibiae and humeri, the variation is only about twice that of the Recent groups. It would appear, then, that length of leg, particularly of the tarsal segment, is more easily, or at least more frequently, modified than length of wing.

CONCLUSIONS

This detailed survey of a comprehensive group of Rancho La Brea Horned Owls verifies Dr. Miller's original conclusions, as stated in the introduction. The measurements taken, and the graphs and tables which were prepared from them, show clearly that the species at this locality exhibits a greater size variation than the present species displays throughout the whole of its North American range. A possible conclusion is that the fossil form was not only a common stock from which came the present more localized geographic races, but was also generalized and extremely variable. An explanation of this unusual variability, based on our knowledge of climatic effect on the Recent *Bubo*, lies in the change of temperature and moisture which apparently took place at this locality during the long Pleistocene period. If, as is indicated, this change of climate affected the size of the original Rancho La Brea *Bubo*, the large and variable accumulation of their bones, in this formation, must be representative of different stages in the size evolution of the bird.

The genus *Bubo* occurs as early as Eocene and Miocene in both Europe and America; while the species *B. virginianus* is found in the Pleistocene Fossil Lake beds of Oregon. These facts, however, showing the wide distribution of the genus throughout the Tertiary period, do not indicate that this locality was a center of dispersal for the group, as the variability of the fossil form might suggest.

Los Angeles, California, August 21, 1924.

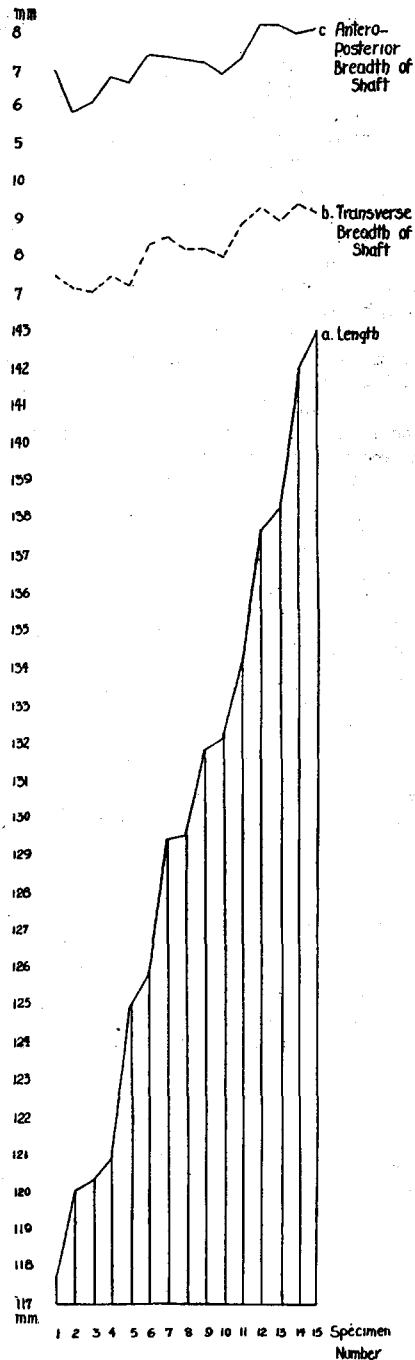


Fig. 58. *Bubo virginianus*. HUMERUS. GRAPH SHOWING COMPARATIVE MEASUREMENTS OF 15 FOSSIL SPECIMENS. X 5.