

The exceptions referred to in the discussions of the two species above pertain to a species of cone in collections of Pinus muricata and of P. attenuata yet seem to be different from the cones of either species. These cones resemble more closely the larger fossil cone than do P. muricata or P. attenuata. Further study should be given to these cones and the trees from which they came to learn whether another species, yet undescribed, is involved.

Pinus muricata Don.

The smallest of the three cones (Figures 17 and 18), found on a mass of matrix excavated from Pit 9, can be assigned without doubt to this species. In every respect, characters of the cone resemble closely many of the modern cones (Figure 19).

The cone is 6.5 cm. long, 7 cm. broad, open; nearly all the scales of the lower portion and ventral side of the cone are present. The topmost scales and several at the tip-end on the dorsal side are missing. The scales on the ventral side have apophyses without umbos. The scales on the dorsal side bear umbos that project upward to a low blunt point. Although the scales show considerable weathering and wear, it is evident in some of the scales that prickles had been present. Three wings, one with the seed intact, and six seeds were found between the scales in the cone.

Occurrence: Rancho La Brea deposits, Pit 9;

no section or depth.

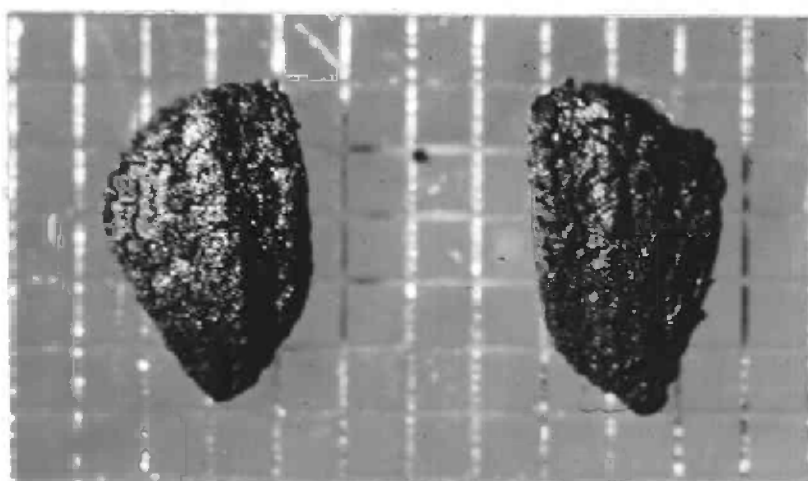
Collection: Los Angeles County Museum, Paleobotany,  
Plesiotype No. PB. 1447 (cone)  
No. PB. 1448 (seeds)



a. Side view of cone.  
Actual Size



b. View of reverse side.  
Actual Size



c. Seeds removed from cone.\*

Figure 17

Pinus muricata Don. (fossil)

\*Each square in grid = 1 sq. mm.





Figure 18

Pinus muricata Don. (fossil)

- a. Scale from near stem end of cone illustrated in Figure 17; view of upper surface showing evidence of prickle.\*
- b. View of lower surface of same scale.\*
- c. Scale from near apex of same cone. 5 x.

\* Each square in grid = 1 sq. mm.

**a****b****c**



a. Side view of open cone.  $2/3$  x.



b. Side view of closed cone.  $2/3$  x.

Figure 19

Pinus muricata Don. (modern)

Pinus masoni var. breaensis n. var.

Two cones were excavated from Pit 9, one at  $12\frac{1}{2}$  feet embedded in socket of elephant scapula and the other was found at 17 feet. Both cones show a tendency toward reflexion of the lower scales toward the stem end.

The larger of the two cones (Figure 20) has nearly all its scales intact, while those of the smaller cone are mostly fragmented on the ventral side and completely denuded to the axis on the dorsal side. The intact scales on the smaller cone appear to be very nearly identical to those in the same position on the larger cone so that one can, with some assurance, assign both cones to the same species.

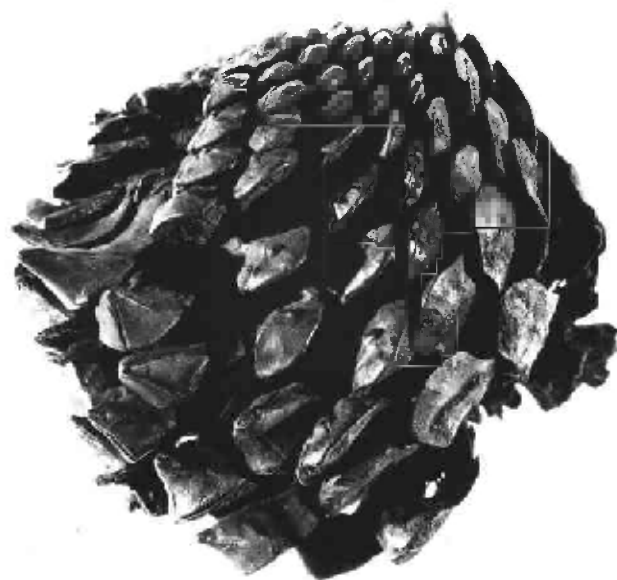
The smaller cone (Figure 21) has about 1/3 of its scales intact. It is about 7.5 cm. in diameter and 8 cm. long. The larger cone, upon which most of this description is based, is 9.5 cm. in diameter and 9.5 cm. long. The cone consists of 13 rows of scales, spiraling clockwise from stem end to apex, and contains approximately 16-18 scales in a row; several of the uppermost scales are missing and the lowermost are broken off; five rows with scales bear pronounced umbos on the dorsal side and eight rows, the majority of which are on the ventral side, have scales with nearly plane apophyses or only slightly raised on those toward the dorsal side. The umbos on the dorsal side are large and heavy, 12-18 mm. broad, 10-12 mm. thick, and projecting upward into a spur-like pyramid, the uppermost being somewhat conical, 9-14 mm. high. The scales on



Figure 20

Pinus masoni var. breaensis n. var.

- a. The larger of two cones found in Pit 9; this one found at depth of  $12\frac{1}{2}$  ft. embedded in socket of elephant scapula. Side view. 1 x.
- b. Top view of same cone showing stem end, the many small scales on ventral side, and conical form of top-most umbos on dorsal side. 1 x.





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Figure 21

Pinus masoni var. breaensis n. var.

- a. Cone, the smaller of the two cones found in Pit 9 at 17-foot depth, showing ventral side with most of scales intact. 1 x.
- b. View of same cone, dorsal side, show scales missing. 1 x.



the ventral side are many, with apophyses that are thin, nearly flat, 5-7 mm. broad in the upper portion to 8-12 mm. broad in the lower portion of the cone. No seeds were found in the cones.

In trying to assign these cones to Pinus muricata or Pinus attenuata, such factors as size of cone, number of rows of scales, number of scales in a row, size of apophyses and of umbos were carefully considered. Although there is a color difference in the cones of the two modern species, this factor could not be used since the fossil specimens are black.

These fossil cones approach the size of the smallest cones of Pinus attenuata and exceed the largest of the cones of Pinus muricata studied. The scales on the ventral side of the fossil cones compare favorably with those on the ventral side of Pinus muricata both in number of scales and size of apophyses. The scales and umbos on the dorsal side of the fossil cone approximate closely those on the dorsal side of Pinus attenuata. Although, in some extreme variations, the apophyses possess enlarged umbos on the dorsal side of Pinus muricata cones, these do not have the massiveness of those in Pinus attenuata and those present in the fossil cone. The fossils resemble very closely the cones of Pinus sp. (Figure 15, a., right) referred to above that appear in collections from La Purissima Ridge, Santa Barbara County, from Mendocino County, and another uncertain locality in California.

Since these fossil cones cannot be referred wholly to modern Pinus muricata or Pinus attenuata I am, for the time being, referring them to Pinus Masoni Dorf, a Pliocene equivalent occurring in deposits along the coast from central to southern California. These Rancho La Brea cones appear to be most clearly related to it, and Dorf (21, p. 71) in his description of Pinus Masoni refers to these cones. Prior to this, Mason seemed to have had some doubt about his own assignment of the Rancho La Brea cones to Pinus muricata (47, p. 50). In all probability, when the cones of Pinus sp. (?) along with the trees producing them are studied, these Rancho La Brea fossil cones can be definitely assigned. In my opinion, specimens of Pinus Masoni described by Dorf appear to resemble more closely the cones of Pinus sp. (?) than they do those of Pinus muricata. Should Pinus sp. (?), when studied, be found to be a relic of Pinus Masoni, it would then extend the paleobotanical range of that fossil species from the lower and upper Pliocene through the Holocene into the modern flora.

Occurrence: Rancho La Brea deposits, Pit 9,

Sect. J-14 at 12 feet, and Sect.

H-13 at 17 feet.

Collection: Los Angeles County Museum, Paleo-

botany, Type No. PB. 1449,

Cotype No. PB. 1450.

CUPRESSACEAE Family

Cupressus L.

The genus Cupressus is represented in the Rancho La Brea flora by a quantity of wood, a tree trunk, by foliage, a single cone, and doubtfully by seeds. The occurrence of this genus in these deposits is of particular interest because of its presence in other Pleistocene floras in California, and because the nearly ten species of Cupressus in California appear in often isolated, discontinuous distribution along the coast.

Part of this material has been reported on from time to time and is variously believed to belong to Cupressus McNabiana (17, p. 10-11 and 25, p. 533), and C. macrocarpa (24, p. 76; 42, p. 85; and 46, p. 156).

Because of the uncertainty of assignment of the Cupressus material to a species, a cross-section was made from one of the large branches on the tree (Figure 3) and sent to United States Department of Agriculture, Forest Products Laboratory, for identification. The results of the very careful study of the anatomy of this wood, and the close comparison and analysis of the wood anatomy of Cupressus macrocarpa, C. Forbesii, Goveniana, C. nevadensis, and C. Sargentii makes it impossible to refer this material to Cupressus macrocarpa Hartw.

Cupressus arizonica var. Hancockii n. var.

The analysis<sup>2</sup> resulted in relating the Rancho La Brea Cupressus to the C. arizonica - C. Benthami - C. lusitanica complex with the wood most nearly resembling that of Cupressus arizonica Greene. Cupressus Forbesii, which occurs in isolated stands in Orange County and San Diego County, California, and could possibly have occurred in the Rancho La Brea area, is considered<sup>3</sup> to be synonymous with C. guadalupensis on the basis of wood anatomy. Greguss' work on wood anatomy (29, p. 94-95) was studied and evaluated on the basis of the species concerned here. The descriptions of these contained distinguishing factors in some cases and overlapping factors in others. As indicated therein, Greguss' did much of his work on young twigs and small branches. Wood in the mature, fully developed part of a trunk differs considerably from that found in small branches and twigs of the same tree. The results he obtained would be entirely different had he used wood from the trunks of trees. Therefore, this work could not be used to resolve the identification of the wood from the trunk of the Rancho La Brea tree.

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<sup>2</sup> Analysis done by Dr. B. Francis Kukachka, Technologist, United States Department of Agriculture, Forest Products Laboratory, Madison, Wisconsin.

<sup>3</sup> Kukachka, B. Francis, correspondence.

Cupressus arizonica var. Hancockii n. var. was located in Pit 3 (Figure 22). The top of the trunk of the tree was encountered at  $4\frac{1}{2}$  feet below the surface with its roots in situ in a clay bank about 12 feet below the surface (see p. 14-18). It is about eight feet tall, has several large, heavy roots extending outward at right angles from the base of the trunk, and one very large lateral branch 3 feet  $9\frac{1}{2}$  inches long extending almost horizontally from the main trunk. The trunk has a circumference of 51 inches at the base, and at 3 feet 2 inches above the base and 12 inches below the crotch it has a circumference of 54 inches. The lateral branch is 44 inches at the crotch and the upright portion of the trunk just above the crotch is  $28\frac{1}{2}$  inches in circumference. There is evidence that several somewhat smaller branches had been broken or cut from the parts of the tree above the crotch. From one such broken branch on the large lateral branch and near the crotch, a cross section was made and used for identification. At this point, the lateral branch has an oblique circumference of 28 inches. The upright portion of the trunk extends 3 feet 3 inches above the crotch. One large root that had been cut off near the base has a diameter of 5 inches; another has a circumference of 20 inches at the base of the trunk, is 3 feet 19 inches long, and has a circumference of approximately 14 inches near the broken end.

A cone of Cupressus (Figure 23) was found on a mass of





Figure 22

Cupressus arizonica var. Hancockii n. var.

Tree after it was excavated from  
a depth of 12 feet in Pit 3. Only  
a portion of its heavy roots are  
shown.



excavated matrix from Pit 16, therefore no depth can be given. The cone is considerably worn and much compressed laterally, 3 cm. in diameter in its compressed condition and 2.5 cm. high. It has about seven scales, the umbos of which are so badly worn and/or weathered as to make any identifying characteristics indistinct.

Knowlton (32, p. 85) first identified this cone as Cupressus macrocarpa Hartw. Later, Mason (46, p. 156) and Frost (24, p. 76-77) assigned it to C. macrocarpa but Mason did so with reservation saying "the reference of this cone to C. macrocarpa is open to question." In its compressed state, its size falls within the range of the smallest of the C. macrocarpa cones, and within the range of the largest of the C. arizonica cones. It is difficult to estimate the undistorted dimensions, but it seems probable that it could have been 5-7 mm. smaller in diameter and greater in height. If this is true, then the size of this cone is well within the average size of C. arizonica. The modern Cupressus arizonica cones (Figure 24) have 6-8 scales and those of C. macrocarpa (Figure 25) have 8-12 scales. Since the Rancho La Brea cone has only about 7 scales, this would exclude it from assigning it to C. macrocarpa.

As it has been established that the tree in the Pleistocene deposits of Rancho La Brea belongs near Cupressus arizonica, it appears also that the cone may belong to the same species. It is difficult to refer this single cone to a definite species because of the

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Figure 23

Cupressus arizonica var. Hancockii n. var.

- a. Worn, compressed cone found in matrix removed from Pit 16. 1.5 x.
- b. View of same cone, reverse side. 1.5 x.

Figure 24

Cupressus arizonica Greene

- a. Cone, side view. 1 x.
- b. Top view of same cone. 1 x.
- c. Stem end view of same cone. 1 x.

Figure 25

Cupressus macrocarpa Hartw.

- a. Cone, side view. 1 x.
- b. Top view of same cone. 1 x.
- c. Stem end view of same cone. 1 x.

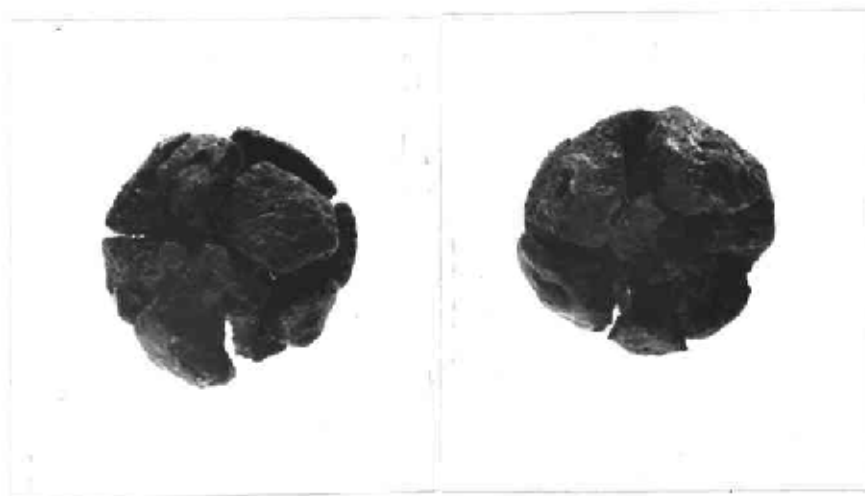


Figure 23



Figure 24

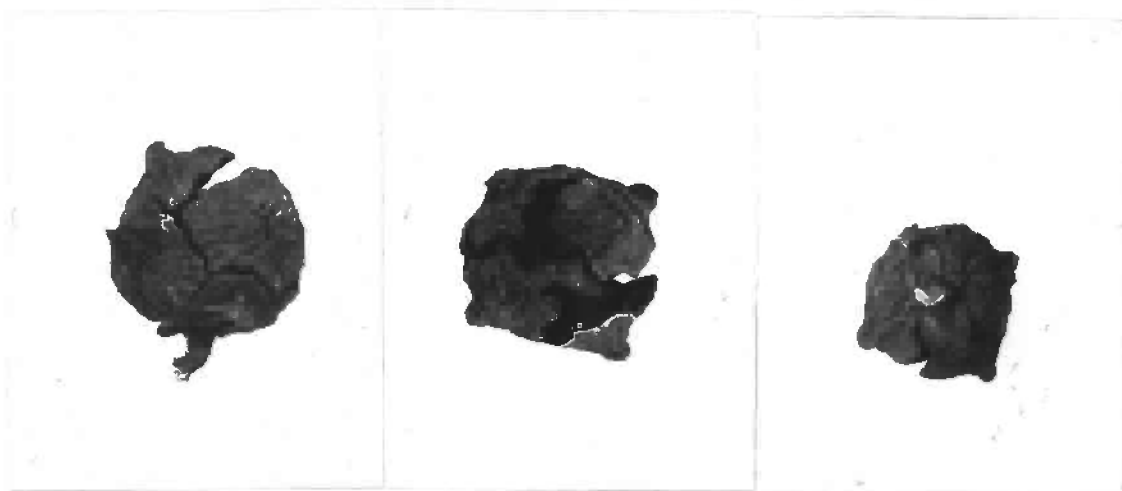


Figure 25

range of variation in the cones of each species under consideration.

Cupressus macrocarpa is presently an endemic species on the Monterey Peninsula, about 332 miles north of the Rancho La Brea deposits, where it is restricted to coastal bluffs, never more than a few hundred feet from the sea. Cupressus arizonica ranges from central to eastern and southern Arizona, across New Mexico to the Chisos Mountains, Brewster County, Texas, thence south to Chihuahua, Mexico. The stand of this species nearest the Rancho La Brea deposits is at Payson, Arizona, a distance of approximately 485 miles. Until the whole fossil flora of the Rancho La Brea deposits is identified and the climatic requirements known for the species involved, one cannot be certain what the climate was like at the time of the deposition of Cupressus and whether the climate at that time came within the tolerance of both species.

Occurrence: Rancho La Brea deposits; tree, Pit 3,  
Sect. D-2, at  $12\frac{1}{2}$  feet; cone, Pit 16,  
on top of matrix excavated from pit.

Collection: Los Angeles County Museum, Paleobotany; tree, Holotype PB. 1466, cone,  
Holotype PB. 1467.

Juniperus L.

Foliage, twigs, berries, and seeds of Juniperus are the most numerous specimens occurring in the material extracted from the matrices of the Rancho La Brea deposits. Of this



material, only the fruits and seeds were studied. Among these there seemed to be two species, one having large seeds and one having small seeds.

In order to identify these or determine their close relative, it was first necessary to study the fruits and seeds of the modern species. There are only about four species of Juniperus in the modern flora of California. Since the small Juniperus seeds did not resemble any of the California species, 22 other species outside of California were studied as well.

The source of most of the modern Juniperus fruits was specimens in the herbarium at the University of California. In most cases only specimens bearing mature berries were sampled, however if specimens contained abundant fruit, samples were taken of the largest, medium, and small-sized berries. In addition to herbarium specimens, stands of Juniperus californica and J. occidentalis in southern California were studied and the berries collected.

Since there appeared to be a great abundance of the small Juniperus seeds and a number of the small berries in the fossil deposits, particular attention was given to the collection of small berries in the field. It was necessary to determine whether these were immature seeds or were from diminutive forms of large seeded species. Also, almost all of the small fossil Juniperus seeds had a number of deep pits and grooves mainly at the base of each seed

which were believed due to shrinkage in undeveloped seeds. Chaney and Mason (13, p. 58), in reporting the occurrence of Juniperus californica in the Carpenteria deposits, noted that "some were of normal size and shape, while others are smaller and more deeply ridged representing immature fruits."

Another purpose in making quantitative collections of berries of Juniperus californica was to determine the number of seeds in a berry. Because there are diverse opinions (1, p. 75-76), (40, p. 59), (58, p. 63) as to whether the berries of J. californica and J. occidentalis are 1-2, 1-3, 2-3, or 1 seeded. I undertook population studies of several stands of Juniperus californica<sup>4</sup> to determine what the case may be; also, because of the variety of form of the large seeded fossil specimens, to determine whether one or both of these species were involved. This study proved conclusively that the large Juniperus seeds in the Rancho La Brea deposits belonged to the one species, J. californica. This study also showed that the small fossil Juniperus seeds did not belong to this species.

Since the berries of the modern Juniperus were hard and dry, they were softened in hot water. The pulp was then carefully removed, the number and position of the seeds contained in each berry, and other morphological features were carefully noted.

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<sup>4</sup> Paper to be published on this and other species of Juniperus.

In the soaking process, immature seeds of J. californica about half the mature size would disintegrate. While removing the pulp of still other species, occasionally seeds were encountered that were almost, but not quite, mature. In Figure 30, a., which shows one such example, it will be noted that the seed was stony at the base, while the upper part was soft. In some species the reverse was true, i. e., the tops of the seeds were hard and the bottom soft. In most instances, the soft part would disintegrate in the soaking process. Immature seeds, therefore, cannot account for the small fossil Juniperus seeds nor are the grooves and pits found in them caused by shrinkage.

This study revealed the fact that the berries of most species of Juniperus contained resin sacs. These occur either in the pulp or closely adhere to the seeds. These resin sacs, in most cases, are narrowly elliptical and, when found closely appressed to the stony seed, cause small grooves and pits where the sacs are embedded. This accounted for the pits and grooves in the fossil seeds.

In the modern species of Juniperus mentioned above, it was found that berries of some species contained only one seed, while those of other species contained 2, 2-3, 4, up to as many as 12 seeds. Certain species had resin sacs scattered in the pulp of the berry, while in most of them the resin sacs were appressed to the seeds forming depressions in the stony surface. It is now possible

to identify with certainty the large Juniperus seeds with those of the modern Juniperus californica, and relate the small Juniperus seeds to a species no longer occurring in the modern flora of California.

Juniperus californica Carr.

In Frost's paper (24, p. 77) Juniperus californica var. breaensis Frost was described, based upon anatomical studies of wood from the Rancho La Brea deposits. He illustrated six seeds attributed to the new variety. However, the seeds shown appear unlike those we have from these deposits. There is no trace of Frost's material and it is impossible to make any comparisons.

There were approximately 170 seeds of Juniperus californica (Figure 26) separated from matrix of two pits. No berries occurred that could be assigned to this species. The seeds are generally broadly ovate, 7-9 mm. long, 5 mm. wide, convex on one side and variously 2-angled to plane on the other; shallow longitudinal grooves or pits are present on the convex surface and occasionally, faintly, on the opposite surface. A light impression of the scale may be seen occasionally at the base of the seed on the dorsal side. These seeds are so nearly identical to the modern seeds (Figure 27) of this species that no varietal name is assigned to this material.

Modern Juniperus californica occurs in the western edge of the Colorado Desert, then north to the west slopes of the Sierra Nevada mountains in Tulare and Kern Counties interior cismontane



Figure 26

Juniperus californica Carr.

- a. Three seeds from Pit. 3, Sect. D-2, at  $11\frac{1}{2}$  feet, showing the ventral side (upper) and dorsal side (lower).
- b. Five seeds from Pit A, showing the dorsal side in most of them.

(Scale: 1 square in grid = 1 sq. mm.)

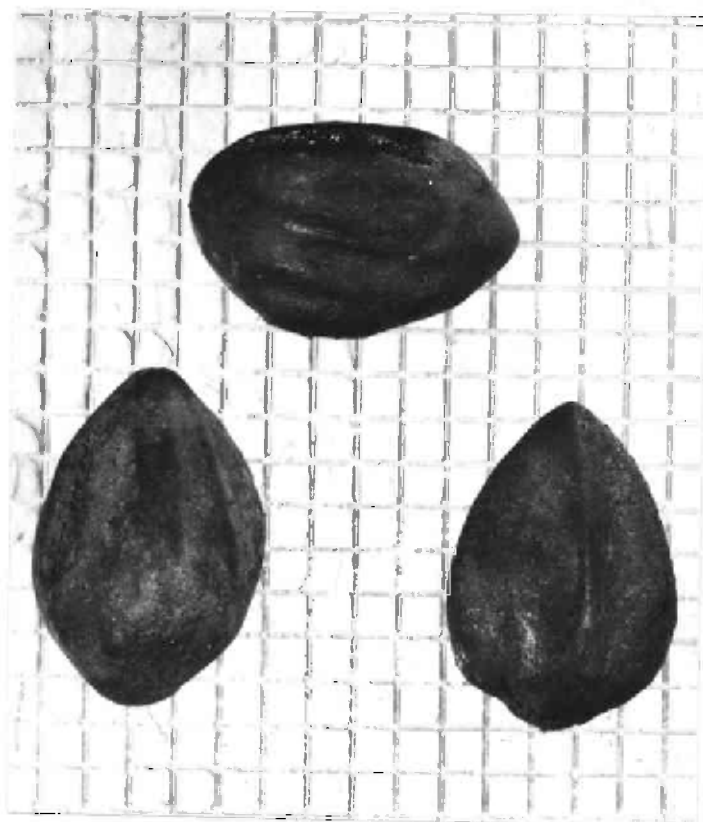




Figure 27

Juniperus californica Carr. (modern)

Seeds from a 3-seeded berry showing dorsal side (lower left) and ventral sides (upper, and lower right). Resin sac may be seen still attached to the ventral side (upper center).

(Scale: 1 square in grid = 1 sq. mm.)



southern California, approaching the coast at the Santa Lucia Mountains in San Luis Obispo County.

Only the southern California localities of specimens studied are charted on Map No. 1. It can be seen that Juniperus californica does not occur today near the area of the deposit. No record of it in the Santa Monica Mountains has been found. The elevation of the terrain between the Los Angeles River and the Rancho La Brea deposits is such that the Juniperus seeds could not have been brought down from the San Gabriel Mountains and carried into the area by the river or flood waters. Therefore, it is believed that Juniperus californica occurred, perhaps sparingly, in the Santa Monica Mountains to the north of the Rancho La Brea deposits.

Occurrence: Rancho La Brea deposits; Pit 3, Sect. D-2  
at depth of  $11\frac{1}{2}$  feet, Pit A, no depth given.

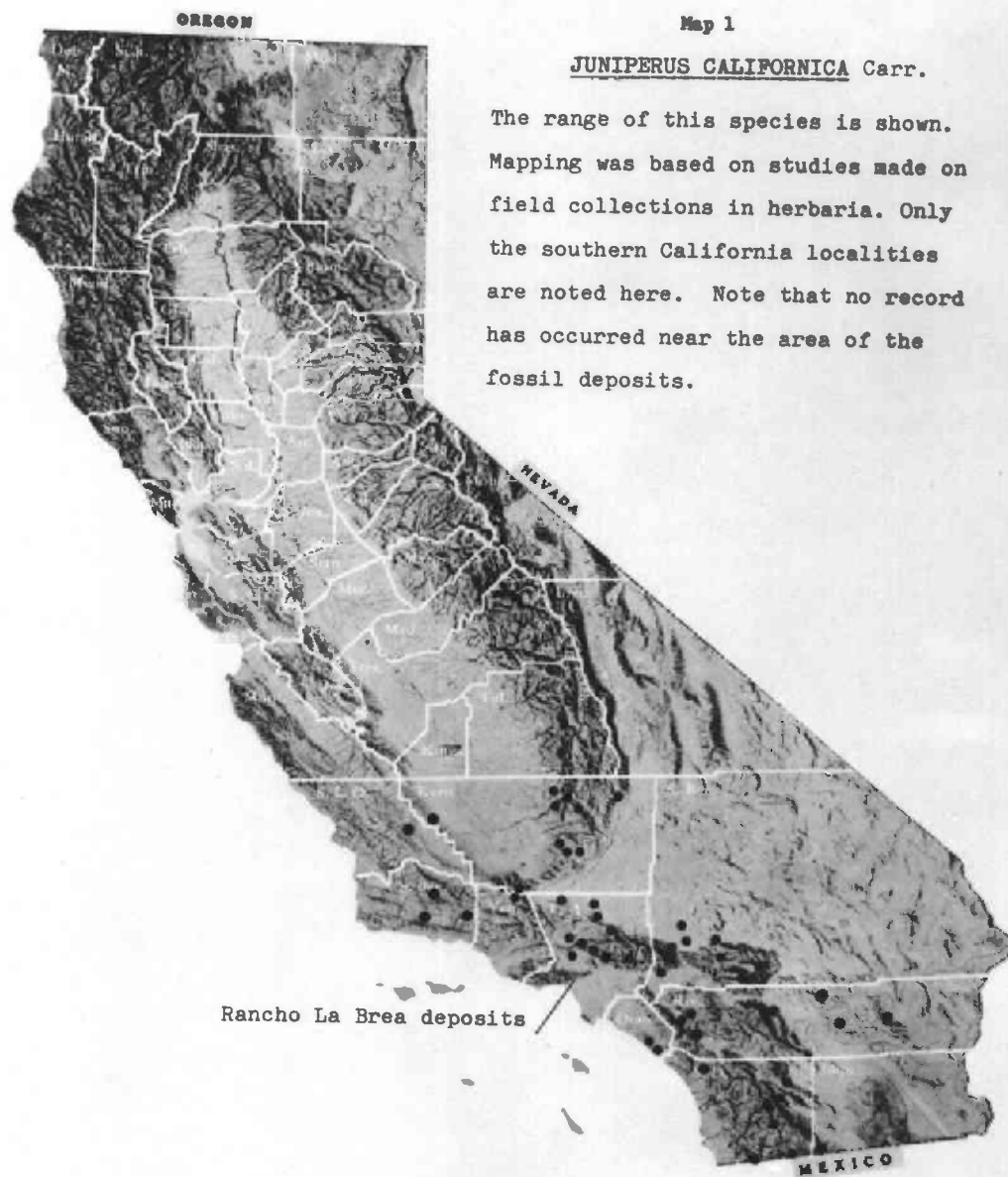
Collection: Los Angeles County Museum, Paleobotany,  
Plesiotype No. PB. 1442; PB. 1468.

Juniperus Hanseni n. sp.

Nearly 1,000 small Juniperus seeds and a number of berries were separated from the matrices removed from inside of sabretooth skulls from several pits. The majority of these seeds occurred in Pit A, while others occurred in Pits 3, 4, 9, 13, 60, 67, 77, and 101.

The seeds (Figure 28, c. and d.; Figure 29, a.) are 3.5 - 4.0 mm. long and 2.5 - 3.0 mm. wide, ovate with rounded base, and

## MAP OF CALIFORNIA



almost acute apex. The resin pits or grooves appear most often near the base of the seeds where they are somewhat oval in form and deeper than those having a more elliptical form. The longer grooves are shallow, slightly elliptical and often appear toward the apex of the seeds.

The berries (Figure 28, a. and b.; Figure 29, b. and c.) are oval to orbicular and contain either one or two seeds; the pulp is badly mascerated in several of these, exposing the one or two seeds in place. In several instances, a small portion of stem with several scale leaves is still attached. The berries ranged in size from 2 mm. in diameter by 4 mm. long in the oval ones to 3.5 - 4.0 mm. in diameter in the orbicular ones.

Of the 22 species of Juniperus studied, the following species came near the fossils in one or more characters in the berry and/or seeds: J. Ashei, J. Barbadensis, J. mexicana, and J. tetragona. Juniperus tetragona was eliminated from consideration because most of the berries contain four seeds. The berries of the following three species contain 1-2 seeds. J. Ashei (Figure 30, a. and b.) does not resemble the fossil seeds as nearly as the remaining two species, for its resin sacs are mostly scattered in the pulp and not appressed to the seeds and no depressions are apparent. J. Barbadensis (Figure 30, c. and d.) and J. mexicana come near to the fossil material both in berries and seeds, except that the berries of J.



Figure 28

Juniperus Hanseni n. sp.

- a. Two berries, one showing two seeds intact.
- b. Two berries with short stems attached; scales leaves still remain on berry at left.
- c. & d. Two views of several seeds, showing various pits and grooves.

All material from Pit A.

(Scale: 1 square in grid = 1 sq. mm.)





Figure 29

Juniperus Hanseni n. sp.

- a. Various seeds from Pit 67, showing depressions where resin sacs may have occurred.
- b. Two berries from Pit 67; one with nearly all the pulp missing, showing it to be a one-seeded berry; the other, a berry complete with stem and scale leaves attached.
- c. Two berries from Pit 4; one complete and the other with part of pulp missing, showing it to be a one-seeded berry.

(Scale: 1 square in grid = 1 sq. mm.)



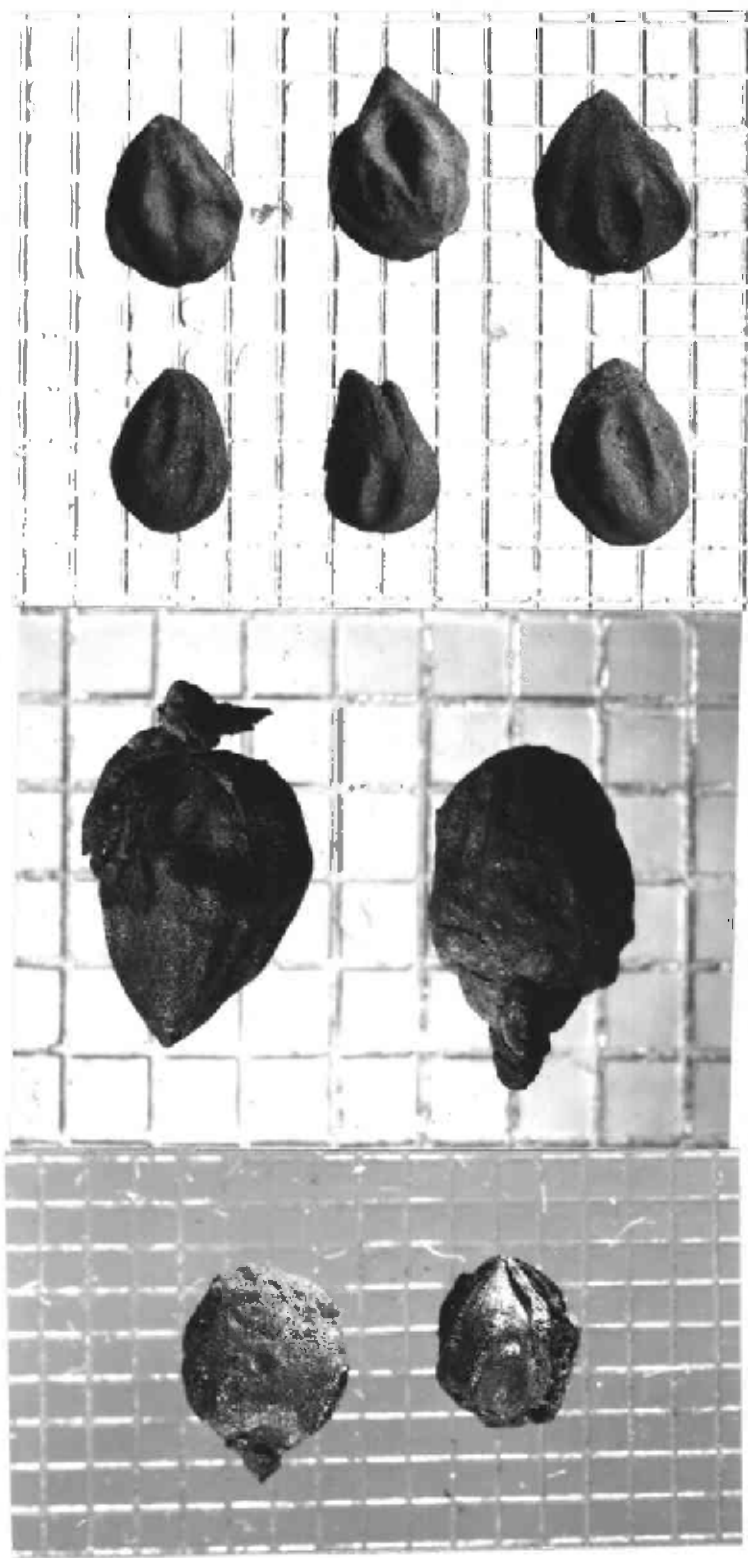


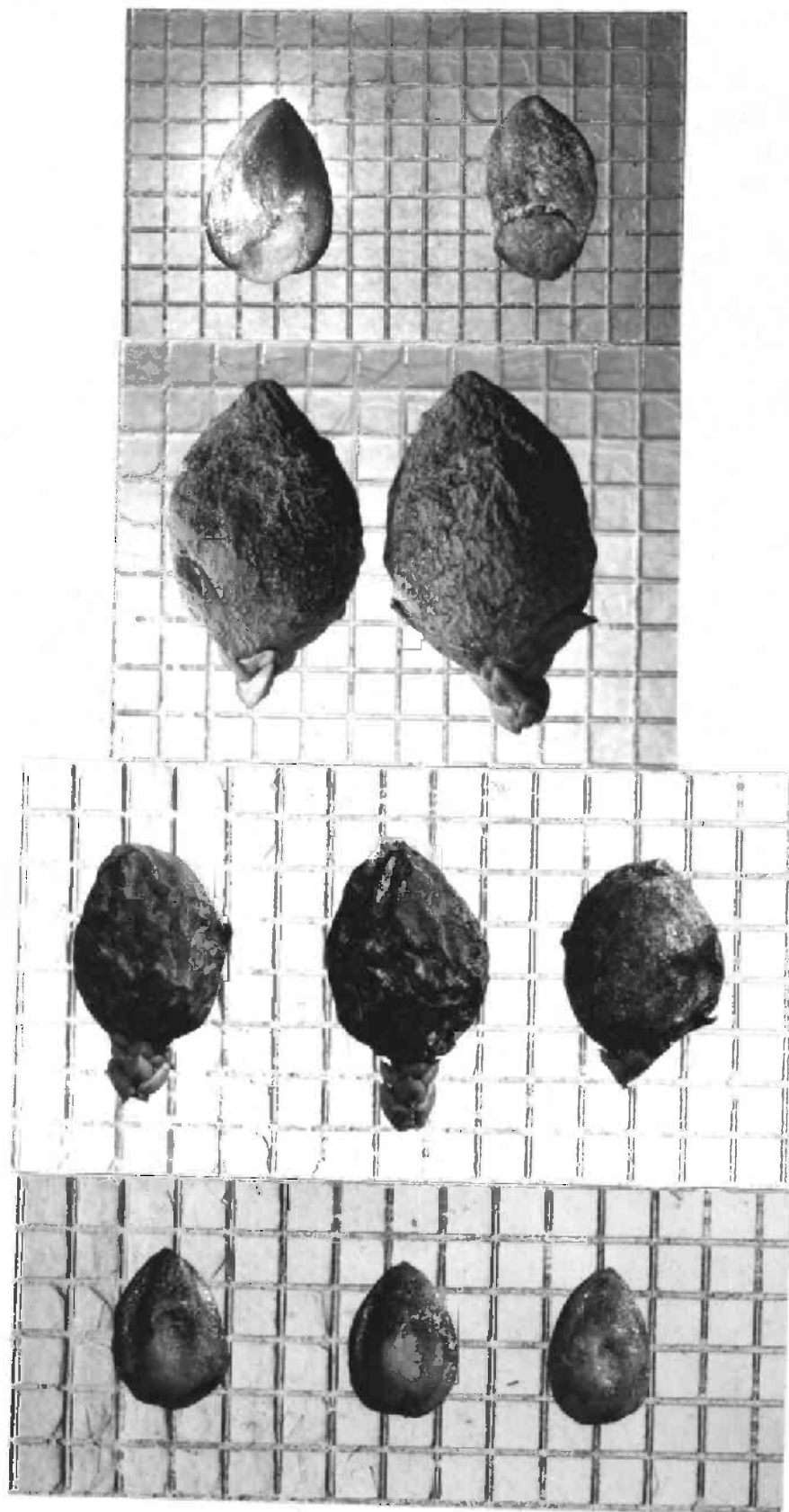


Figure 30

Part of the modern species of Juniperus used in comparison with the small-seeded fossil Juniperus.

- a. Seeds of Juniperus Ashei; the seed on the right is immature and almost disintegrated during the process of softening the berry.
- b. Berries of Juniperus Ashei; these appeared too large and otherwise do not compare closely with the fossils.
- c. Berries of Juniperus Barbadensis; appear to be very near to the fossils.
- d. Seeds of Juniperus Barbadensis; like the berries of this species, they resemble those of the fossils.

(Scale: 1 square in grid = 1 sq. mm.)



mexicana (Figure 31, a. and b.) are much larger than those of the fossil. Whether shrinkage would account for this difference is questionable since in normal drying the modern berries are considerably reduced in size.

Juniperus mexicana occurs from central Texas where it covers low limestone hills, south nearly throughout Mexico. Juniperus Barbadensis occurs along coastal swamps, river swamps, streams and creek margin, from eastern and south-eastern Texas east across the southern United States to Jamaica.

Since, from the limited material available for comparison, the small fossil Juniperus fruit and seeds appear to resemble more closely those of Juniperus Barbadensis than J. mexicana, one may suppose that either J. Barbadensis or a relic of it occurred in the Rancho La Brea area at the time of deposition and has since become extinct. Certainly the ecological conditions characteristic of the present range of J. Barbadensis may well have occurred in this area during the Pleistocene. Reports from about 200 years ago show that springs and streams occurred in the immediate area of the deposits and early residents in the Los Angeles area still remember bogs and marshes in a number of places in the vicinity not too many years ago.

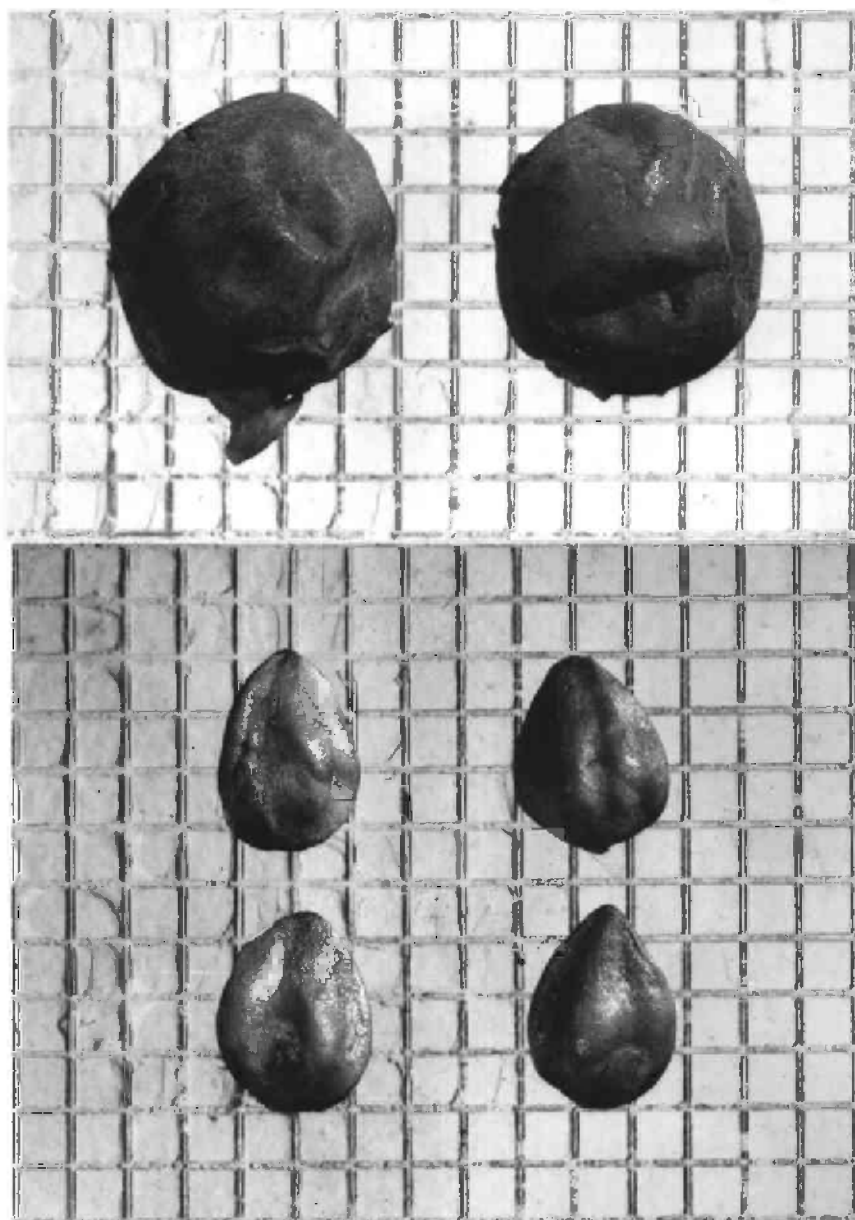
Occurrence: Rancho La Brea deposits; Pit A, no depth given; Pit 3, D-2 at  $11\frac{1}{2}$  foot depth; Pit 4



Figure 31

Berries and seeds of Juniperus mexicana.  
The seeds appear to resemble those of the  
fossils in form and size but lack the pits  
at the base of the seeds. The berries are  
somewhat larger than the fossils.

(Scale: 1 square in grid = 1 sq. mm.)





in B-4 at 14 feet; Pit 9, no data; Pit 13,  
in F-11 at  $11\frac{1}{2}$  feet; Pit 60, in D-10 at 12  
feet; Pit 67, in D and C-8, at 16 to 18-  
foot depth; Pit 77, in F-10 to 12 feet; Pit  
101, in 3-E at 6 feet.

Collection: Los Angeles County Museum, Paleobotany,  
Type No. PB. 1469, Type No. PB. 1470,  
Type No. PB. 1471, and Cotype Nos. 1472  
to 1480.

#### IRIDACEAE Family

##### Sisyrinchium

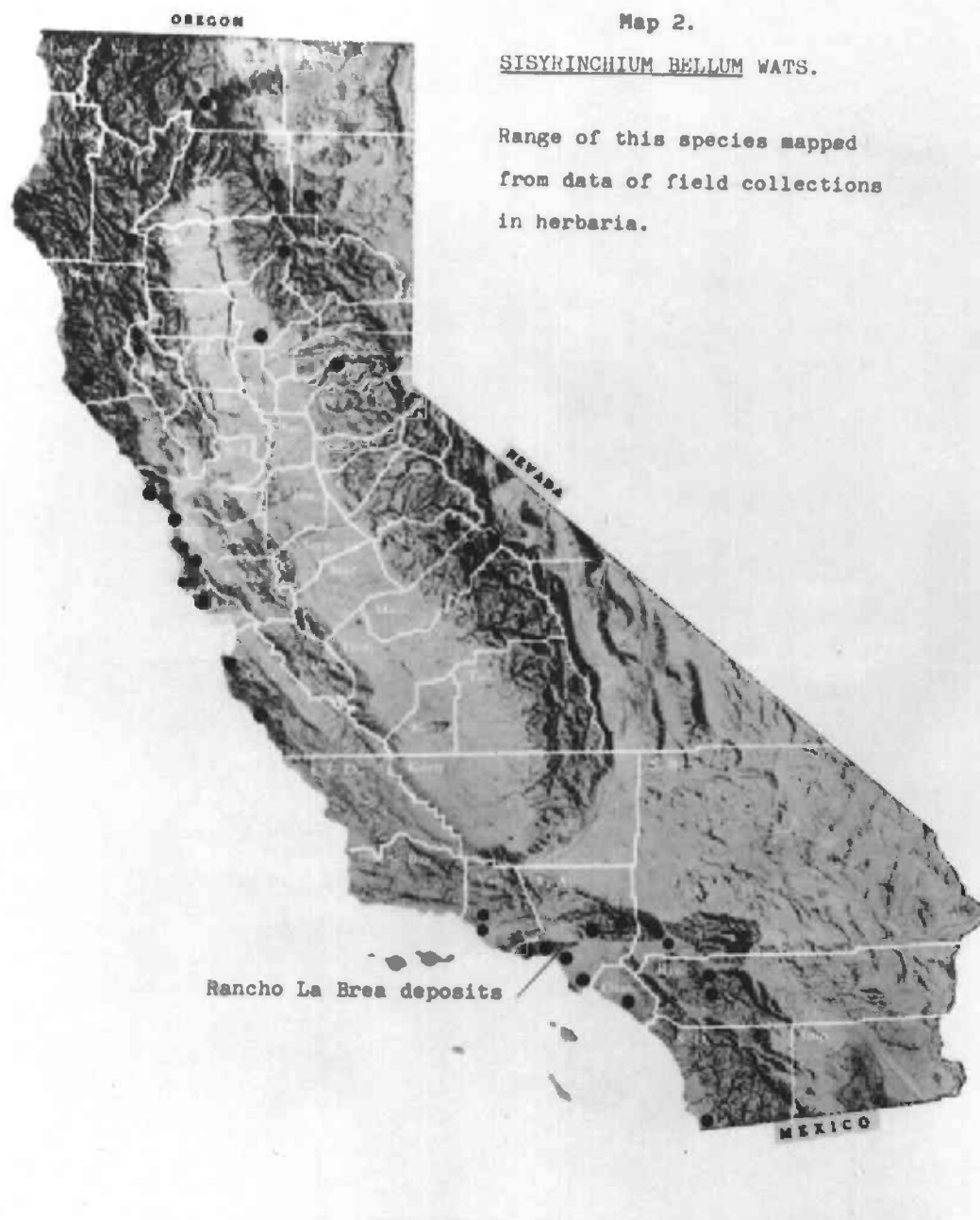
Seeds of Sisyrinchium occurred in several of  
Rancho La Brea deposits. This genus is represented in the modern  
flora of California by the following species:

Sisyrinchium bellum  
Sisyrinchium californicum  
Sisyrinchium Douglasii

Sisyrinchium Elmeri  
Sisyrinchium halophilum  
Sisyrinchium idahoense

Five of these species occur mainly from central California  
northward and two of these extend into the high mountain areas in  
southern California. These latter are remote from the site and it  
seems improbable that they could have been deposited at Rancho La  
Brea. One species, Sisyrinchium bellum, which is exceedingly  
variable, is widely distributed and does occur fairly close to the site  
(Map No. 2).

## MAP OF CALIFORNIA



Sisyrinchium bellum Wats.

Modern seeds of this and other species in the genus were studied and compared to the fossil material. The fossil seeds (Figure 32) resemble almost exactly in form, size, and pattern on the seed-coat those of the modern seeds of Sisyrinchium bellum (Figure 33). Except for some masceration of the seed-coat and evidence of tar impregnation in the fossil material, there appear no observable difference.

In the modern flora of California, Sisyrinchium bellum inhabits open grassy places below 3,000 feet. Although widely distributed, it occurs principally near the coast. The plants appear more abundantly during the wet, rainy seasons, and disappear during periods of drought.

Five seeds were found in Pit 67 and six seeds in Pit A. The seeds are almost spherical 1 mm. to 1.5 mm. in diameter. Every seed has retained all or part of the seedcoat showing a minutely pitted surface.

Occurrence: Pit 67, C-8 at 16 feet; Pit A, no depth given.

Collection: Los Angeles County Museum, Paleobotany, Plesiotype No. PB .1451 and Cotype No. PB. 1452.



Figure 32

a. Sisyrinchium bellum Wats. (fossil)

Seeds extracted from matrix removed  
from inside of sabre-tooth skull in Pit  
67, Sect. C-8 at 16 ft.

b. Sisyrinchium bellum Wats. (fossil)

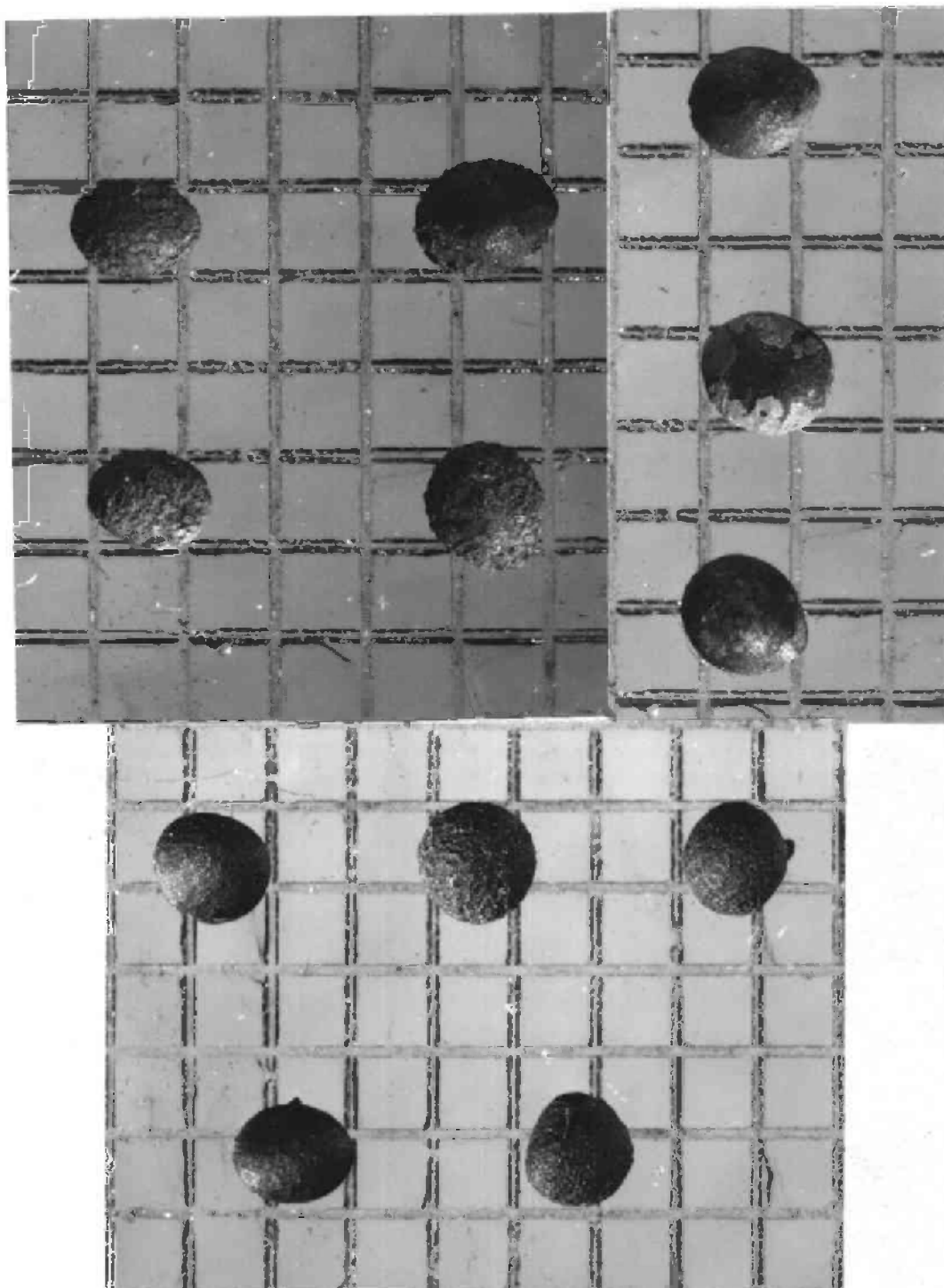
Seeds extracted from Pit A matrix;  
no depth given.

Figure 33

Sisyrinchium bellum Wats.

Seeds of the modern species.

(Scale: 1 square in grid = 1 sq. mm.)



FAGACEAE FamilyQuercus L.

Several species are represented by quantities of acorn cups, acorns, and leaf fragments. Frost (24, p. 81-82) reported the occurrence of Quercus agrifolia in the deposits, and based his determination on wood, acorns and cups, and leaves.

The species of Quercus occurring in the modern flora of southern California were studied and compared with the fossil material. Munz (58, p. 902-907) lists 16 species. All but two species, exclusive of varieties, occur either in the vicinity of these fossil deposits or sufficiently near to be considered as having possibly grown here during Pleistocene time. The following species without doubt, occurred here or in the vicinity during the time deposition was taking place.

Quercus agrifolia Née.

Frost (24, p. 81-82) listed Quercus agrifolia Née species and based his determination on analysis of the anatomy of wood, leaves, acorns and an acorn cup.

A number of acorns and acorn fragments have been separated from material from Pits A, 3, and 4, a part of which can be assigned to this species. Figure 34 shows an acorn believed to be this species that had been infested by insects. Map 3 shows the distribution of Quercus agrifolia charted from data on herbarium specimens studied of this species.



Figure 34

Quercus agrifolia Nee.

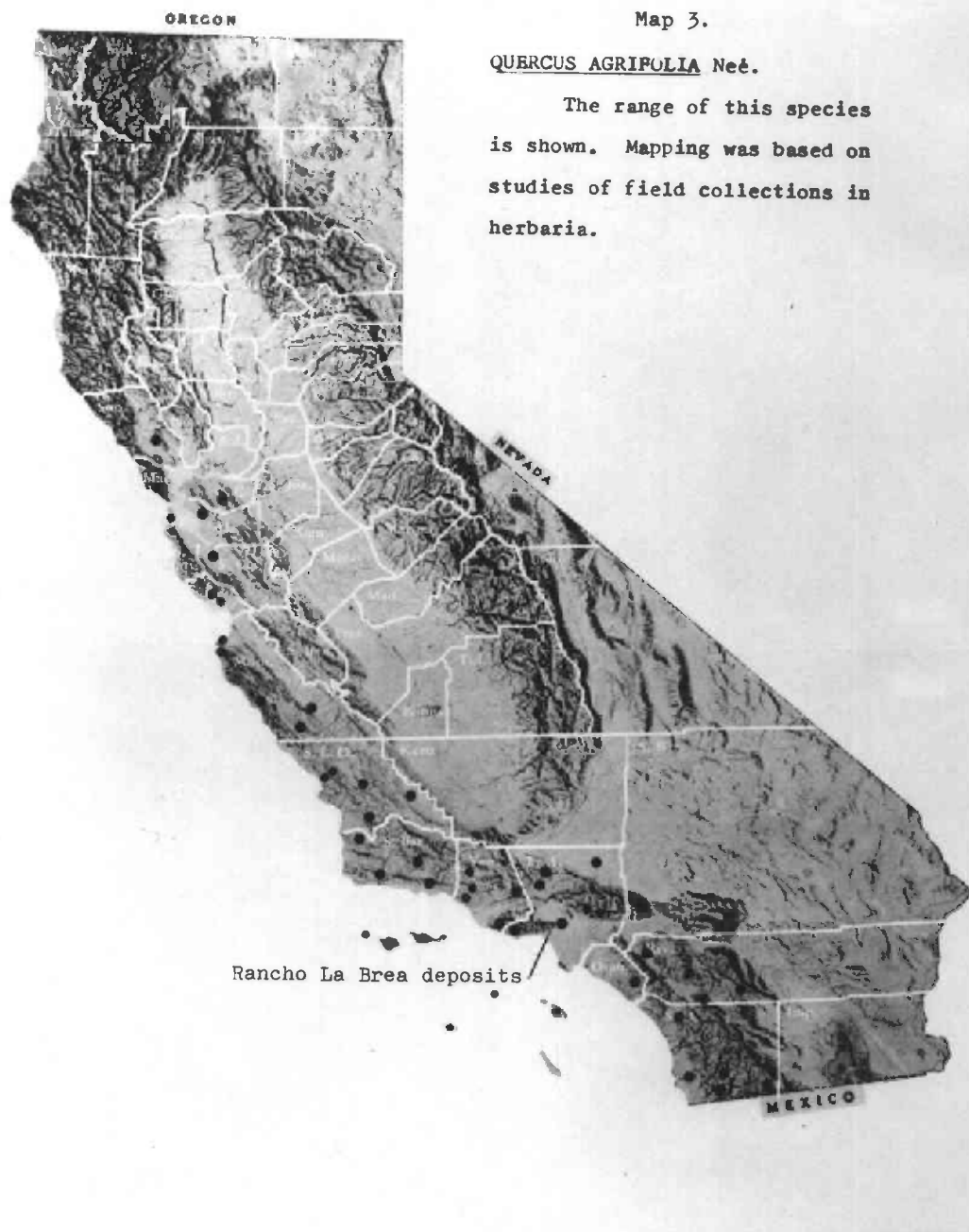
(fossil)

Acorn, without cup, showing insect infestation; excavated from Pit A. No depth given.

(Scale: 1 square in grid = 1 sq. mm.)



## MAP OF CALIFORNIA



Occurrence: Rancho La Brea deposits, Pit A, no data  
of depth given.

Collection: Los Angeles County Museum, Paleobotany,  
Plesiotype No. PB. 1481.

Quercus dumosa Nutt.

Several fragmented acorns and a number of quite immature acorns with cups appear to belong to this species. These were separated from matrix in Pit A and Pit 3.

It is difficult to assign this material to a definite species, but careful study of the young and mature material of this species makes it possible to assign the young acorns (Figure 35) and the acorns without the cups attached (Figure 36) to this species. The modern young acorns and the mature acorn without a cup attached (Figure 37) resemble very closely the fossils.

Quercus dumosa is a common component of the chaparral flora in the Santa Monica Mountains and other mountain areas in southern California. It generally occurs on dry slopes below 5,000 feet, and ranges through cismontane southern California, along the western base of the Sierra Nevada, and in the North Coast Ranges (Map 4).

Occurrence: Rancho La Brea deposits, Pit A, no  
depth given; Pit 3, Sect. C-4 at 6  $\frac{1}{2}$  feet.

Collection: Los Angeles County Museum, Paleobotany, Plesiotypes Nos. PB. 1482,

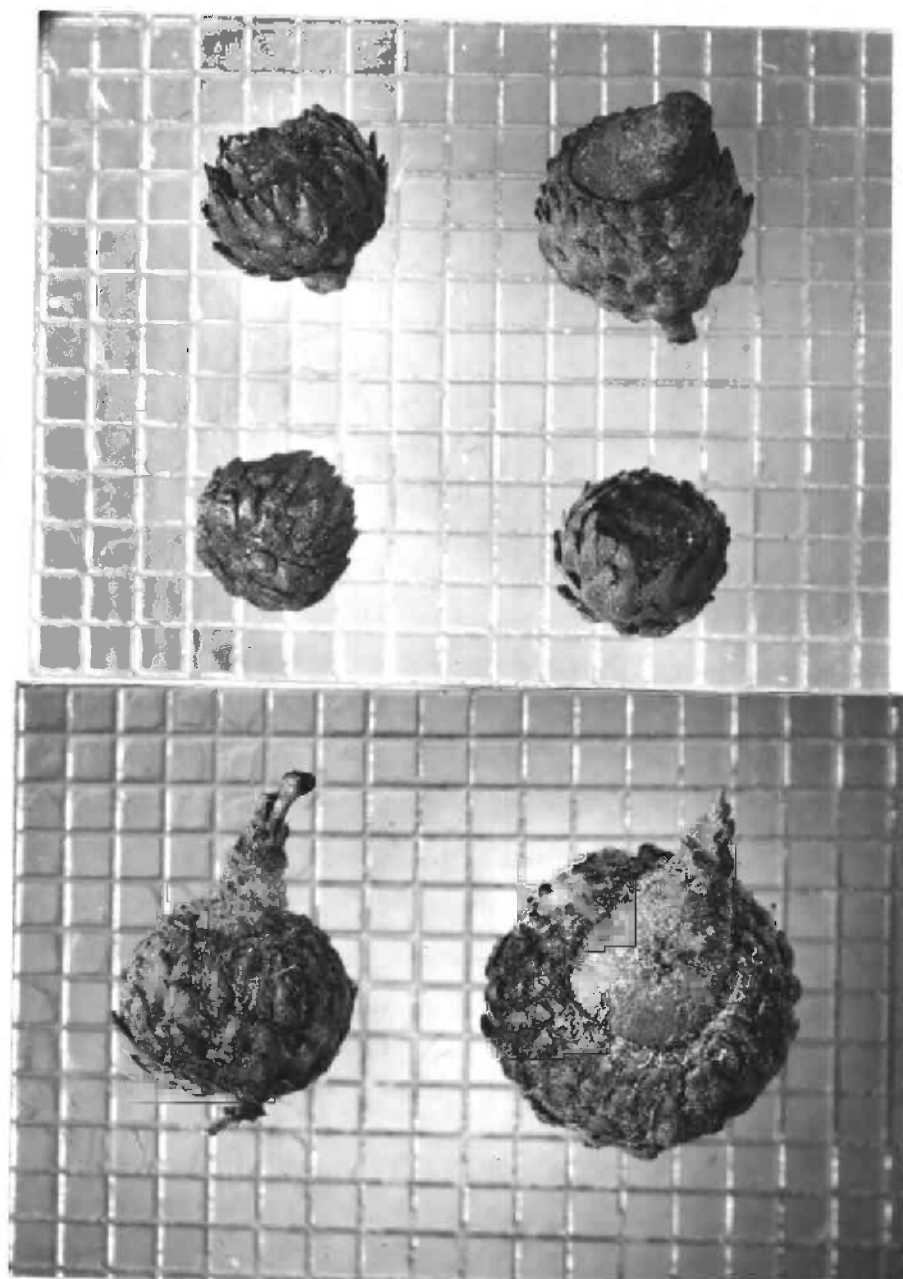


Figure 35

Quercus dumosa Nutt.

- a. Fossil young acorn cups from Pit 3.
- b. Modern acorn cups of about the same size showing similarity to those found in Pit 3.

(Scale: 1 square in grid = 1 sq. mm.)



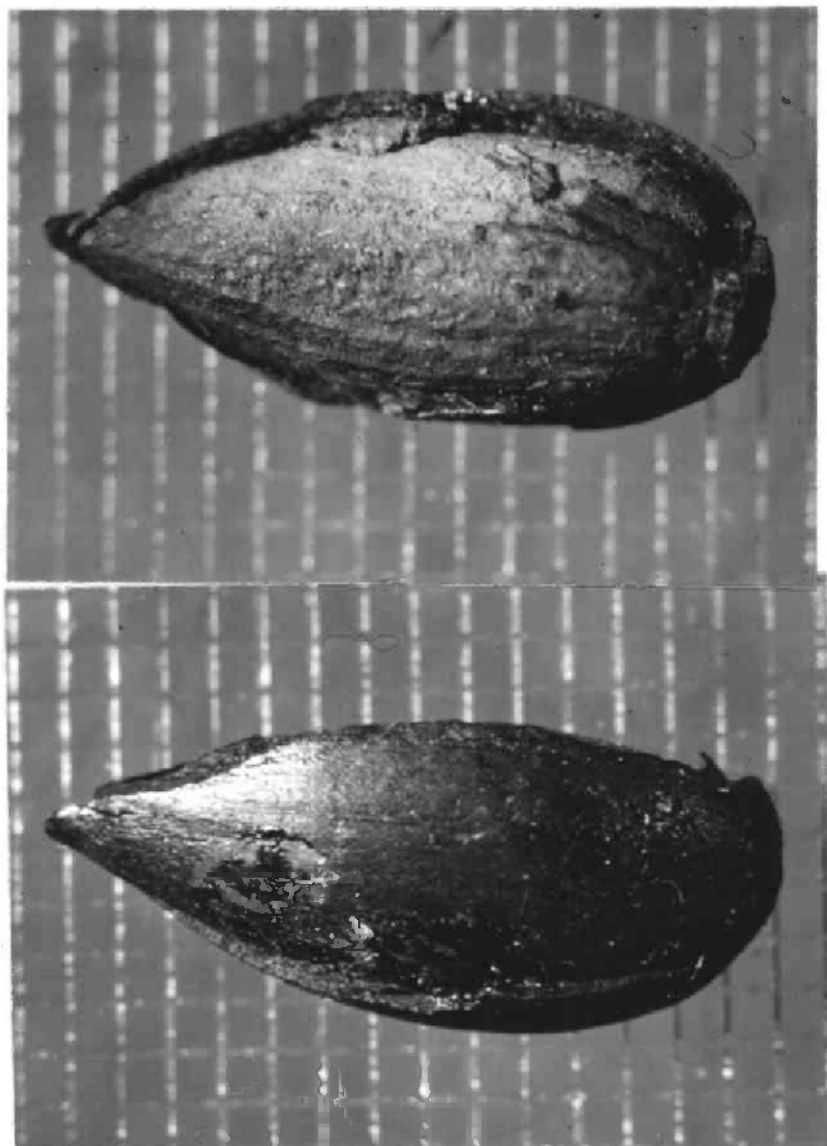
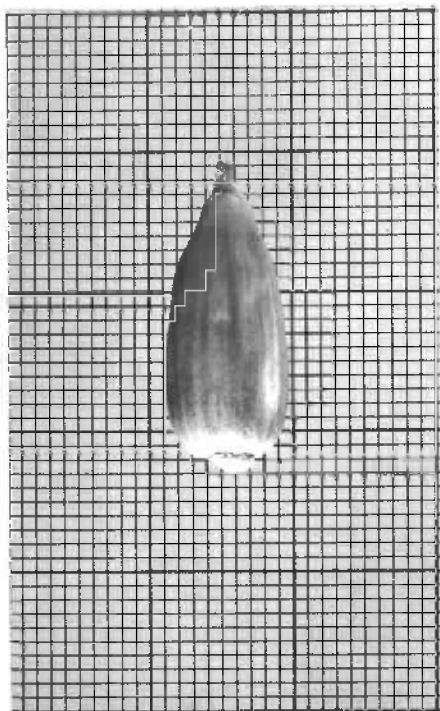
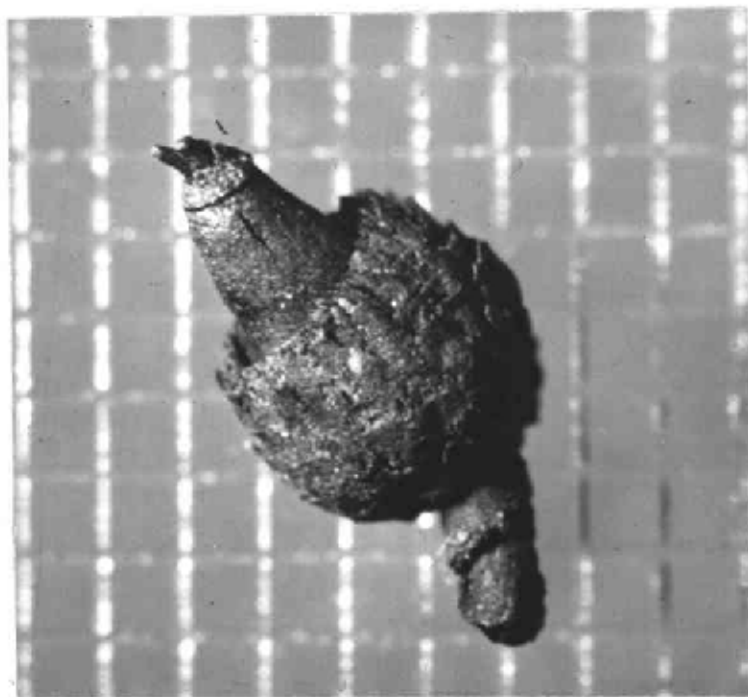


Figure 36

Fossil acorns found in Pit A that appear to be those of Quercus dumosa Nutt.

(Scale: 1 square in grid = 1 sq. mm.)



Modern acorn of *Quercus dumosa* Nutt.  
 Comparison with Figure 36.

Scale: 1 square in grid = 1 sq. mm.)

PB. 1483, and Cotype No. PB. 1484.

Quercus lobata Née.

A number of young acorns enclosed in cups and a portion of an older cup were obtained from matrix excavated from Pit 4 at a depth of ten feet (Figure 38).

These were difficult to identify and assign to a species because of the natural hybrids occurring in the modern Quercus flora in California. Studies were made of many herbarium specimens of all the species of Quercus occurring in California. Particular attention was given to acorns and young acorn cups of comparable size to those of the fossil material. There appeared to be distinct differences in the scale characters of young cups among the species that make it possible to assign the fossil material to Quercus lobata. The scales of the fossil and modern cups are broad at the base, abruptly acuminate; the scales are attached to the cup by their broad bases and are free above. In mature acorn cups the broad bases develop into wart-like processes (Figure 39).

In the modern flora, Quercus lobata occurs on slopes below 2000 feet in the central valley and the valley between the inner and middle Coast Ranges south to San Fernando Valley and San Marino, California (Map 5). It occurs occasionally at higher elevations. Its occurrence in the Rancho La Brea deposits indicates that it may have occurred at the base of foothills of the Santa Monica Mountains, where these intercept the fossil area and the San Fernando Valley area.



## MAP OF CALIFORNIA



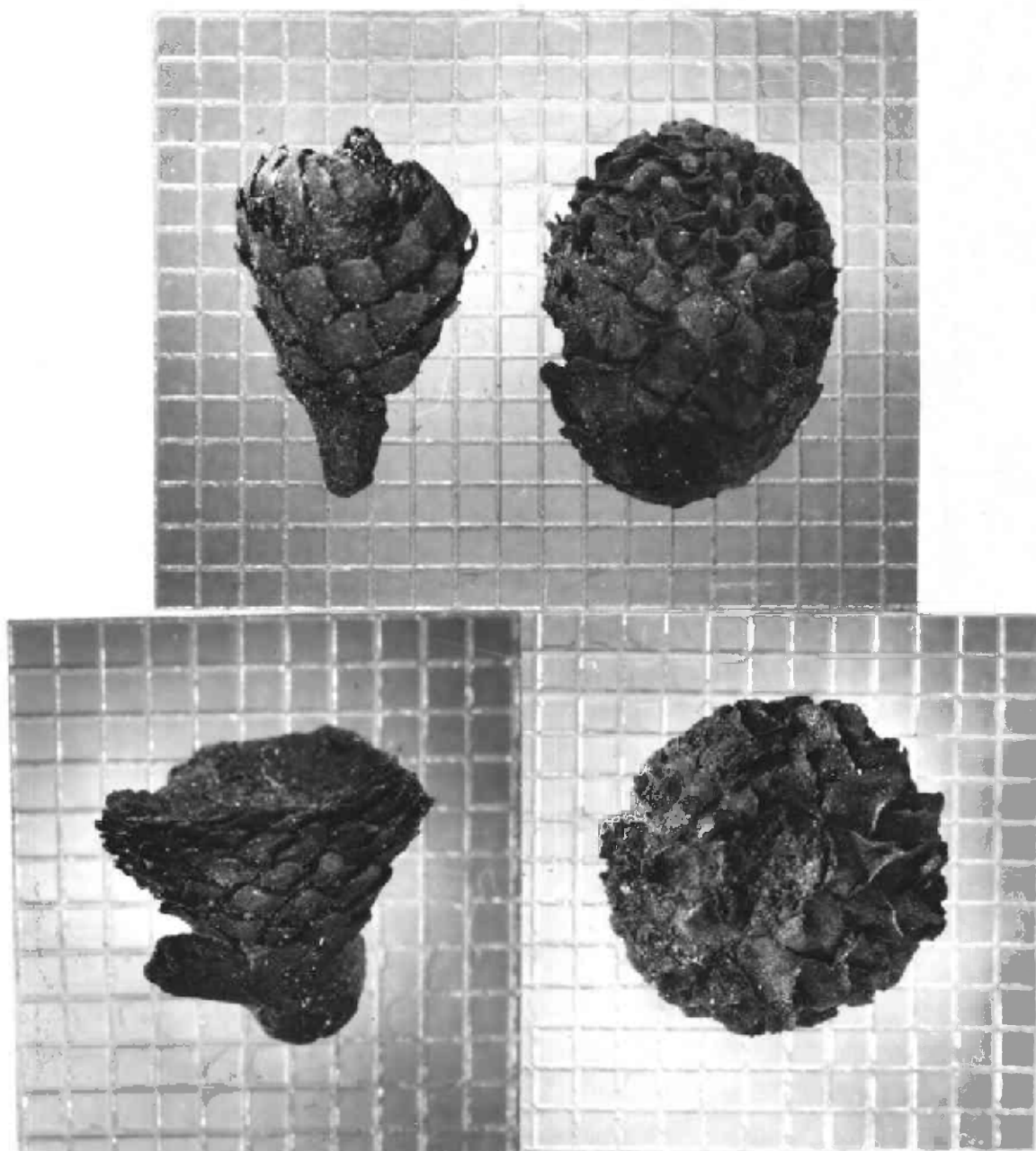


Figure 38

Quercus lobata Nee (fossil)

- a. Side view of young acorn and a portion of a mature acorn cup excavated from Pit 4, section F-4, at  $10\frac{1}{2}$  feet.
- b. Side view of another acorn, immature and much worn, from same locality.
- c. Stem-end view of a larger young acorn cup; same datum as in "a." above.

(Scale: 1 square in grid = 1 sq. mm.)



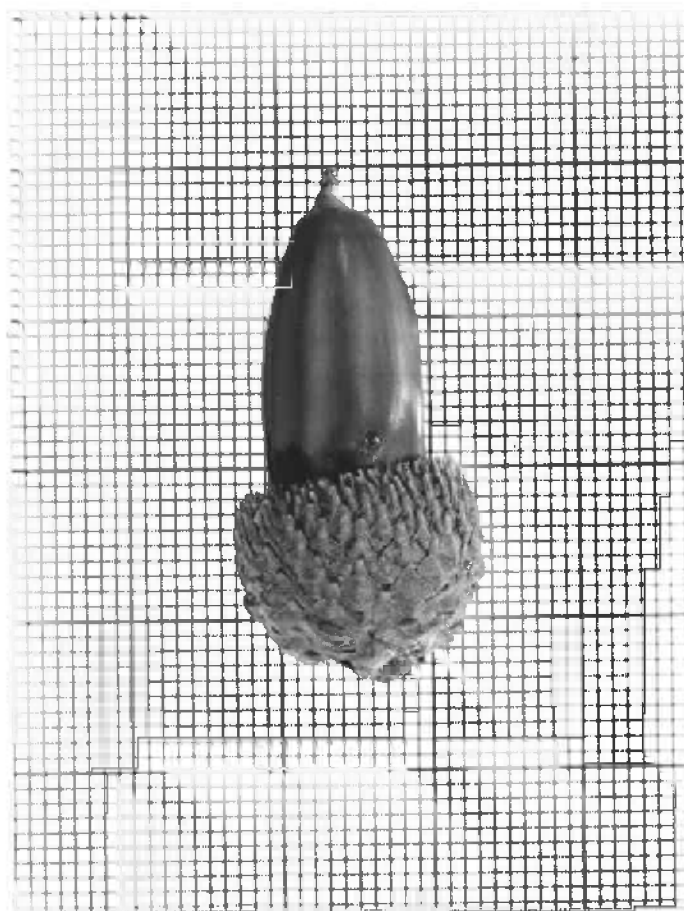


Figure 39

Quercus lobata Nee

(modern)

Mature acorn with cup shown for  
comparison with the fossils illus-  
trated in Figure 38.

(Scale: 1 square in grid = 1 sq. mm.)

## MAP OF CALIFORNIA



Occurrence: Rancho La Brea deposits, Pit 4, Sect.  
F-4 at ten feet.

Collection: Los Angeles County Museum, Paleobotany, Plesiotype No. PB. 1485, Cotype No. PB. 1486.

POLYGONACEAE Family

Rumex L.

A single fruit of Rumex was extracted from matrix in one Pit. The sepals are somewhat mascerated and bear callous grains on two of the valves; the achene is still intact.

The mature fruits of all 24 species represented in the modern flora of California were studied. An additional 28 species of Rumex occurring outside the State and ranging across the United States and into Mexico were also studied. Species having no callous grains on their valves were eliminated from morphological comparison. The following species were used in the final analysis:

<u>Rumex altissimus</u>	<u>Rumex paraguayensis</u>
<u>Rumex Berlandieri</u>	<u>Rumex patenia</u>
<u>Rumex britannicus</u>	<u>Rumex persicarioides</u>
<u>Rumex chrysocarpus</u>	<u>Rumex pulcher</u>
<u>Rumex conglomeratus</u>	<u>Rumex regelii</u>
<u>Rumex fueginus</u>	<u>Rumex salicifolius</u>
<u>Rumex Kernerii</u>	<u>Rumex stenophyllus</u>
<u>Rumex lacustris</u>	<u>Rumex transitorius</u>
<u>Rumex mexicanus</u>	<u>Rumex triangulivalvis</u>
<u>Rumex obtusifolius</u>	<u>Rumex verticillatus</u>
<u>Rumex palustris</u>	<u>Rumex violescens</u>

The comparison of the fossil specimen with the above modern

species was based on the size of the fruit, form of the valve, the number and size of callosities, and the type of venation on the valves.

The fossil specimen resembled closely, in two or more of these characters, Rumex Berlandieri, R. mexicanus, and R. salicifolius. The last two species have the greater number of characters found in the fossil specimen.

Rumex mexicanus Meism.

The fossil fruit is 3 mm. wide, 4 mm. long, including the calyx. One valve has a large callous grain 2 mm. long, 1.5 mm. wide, and ca. 1 mm. thick; one valve has a smaller callous grain 1.5 mm. long, 0.5 mm. wide and ca. 0.5 mm. thick; the third valve is apparently without a callous grain. Two of the valves were partially mascerated, while one valve was almost complete, showing only slight masceration on margin and apex. An achene is enclosed in the valves.

The morphological characters present in the fossil fruit resembles best the modern Rumex mexicanus. It is about 1 mm. smaller, but this could be due to masceration and to shrinkage. The size, form, and position of the callosities are very much like those in its modern counterpart; these, in the modern species vary from one to three. Finally, the primary veins leading away from the callous grain or center of the valve are predominantly pinnate in arrangement in the fossil (Figure 40) and also in Rumex mexicanus (Figure 41). These are predominantly netted veined in the remaining species.





Figure 40

Rumex mexicanus Meism.

(fossil)

A single fruit extracted from matrix removed from cavity of Sabre-tooth skull excavated from Pit 61, Sect. D-14 at depth of  $18\frac{1}{2}$  feet.

(Scale: 1 square in grid = 1 sq. mm.)

Figure 41

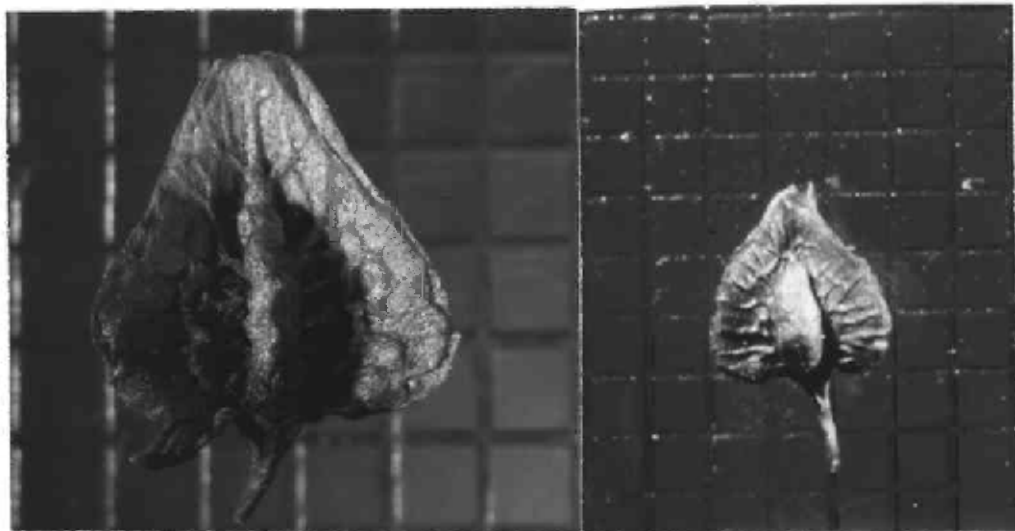
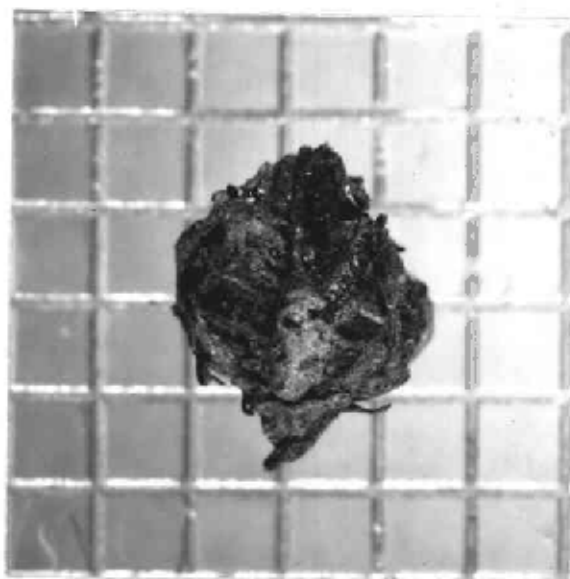
Rumex mexicanus Meism.

(modern)

- a. Fruit of specimen collected at Yellowstone Park.
- b. Fruit of specimen collected at Chihuahua, Mexico.

Shown for comparison with fossil in Figure 40.

(Scale: 1 square in grid = 1 sq. mm.)



Rumex mexicanus occurs along rivers, streams, ditches, and wet places in valleys and canyons, ranging from Labrador to British Columbia, southward to Maine, Missouri, throughout the Rocky Mountains, Arizona, New Mexico, and southward into Mexico. The California floras (2, 40, 50, 58) do not list it as occurring in California.

Occurrence: Rancho La Brea, Pit 61, Sect. D-14,  
18 feet in matrix from sabre-tooth  
skull.

Collection: Los Angeles County Museum, Paleobotany, Plesiotype No. PB. 1446.

#### PORTULACACEAE Family

Many small, round to oval lenticular seeds were extracted from the matrix of several pits. Most of these seeds are less than 1 mm. in diameter, but range up to 2 mm. in diameter. Some of the seeds, whose external shape indicated curved embryos within, have the characteristic form and external markings of seeds belonging to Portulacaceae.

The Portulacaceae is represented in the modern flora of California by six genera. The seeds of species of Calandrinia, Calyptridium, Claytonia, Lewisia, Montia, and Portulaca that occur within the ecological and floristic range of the Rancho La Brea

deposits were studied and compared with the fossils. From this, it was found that many of the species had seeds with distinctive diagnostic characters that made it possible to identify two groups of fossil seeds. The seeds of other genera in the Caryophyllales need to be collected and studied before the remainder of these fossil seeds can be identified. The following species have thus far been identified:

Calandrinia ciliata var. Menziesii (Hook.) Macbr.

Many seeds, identifiable with Calandrinia ciliata var. Menziesii, were separated from matrix in several pits. The fossil seeds (Figure 42), like the modern counterparts (Figure 43), are black, shining, 0.8-1 mm. in diameter, lenticular, faintly tuberculate over most of their convex sides, the convex sides tapering to a flattened rim on which appear several rows of evenly distributed fine tuberculations. Many of the seeds are fragmented.

In the modern flora, this species occurs in open grassy places throughout the cismontane region from British Columbia to northern Lower California (Map 6). These herbaceous annuals thrive in moist situations, and the rapidity with which they attain their full size, perfect their seed and pass away makes it possible for them to escape seasonal drought periods.

Occurrence: Rancho La Brea deposits, Pit 3, F-2 at  
15  $\frac{1}{2}$  feet; Pit 13, F-11 at 15  $\frac{1}{2}$  feet; Pit 61



Figure 42

Calandrinia ciliata var. Menziesii (Hook.) McBr.

- a. Seeds (fossil) from Pit 3, Sect. F-2, 15  $\frac{1}{2}$  ft.
- b. Enlarged view of one of the seeds.

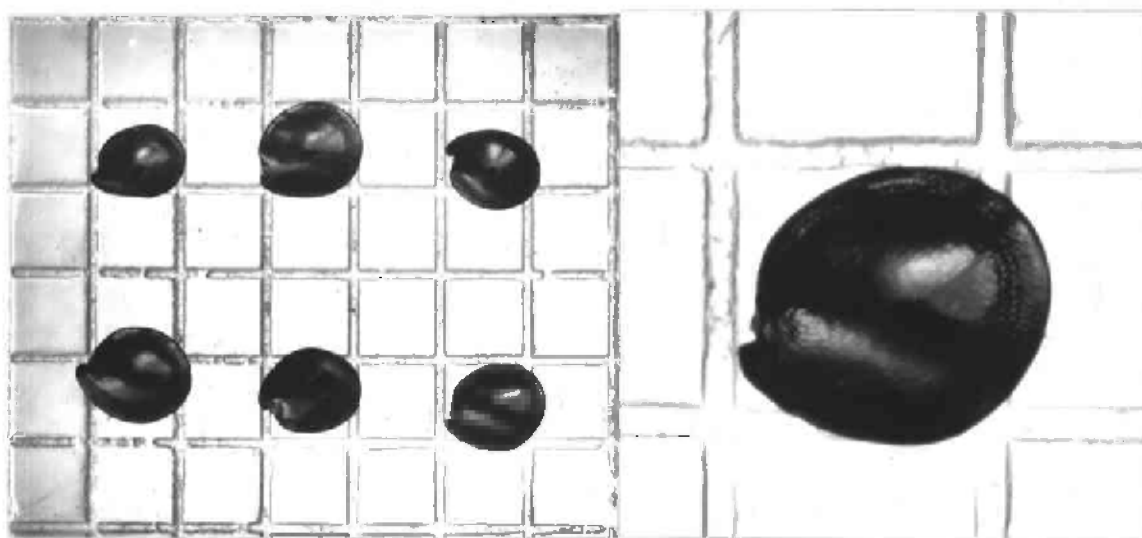
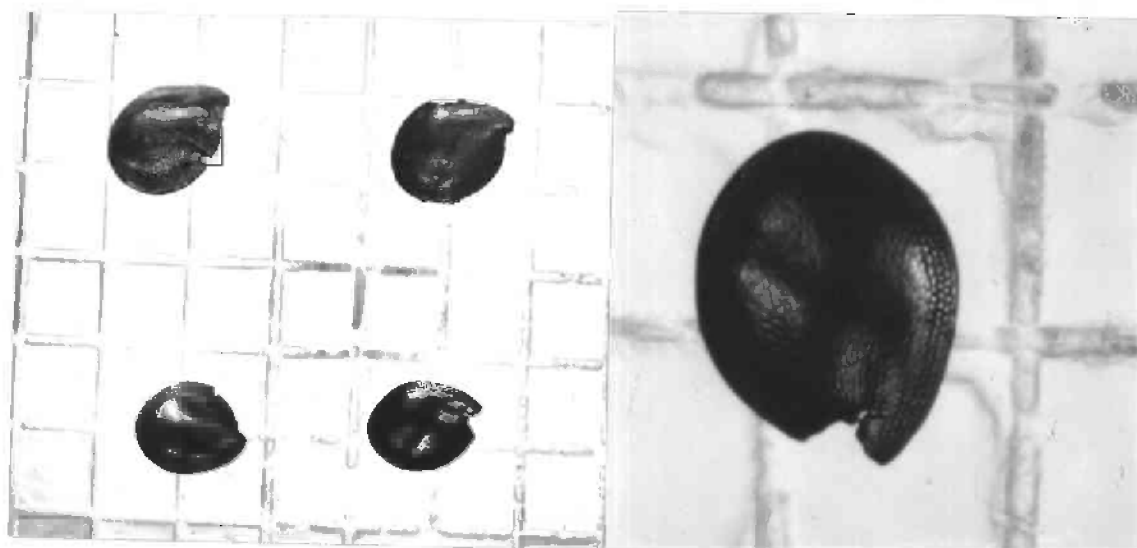
(Scale: 1 square in grid = 1 sq. mm.)

Figure 43

Calandrinia ciliata var. Menziesii (Hook.) McBr.

- a. Seeds of modern material for comparison.
- b. Enlarged view of one of the seeds.

(Scale: 1 square in grid = 1 sq. mm.)





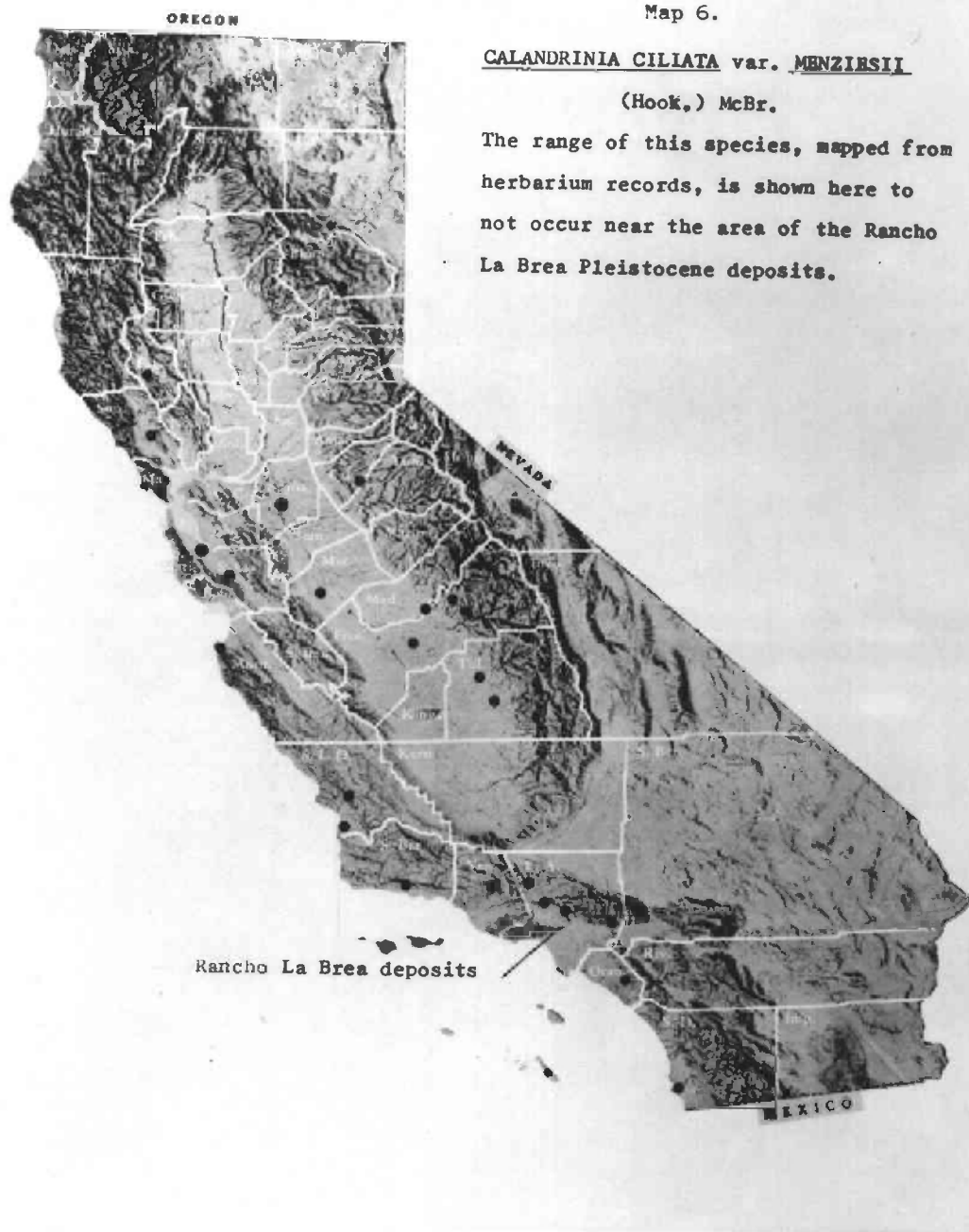
## MAP OF CALIFORNIA

Map 6.

CALANDRINIA CILIATA var. MENZIESII

(Hook.) McBr.

The range of this species, mapped from herbarium records, is shown here to not occur near the area of the Rancho La Brea Pleistocene deposits.



at 10 feet; Pit 101, E-3 at 6 feet and F-4  
at 4 feet; Pit 67, C-8, 16 feet.

Collection: Los Angeles County Museum, Plesiotype  
Nos. PB. 1459, PB. 1460, PB. 1461, PB.  
1462, PB. 1463.

Montia spathulata (Dougl.) Howell

More than 20 seeds, identifiable with Montia spathulata, occurred in the matrix from Pit 16 and Pit 101. There are 15 species of Montia in California. The seeds of most of these species were studied and compared with the fossil seeds. The fossil seeds are nearly identical to those of Montia spathulata.

The fossil seeds (Figure 44), like the modern counterparts (Figure 45), are oval, somewhat lenticular, oblique at hilum end, 1-1.5 mm. long, black, shiny, closely granulated with small tubercles. The caruncle, present in modern seeds is missing in the fossil ones.

Montia spathulata, in the modern flora, occurs on open grassy hill slopes from British Columbia south through the Coast Ranges of California to the Mexican border (Map 7). These plants grow in somewhat drier situations than does the previous species. The seeds of Montia Chamissoi and M. sibirica were not available in the present study. The edaphic requirement of these species is of moist,



Figure 44

Montia spathulata (Dougl.) Howell

- a. Fossil seeds extracted from matrix in Pit 13, Sect. F-11, at  $15\frac{1}{2}$  feet.
- b. Enlarged view of one of the seeds.

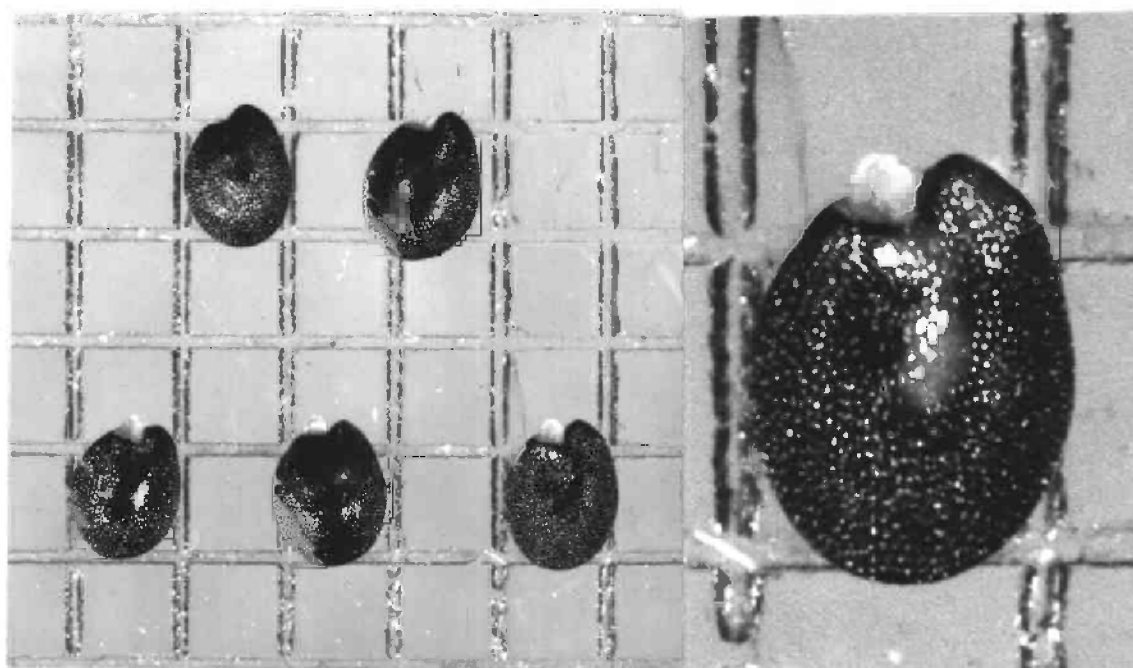
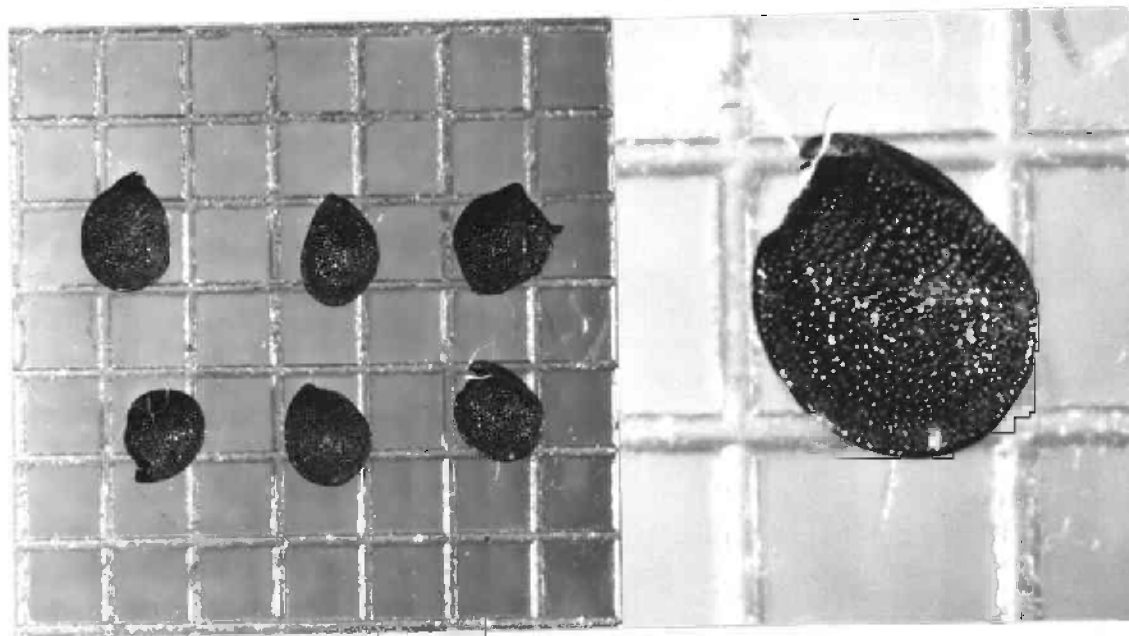
(Scale: 1 square in grid = 1 sq. mm.)

Figure 45

Montia spathulata (Dougl.) Howell

- a. Modern seeds shown for comparison.
- b. Enlarged view of one of the seeds.

(Scale: 1 square in grid = 1 sq. mm.)

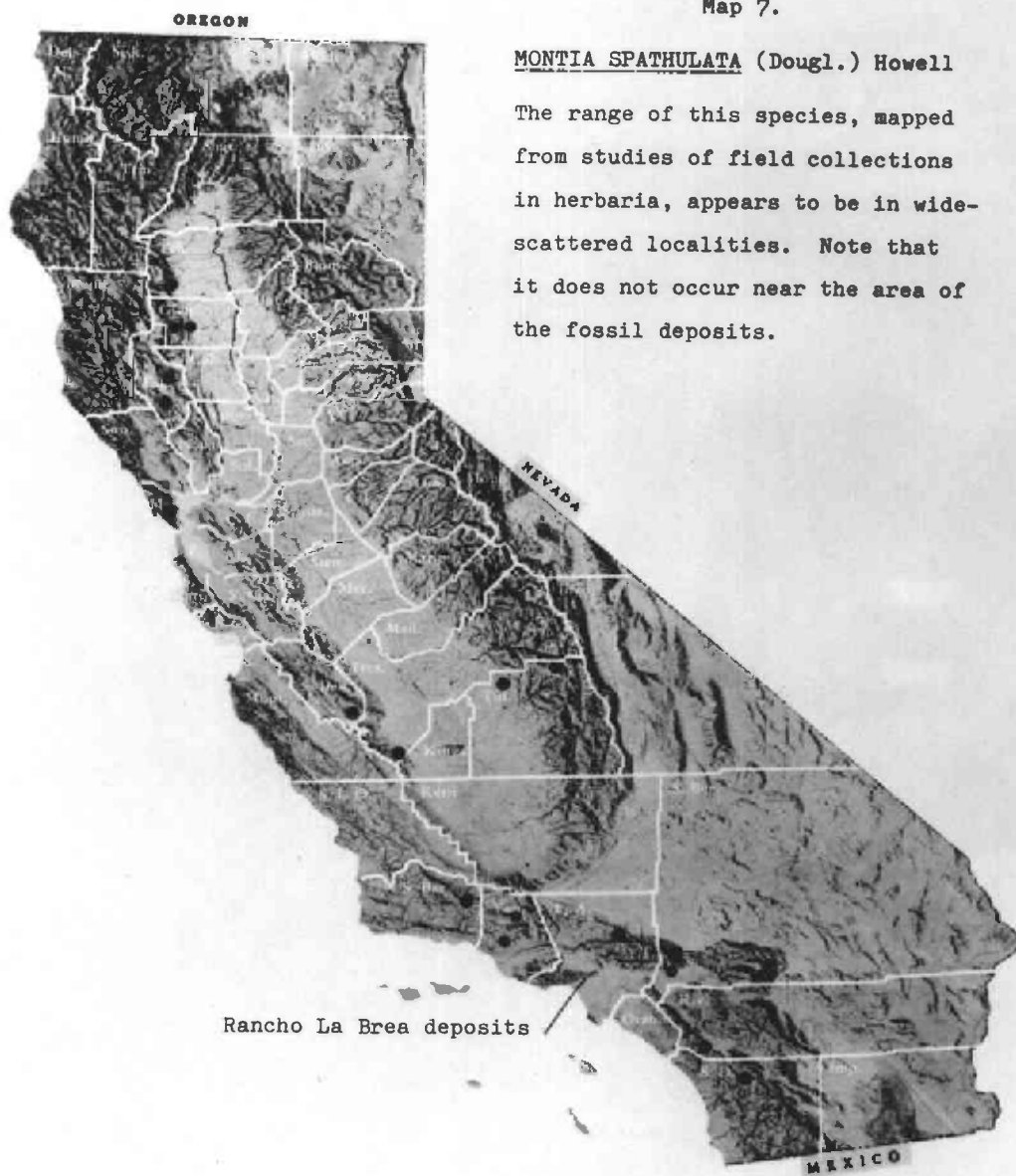


## MAP OF CALIFORNIA

Map 7.

MONTIA SPATHULATA (Dougl.) Howell

The range of this species, mapped from studies of field collections in herbaria, appears to be in wide-scattered localities. Note that it does not occur near the area of the fossil deposits.



shady places, wet meadows, or stream banks. Should the fossil seeds, here assigned to Montia spathulata, later prove to be those of one of these species their ecology would be reflected in the total aspect of the Rancho La Brea flora.

Occurrence: Rancho La Brea deposits, Pit 13, F-11 at 15 feet; Pit 101, F-4 at 4 feet.

Collection: Los Angeles County Museum, Plesiotype Nos. PB. 1464, PB. 1465.

#### ACERACEAE Family

#### Acer L.

Seeds closely resembling those of Acer Negundo and A. Negundo var. californicum were separated from the matrix in two pits in the Rancho La Brea deposits. The following species in the modern flora were studied in order to determine the identification of the fossil material:

<u>Acer circinatum</u>	<u>Acer Negundo</u> var. <u>arizonicum</u>
<u>Acer glabrum</u>	<u>Acer Negundo</u> var. <u>californicum</u>
<u>Acer macrophyllum</u>	<u>Acer Negundo</u> var. <u>interior</u>
<u>Acer Negundo</u>	<u>Acer Negundo</u> var. <u>texanum</u>
	<u>Acer Negundo</u> var. <u>violaceum</u>

It was found that fruits and seeds of Acer Negundo and its varieties resemble the fossil material closely.

The morphology of the seeds of Acer was not found in the

literature. In the studies of Acer Negundo and Acer Negundo var. californicum it was found that the seeds are from 7-9 mm. long and 3-4 mm. wide at the broadest point, comparatively straight on the dorsal side, convex on the ventral side, compressed laterally with a depression in the middle or toward the base, usually on one side but occasionally on both (Figure 48, p. 178).

Acer Negundo L. is one of the most widely distributed species of Acer in the United States. In some areas it is one of the commonest trees. In western United States, several varieties of A. Negundo take over the range of this species. In California, it is represented by A. Negundo var. californicum (Map 8). It is nowhere abundant, occurring in isolated areas along stream banks and moist bottom lands. The climate in most of its range is humid because of proximity to the sea, but in some areas there are high temperatures and low humidity.

Acer praecalifornicum n. sp.

Six whole or slightly fragmented seeds were extracted from the matrix removed from inside sabre-tooth skulls in Pit 3. No wings were present. The exocarp was absent in nearly all of them but in some the vascular bundles of the exocarp still remained intact (Figure 46).

Acer praecalifornicum differs from its nearest modern



## MAP OF CALIFORNIA

Map 8.

*ACER NEGUNDO* var. *CALIFORNICUM*

The distribution of this species, mapped from data of field collections, is nowhere abundant, occurring in isolated areas along stream banks and moist bottom lands.

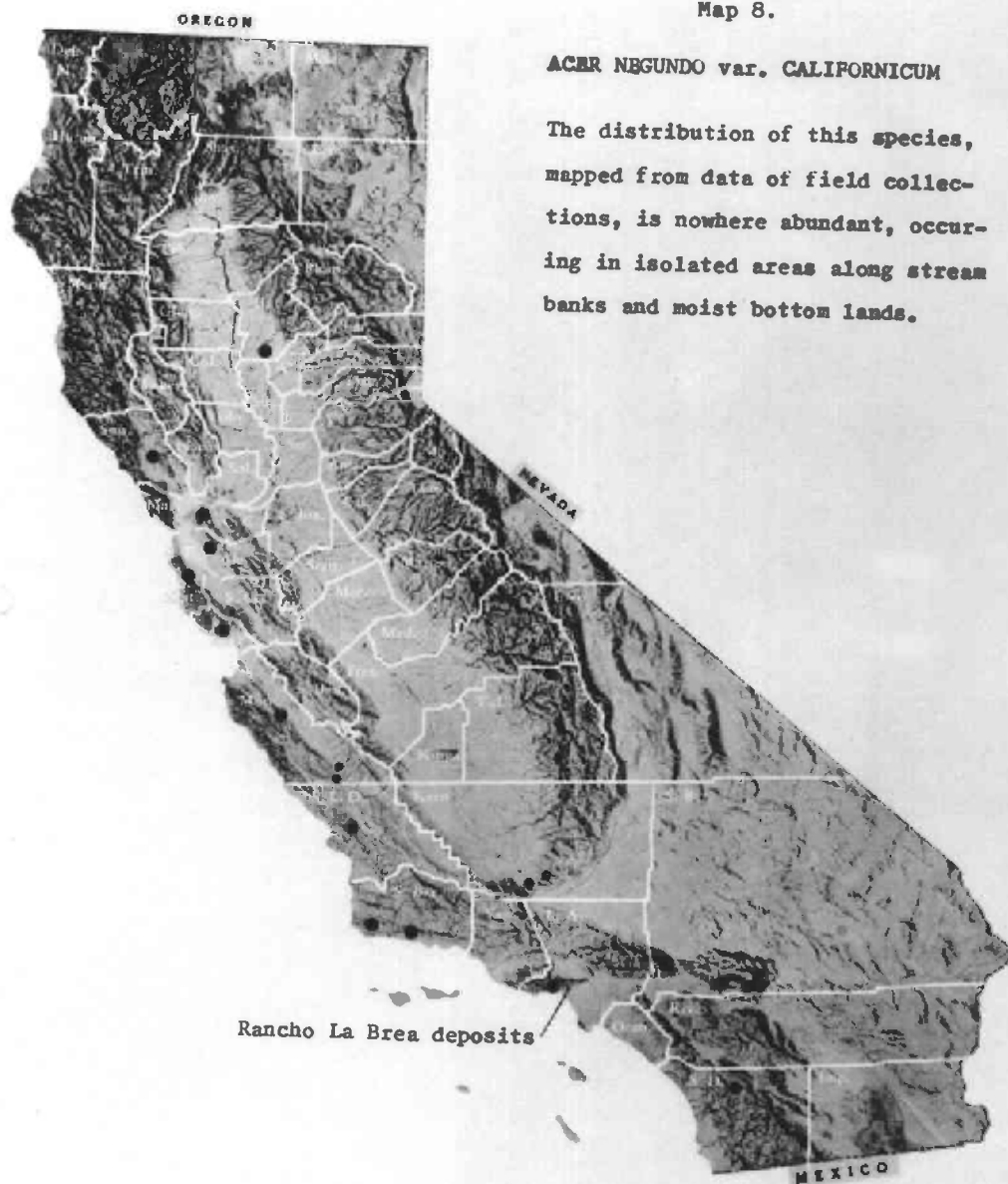


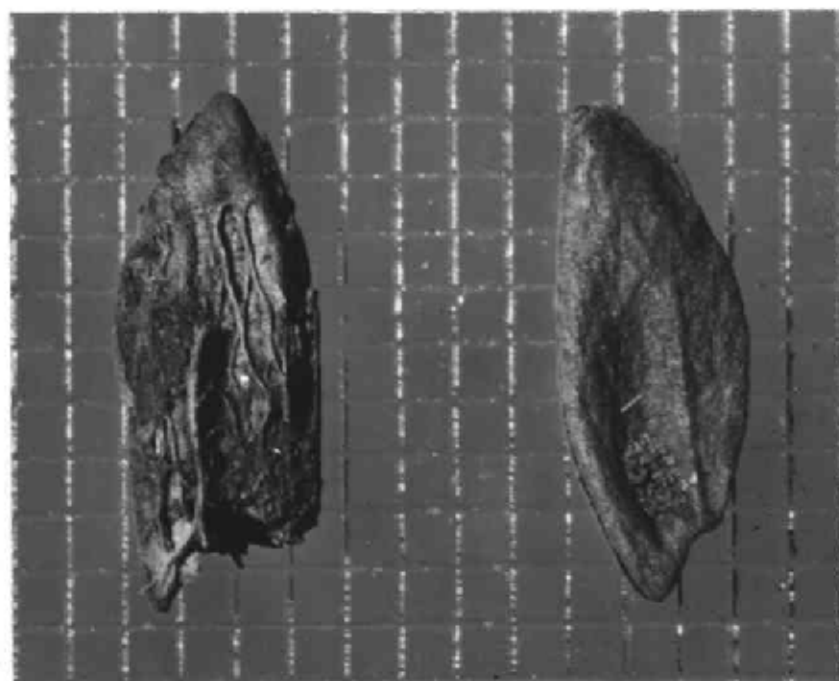


Figure 46

Acer praecalifornicum n. sp.

- a. Two fossil seeds found in Pit 3, Sect. C-4 at  $6\frac{1}{2}$  foot depth. One is without testa and the other shows vascular bundles of the testa still intact.
- b. Shows the reverse sides of these two seeds.

(Scale: 1 square in grid = 1 sq. mm.)



counterpart by being broadest at the middle and above, variously reticulated over its surface, and by curving in toward the micropylar end on the dorsal side. The modern seeds are broadest below the middle and almost straight on the dorsal side.

Determined from field records, the modern occurrence nearest the fossil deposit, is along a stream bank in Topango Canyon, Los Angeles County, a distance of about 35 miles northwest.

Occurrence: Pit 3, Sect. C-4, depth  $6\frac{1}{2}$  feet.

Collection: Los Angeles County Museum, Paleobotany,  
Type No. PB. 1443.

Acer Negundo var. breaense n. var.

One whole seed and a portion of another were found in Pit 101 (Figure 47). It resembles Acer Negundo var. californicum in that its broadest portion is below the middle but differs from it and from Acer praecalifornicum as it is acutely angled about 3 mm. above the base from the ventral side down to the dorsal point. It is 9 mm. long and 3.5 mm. at its broadest point.

Occurrence: Pit 101, Sect. F-4, depth 4 feet.

Collection: Los Angeles County Museum, Paleobotany,  
Type No. PB. 1444.



Figure 47

Acer Negundo var. breaense n. var.

a. Fossil seed found in Pit 101, Sect.  
F-4 at  $4\frac{1}{2}$  ft. depth.

b. Reverse view of the same seed .

(Scale: 1 square in grid = 1 sq. mm.)



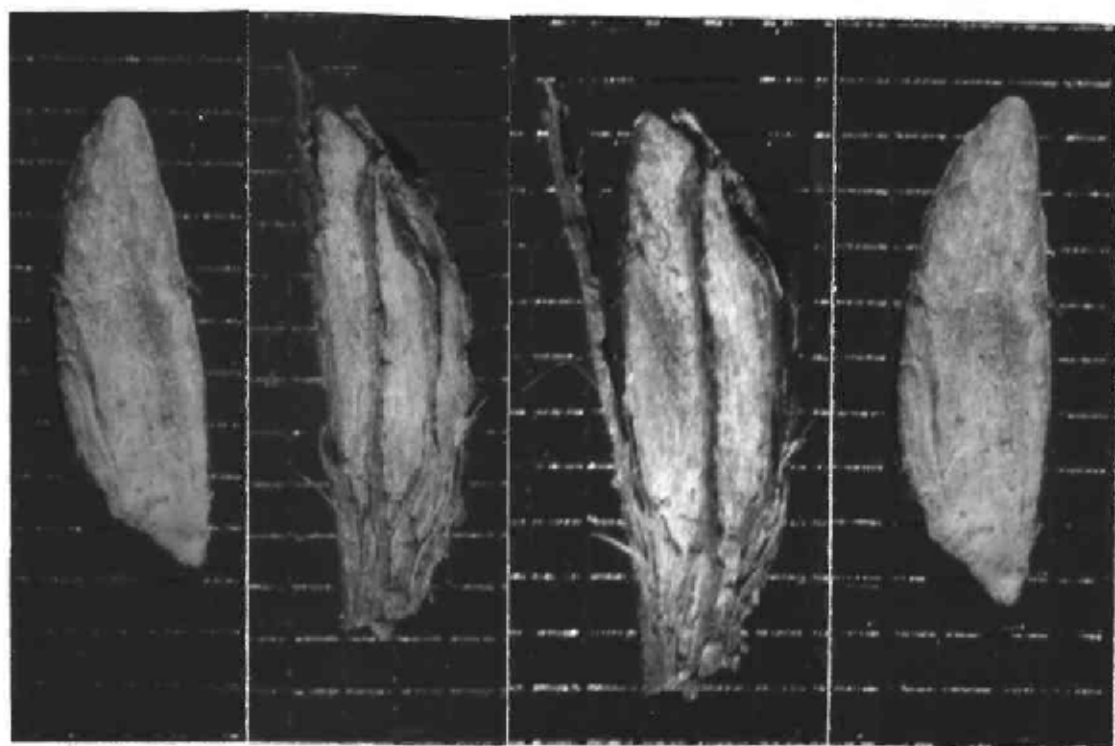
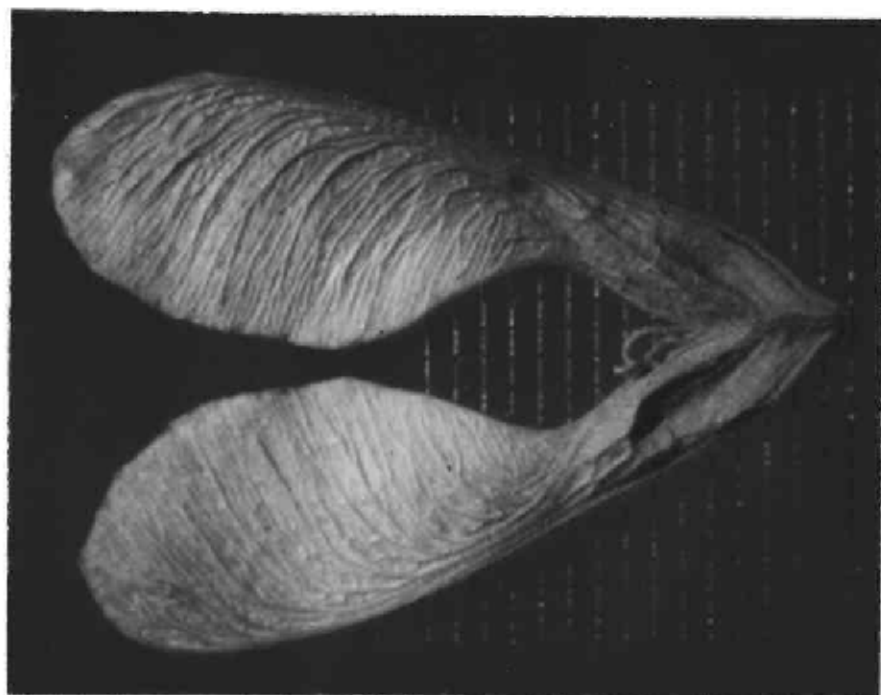
Figure 48

Acer Negundo var. californicum Sarg.

- a. A pair of modern samaras.
- b. Two seeds, one with the exocarp completely removed and the other with part of the vascular bundles, which occur in the seed coat, left intact for comparison.
- c. Reverse view of seeds shown in "b."

(Scale: 1 square in grid = 1 sq. mm.)





CORNACEAE FamilyCornus L.

A number of seeds (stones) belonging to Cornus occurred in several pits of the Rancho La Brea deposits. There are six species of Cornus in California:

Cornus canadensisCornus NuttalliiCornus californicaCornus sessilisCornus glabrataCornus stolonifera

Cornus californica, C. glabrata, and C. stolonifera showed similarity to the fossil seeds. The seeds of the remaining species were so dissimilar to these and the fossil species that these were eliminated from further consideration.

The stones of the modern Cornus californica were somewhat flattened, slightly to extremely oblique, with three often low ridges on each face and furrowed on the edges, 4-5 mm. broad, 3-3.5 mm. high, and 3 mm. or less thick. Cornus glabrata stones were nearly always globose, 5-6 mm. in diameter, usually smooth and a broad darkened band on the margin instead of the furrowed edge of C. californica. Cornus stolonifera stones were very similar to those of C. californica in size and form, differing from that species mainly in having a smooth face and the lateral furrow less pronounced.

In general, the range of Cornus glabrata is from southern Oregon south to San Diego County, California, while that of C. californica

extends from southern California north to British Columbia. C. stolonifera is quite widespread, extending across most of Canada, the northern part of the United States, extending southward into the Sierra Nevadas of California and rare in southern California.

The fossil material resembles closely Cornus californica and C. stolonifera. Map 9 shows the distribution of C. californica, based on studies of collections in herbaria. Because of the wide distribution of C. stolonifera, it was not mapped. There is much confusion in the literature as to which is the correct name for each species, but the names of the species used here are those generally used in floras on California plants.

Cornus californica var. breaense n. var.

Four stones were found in matrix extracted from inside the skull of sabre-tooth cat. All resembled the above named species in that, although quite worn, the low ridges on the face of the seeds were still evident (Figure 49). They differed, however, in that the largest seeds were smaller than the smallest of the modern counterpart (Figure 50). The fossil seeds ranged in size from 2.5-3 mm. high and 3-3.5 mm. broad.

Ecologically, its occurrence indicates the more moist situation in this area than does occur today, quite possibly a riparian situation since its modern counterpart often inhabits stream banks forming

## MAP OF CALIFORNIA

Map 9.

CORNUS CALIFORNICA C. A. MEY.

The range of this species, mapped from studies of field records in herbaria, is shown. From this it appears that it does not occur near to site of deposition.

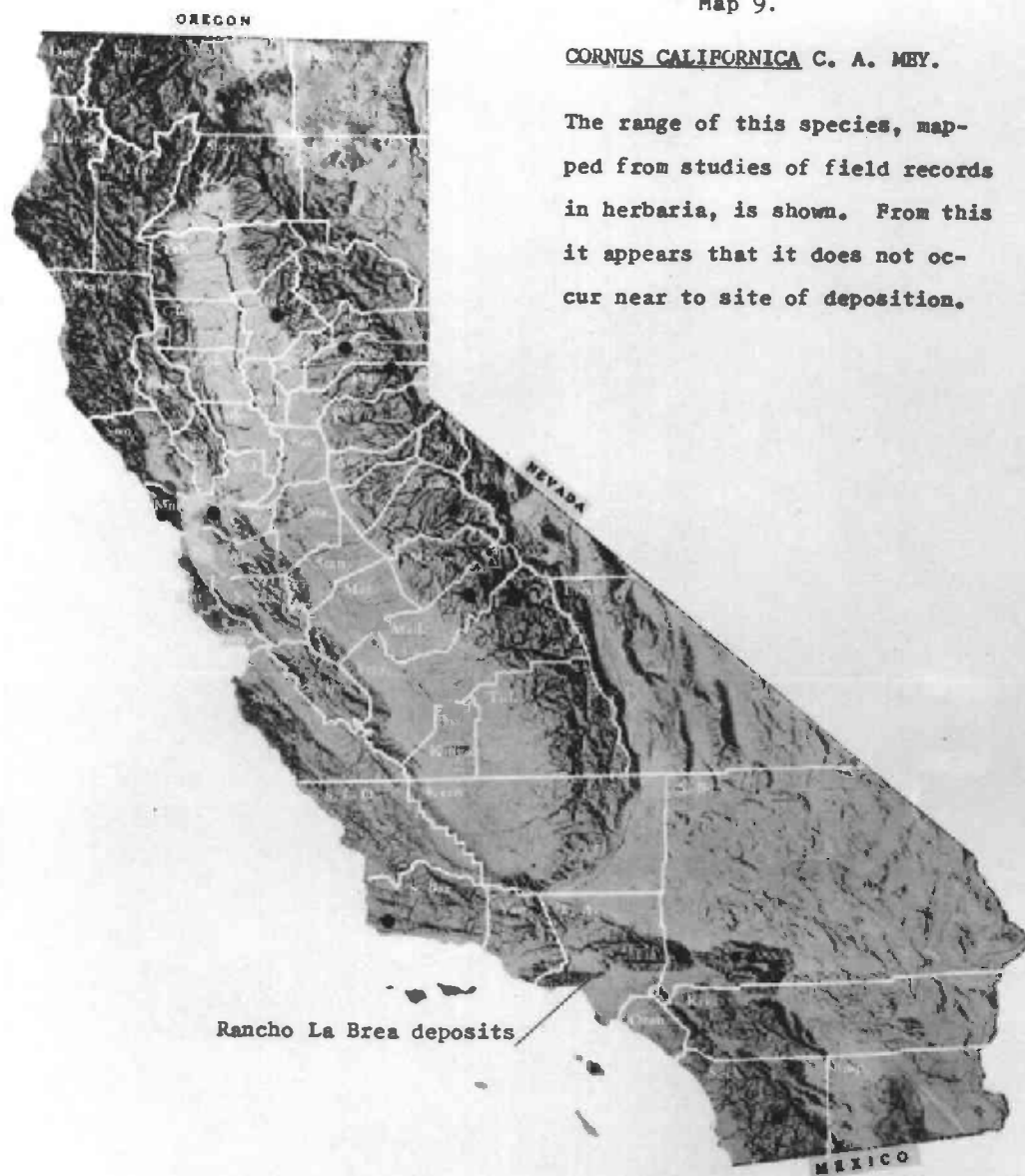




Figure 49

Cornus californica var. breaense n. var.

One of four stones found in Pit 101  
Sect. F-3 at depth of  $6\frac{1}{2}$  feet.

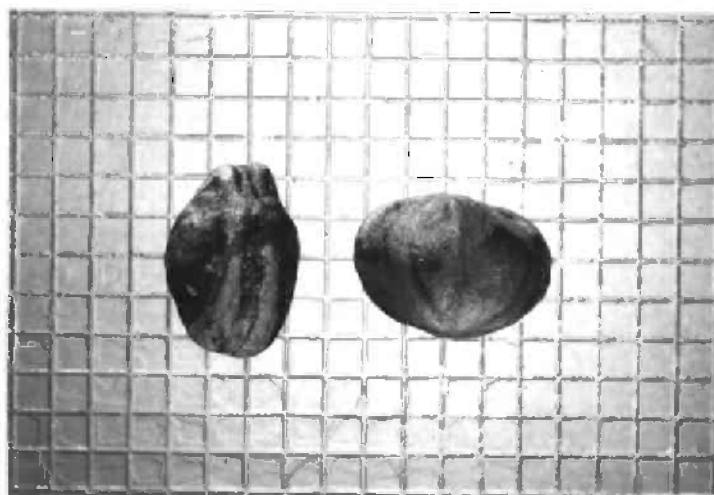
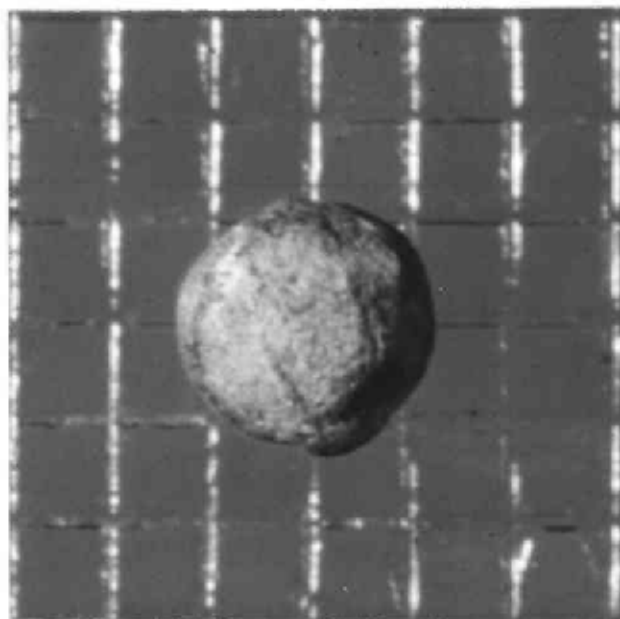
(Scale: 1 square in grid = 1 sq. mm.)

Figure 50

Cornus californica C. A. Mey.

Two seeds (stones) of the modern  
species, one showing end view and  
one showing side view for comparison  
with the fossil.

(Scale: 1 square in grid = 1 sq. mm.)



dense thickets in some areas in more northern parts of California.

Occurrence: Pit 101, Sect. F-3, at  $6\frac{1}{2}$  feet.

Collection: Los Angeles County Museum, Paleobotany, Type No. PB. 1441.

Cornus Stockii n. sp.

Twelve stones were obtained from Pit A (Figure 51) that showed a close relationship to Cornus stolonifera. The seeds (stones) differed from the modern counterpart in that they lacked the obliqueness of seeds of Cornus stolonifera (Figure 52, p.152), and were generally much smaller.

Seeds (stones) broader than high to orbicular, symmetrical, with furrowed edges and without low ridges on face; size of the orbicular ones, 2.5-3 mm. broad and high and 2.5 mm. thick; the size of the oval ones, 3.5 mm. broad, 3 mm. high and thick. One larger seed was nearly 4 mm. broad.

The quantity of seeds occurring in a small amount of matrix indicates that Cornus Stockii was well established in the area. Since its near relative, Cornus stolonifera occurs in swamps that are often sandy or along streams, it appears likely that a similar situation was present in the area of deposition during the Pleistocene.

Occurrence: Rancho La Brea deposits, Pit A.

No depth was given.