

## AN EARLY CRETACEOUS (HAUTERIVIAN) ANGIOSPERM FRUIT FROM CALIFORNIA

MARJORIE E. J. CHANDLER\*† and DANIEL I. AXELROD\*\*

ABSTRACT. A well-preserved fruit that may represent an extinct angiosperm of the family Icacinaceae, or a precursor of the family, has been found in the Ono formation of northern California associated with marine invertebrates of Hauterivian age. This section has earlier yielded a small transported flora consisting of an angiosperm of doubtful affinity, together with typically Neocomian conifers, ferns, and cycadophytes that appear to have characterized the vegetation of the adjacent shore area.

### INTRODUCTION

Only a few older Cretaceous (Neocomian) sections have provided us with the remains of flowering plants. Most of those from California, Virginia, and Portugal are leaf impressions that can not be assigned with certainty to living taxa. Chiefly for this reason, some investigators have thought that they may not even be valid records of ancient angiosperms. Thus it is highly significant that a well-preserved angiosperm fruit was found recently in the Ono formation, northern California, in a section that has previously yielded an angiosperm leaf impression of doubtful affinity associated with a typically Early Cretaceous flora (Fontaine, *in* Ward, 1905). By a curious coincidence, a similar find of a slightly older (Valanginian) fruit was reported at approximately the same time from Vaucluse, southern France (Chandler, 1958). It is to be hoped that these discoveries of angiosperm fruits will stimulate the search for additional material in Lower Cretaceous and even older rocks. Finds of this sort may be expected to increase now that geologists are directing more detailed attention to the finer structures of ancient sediments.

Interpretation and identification of an isolated specimen of the sort recorded here presents a number of difficulties. Most important is the fact that no (or very few) comparable living angiosperms can be expected in rocks of this age. Even in the latest Cretaceous and earliest Tertiary (Danian-Ypresian), many of the genera based on fruits and seeds are extinct, though most of them can be related to living families. Further, only a few fruits are as yet known from strata of Cretaceous age and most of them do not assist in evaluating the affinities of the present material. Yet special mention must be made in this connection of a species of *Phytocrene* from the Upper Cretaceous Raritan formation of New York (Scott and Barghoorn, 1957), and of *Paleophytocrene* from the Eocene London Clay (Reid and Chandler, 1933) and from the Eocene Clarno of Oregon (Scott, 1954), for they aid in some measure in evaluating the present fossil. Finally, the preservation of the unique specimen described here leaves some room for doubt as to certain of its structures, and the transparent plastic in which it had to be embedded for sectioning causes reflections that make it difficult to assess some of the finest details.

It is a pleasure to record here our indebtedness to Drs. Michael A. Murphy and Peter Rhodda who turned over the fossil to us for study. Owing

\* British Museum (Natural History), London

\*\* University of California, Los Angeles, California

† Published by permission of the Trustees of the British Museum (Natural History), London.

to their detailed geologic studies in the Ono region, the fossil fruit has a well-defined stratigraphic position.

#### GEOLOGIC OCCURRENCE

The thick section of fossiliferous Lower Cretaceous rocks exposed in the Ono region 20 miles southwest of Redding, California is the type area for the stratal unit previously termed the Horsetown group or formation and recently redefined as the Horsetown stage (Murphy, 1956). The lower part of the section is represented by the Rector formation, which ranges from 20 to 400 feet in thickness. This sandstone and conglomerate unit is markedly transgressive on the igneous and metamorphic rocks of the bordering Klamath Mountains at the west. The Ono formation, which has yielded the fossil fruit, conformably overlies the Rector. It is approximately 4200 feet thick and is composed chiefly of mudstone and nodular limestone, interrupted by two coarse clastic tongues of graywacke and conglomerate. The section is exposed as a gently southeast-dipping homocline which is complicated by many small, and a few large faults.

The fossil fruit was recovered from a limestone nodule in calcareous grit associated with mudstones in the lower part of the Ono formation, about 500 feet below the base of the Roaring River conglomerate tongue. The locality is 3½ miles southwest of Ono, near the head of a small branch of Roaring River. The exact site is 1500 feet N 65° W of the southeast corner of sec. 17, T. 30 N., R. 7 W., Ono quadrangle, U. S. Geol. Survey, 1952 ed. The locality is in the *Neocraspedites aguila* zone, the lowest biostratigraphic unit of the Horsetown stage (Murphy, 1956). Other diagnostic fossils of this zone include *Potamides diadema* Gabb and *Plicatula variata* Gabb. Among their usual associates are *Nucula gabbi* Stanton, *Turbo festivus* Anderson, and *Tessarolax bicarinata* (Gabb). Fragmentary plant remains are common in these strata. Plants previously reported from this section have been referred to the following genera (Fontaine, in Ward, 1905): *Cladophlebis*, *Ctenopteris*, *Sagenopteris*, *Dioonites*, *Ctenophyllum*, *Cephalotaxopsis*, *Sphenolepidium*, and *Acaciaephyllum*.

#### TAXONOMIC DESCRIPTION

? FAMILY *Icacinaeae*

Genus *Onoana* nov.

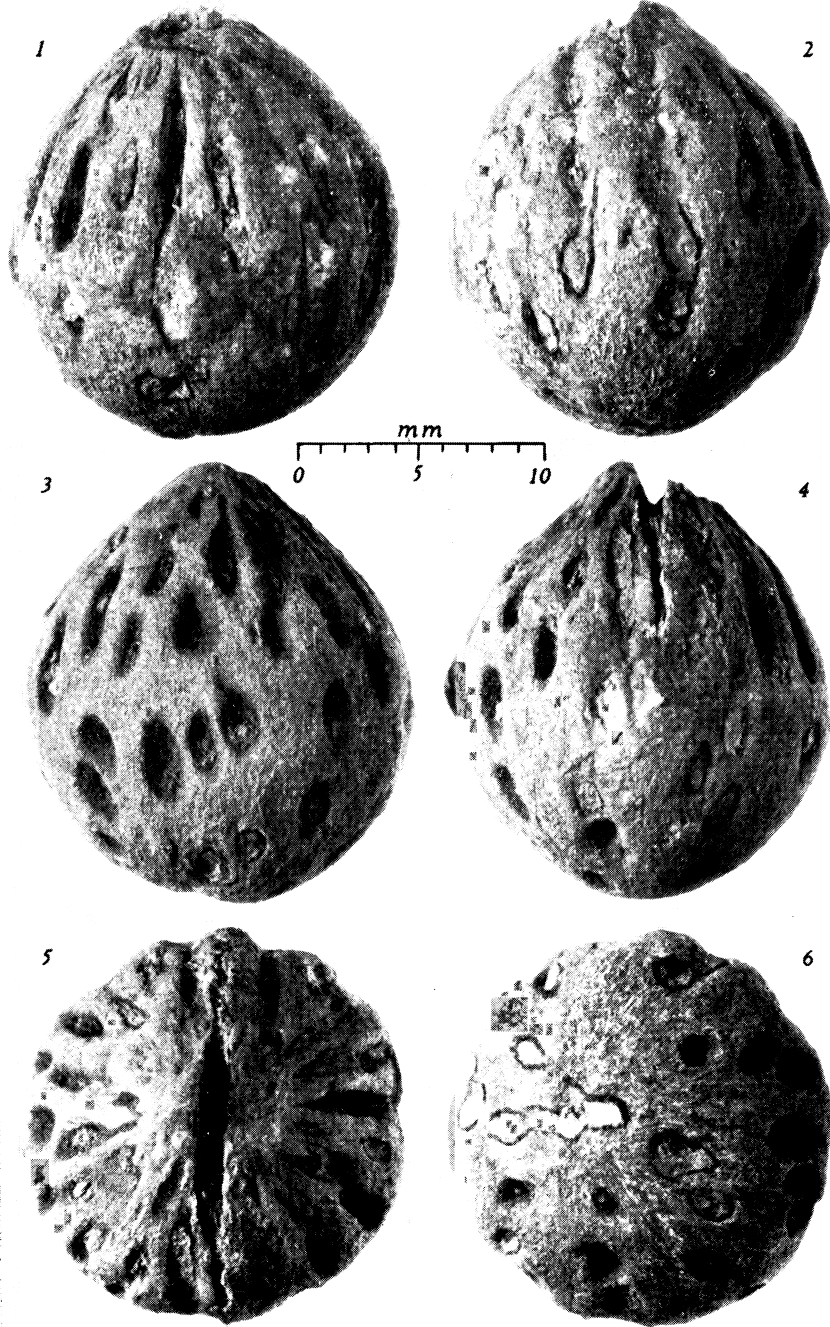
*Onoana californica* n. sp.

(Pl. 1, figs. 1-6; pl. 2, figs. 1-2)

*Diagnosis*.—Endocarp apparently obovoid, with a median longitudinal fissure at the narrow end giving an obscure bisymmetry. Endocarp 20 mm long, with a transverse diameter of 15 mm. Wall thick, having numerous deep, large pits with closed inner ends which do not form protuberances on the locule surface, those near the proximal end traversing the wall obliquely, those at the distal end perpendicular to the surface of the endocarp. Solitary locule.

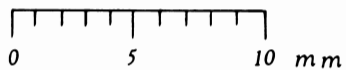
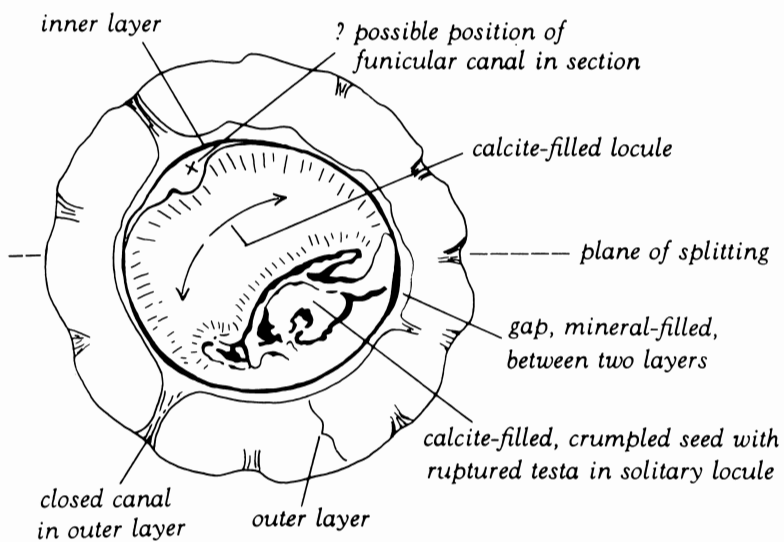
*Description*.—Endocarp woody, thick walled, with a finely fibrous surface on which the fibers are chiefly aligned longitudinally. Pointed-obovoid, with a slight bisymmetry at the pointed, proximal (?) end owing to a median longi-

PLATE 1



External views of *Onoana californica* Chandler and Axelrod.

## PLATE 2

Transverse section of *Onoana californica* Chandler and Axelrod.

tudinal fissure (pl. 1, figs. 2, 4, 5). The fissure extends for one-third of the length of the endocarp on one side (pl. 1, fig. 4), and for a shorter distance on the other (pl. 1, fig. 2).

The whole surface shows deep, coarse, irregularly scattered pits particularly well exposed owing to abrasion of the surface. That abrasion has occurred is indicated by the finely frayed margin of the endocarp when seen in section under the microscope. In surface view the pits are circular to linear in outline (pl. 1, figs. 1-6), and the majority are elliptical. Most of the circular pits are at the presumed distal end and the linear pits at the proximal end. This variation of form suggests that if they are due to hair bases, as in *Stizocarya* from the London Clay (Reid and Chandler, 1933), those nearest the proximal end traversed the wall obliquely, whereas those at the distal end pierced it in a perpendicular direction in such a manner that all hairs were directed upwards. A slight apparent variation in the distribution of the pits may be original but may also be due to varying degrees of abrasion on different sides of the specimen. It is possible, but cannot be ascertained beyond doubt, that there may have been a small round depression at the distal (?) end of the endocarp; if so, abrasion caused it to merge with adjacent pits.

The surface pits are clearly visible in the transverse section of the endocarp, which passes through the deepest part of several, and shows that they extend to the limit of an outer thick layer of the endocarp wall but never penetrate to a thin inner layer. Where the section has cut near to the edge of a pit, it passes for only a short distance into the outer layer (pl. 2, figs. 1-2), the depth varying with the position of the section in the pit.

The transverse section of the endocarp has been cut at the middle. It shows a compact outer layer about 3 mm thick, which appears to be formed of parenchyma with radially aligned cells at least towards the exterior, giving the finely frayed edge mentioned above. A thin inner part is composed of transversely aligned cells. It has become separated from the outer 3 mm and forms a thin compact inner layer surrounding the locule. Separation of the two layers may be due to natural maceration and is emphasized by mineralization of the gap now seen between them. The surface of separation is slightly uneven; in one place, at least, the two layers are connected.

The fruit appears to show one locule enclosing a contracted and crumpled seed to one side of it, the space left by the shrinkage of the seed being filled with white calcite. Only remnants of the testa are preserved and are represented by disrupted fragments in which no cells can be distinguished. There may be evidence of a funicular-canal on the opposite side of the locule to the seed, but this is very doubtful as it is seen only in transverse section and may merely represent a bulge in the loosened locule lining.

It was necessary to consider whether two locules were present, one without a seed (filled with white calcite), the other less developed, with a shrunken seed, and broken remains of a thin septum between the two locules. This view was discarded because the presumed septum is so thin and it also bears no relationship to the plane of symmetry. It is therefore regarded as part of the testa of the collapsed seed.

All hard woody endocarps are provided with some means by which the germinating embryo can emerge. There seems little doubt that in *Onoana* germination was by partial separation of two valves along the proximal fissure leaving a gap for the radicle.

*Affinity.*—In the case of an endocarp of such antiquity as the present one, the question naturally arises as to whether it shows relationships to the woody ranalian alliance. There appear to be no grounds for regarding the fossil as ranalian but rather as representing a plant that had evolved well beyond that level.

The presumed unilocular endocarp with wall partially pierced by canals recalls the section *Phytocreneae* of the family *Icacinaceae*. In some species of *Phytocrene* itself, and in the extinct genus *Stizocarya*, the canals do not penetrate the inner part of the wall, whereas in *Phytocrene* they may be distributed irregularly. In both these genera, and in *Paleophytocrene* (Reid and Chandler, 1933), they traverse the wall in a perpendicular direction. By contrast, in the Ono fossil some of the canals, and especially those at the proximal end of the endocarp, appear to traverse it obliquely as described above. Thus it seems necessary to establish a new genus, for which the describer (Chandler) proposes the name *Onoana*. The points above indicated as doubtful make it advisable to refer this genus only provisionally to the *Icacinaceae*, though bearing in mind that it may represent a precursor of the family.

It is greatly to be hoped that the discovery of additional material in the Ono section may afford more definite evidence of the morphology of this unique fruit, especially as regards the course of the funicle which in the *Icacinaceae* lies in the plane of splitting, and also of the position of the placenta, and the character of the seed.

*Collection.* British Museum (Nat. History) No. V. 42334. Since the largest fossil seed collections are in the British Museum, the California specimen has been added to them so that as new finds are made this and other ancient angiosperm fruits can more readily be studied.

#### REFERENCES

- Chandler, M. E. J., 1958, Angiosperm fruits from the Lower Cretaceous of France and Lower Eocene (London Clay) of Germany: *Ann. Mag. Nat. History London*, (13 ser.), v. 1, p. 354-358.
- Murphy, M. A., 1956, Lower Cretaceous stratigraphic units of northern California: *Am. Assoc. Petroleum Geologists Bull.*, v. 40, p. 2098-2119.
- Reid, E. M., and Chandler, M. E. J., 1933, The London Clay flora: London, British Museum (Natural History), 561 p.
- Scott, R. A., 1954, Fossil fruits and seeds from the Eocene Clarno formation of Oregon: *Paleontographica*, Band 96, Abt. B, p. 66-97.
- Scott, R. A., and Barghoorn, E. S., 1957, *Phytocrene microcarpa*—a new species of *Icacinaceae* based on Cretaceous fruits from Kreisheviller, New York: *The Paleobotanist*, v. 6, p. 25-28.
- Ward, L. F., and others, 1905, Status of the Mesozoic floras of the United States: *U. S. Geol. Survey Mon.* 48, 616 p.