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## STONES OF *CELTIS* IN THE TERTIARY OF THE WESTERN UNITED STATES<sup>1</sup>

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In 1909 Professor Cockerell described what he considered to be the seed of a spurge (*Euphorbia*) as *Tithymalus willistoni* from the "Loup Fork Miocene" of Long Island, Kansas.<sup>2</sup> Five years later this author described a second species from the Eocene (Wasatch or slightly older) of Clark's Fork Basin, Wyoming, which he called *Tithymalus phenacodorum*,<sup>3</sup> and in connection with this he published a drawing of the former species, which had not before been figured. More recently Chaney has described the fruit of *Celtis hatcheri* from the White River Oligocene of South Dakota.<sup>4</sup>

In 1884 the late John B. Hatcher made a large collection of silicified fruits and seeds from the "Loup Fork Miocene" of Phillips County, Kansas. These were deposited in the U. S. National Museum where they have lain undescribed until the present time. More recently Mr. A. W. Etnyre has sent in similar silicified material from the undifferentiated Tertiary of eastern Colorado (Township 6 N., Range 44 W., Kit Carson County). Part of these collections have already been described as a new species belonging to the genus *Lithospermum* of the family *Boraginaceæ*.<sup>5</sup> A considerable part of the remainder of both the Hatcher and Etnyre collections represents what I consider to be the stones of a species of *Celtis* (*Ulmaceæ*) and these are identical with what Cockerell called *Tithymalus willistoni*.

I am indebted to Chester A. Reeds of the American Museum of Natural History for the loan of the type of *Tithymalus phenacodorum* Cockerell (a single specimen), to Junius Henderson Curator of the Museum of the University of Colorado for the type of *Tithymalus willistoni* (comprising 2 specimens), and to Wm. J. Sinclair of Princeton University for several specimens of *Celtis hatcheri*. I have seen several hundred

<sup>1</sup>Published by permission of the Director, U. S. Geological Survey.

<sup>2</sup>Cockerell, T. D. A. C. *Torreyana*, vol. 9, p. 119, 1909.

<sup>3</sup>Cockerell, T. D. A. C. *Idem.*, vol. 14, p. 137, 1914.

<sup>4</sup>Chaney, R. W. *Carnegie Institution Publ.* 349, p. 54, pl. 1, fig. 8, 1925.

<sup>5</sup>Berry, Edward W. *U. S. Natl. Museum Proc.* (in press)

specimens of the fossil in all sizes, and a considerable collection of Recent Euphorbia seeds and Celtis stones for comparison with the fossils.

The study of this material leads to the conclusion, for reasons given in the following paragraphs, that Professor Cockerell was mistaken in identifying his material with *Tithymalus* of the Euphorbiaceæ, although it does show a striking superficial resemblance to the seeds of some of the spurges. *Tithymalus willistoni* becomes *Celtis willistoni* and is described and illustrated in somewhat greater detail below. *Tithymalus phenacodorum* Cockerell from the "Wasatch or slightly older Eocene" of Wyoming becomes *Celtis phenacodorum*, and it is very likely that *Celtis hatcheri* Chaney of the South Dakota Oligocene should be regarded as a synonym of that species, although I am not certain of this last point. Both are the same size and have the same form, but the single known specimen of *Celtis phenacodorum* is rugose, whereas in the vast majority of the very numerous stones of *Celtis hatcheri* the corresponding rugosities are but faintly developed.

Chaney interpreted the latter (op. cit., p. 54) as the complete fruits with the thin fleshy outer layer shrunken by drying and thereby thrown into reticulate wrinkles, but I believe that he was mistaken in this, and that the fossils represent the stones from which the fleshy layer had disappeared before fossilization, because the wall is but one layer thick instead of two as it should be if Chaney's interpretation was correct. Moreover *Celtis* fruits, even in arid regions so far as I have observed, and I have collected them in both North and South America, usually lose the flesh from the stones naturally by drying and abscission or by the digestive juices of the birds which compete for the relatively scanty food supply in such regions.

Of course I realize that smoothness and rugosity are not very good specific characters—the present collection of *Celtis willistoni* emphasizes this, and it is also illustrated among the stones of our existing North American species, but inasmuch as *Celtis phenacodorum* and *Celtis hatcheri* are found at different geological horizons and in different regions I do not feel justified in asserting their specific identity.

#### Figures 1 to 6

DESCRIPTIONS.—Stones ranging from nearly spherical to prolate, usually evenly rounded proximad, slightly narrowed and bluntly pointed distad where the lateral rugæ unite. Nearly circular in transverse profile, the diameter at right angles to the sutures slightly greater than the diameter parallel with the sutures in the larger and more normal sized stones. As might be expected, the smaller stones show just the reverse dimensions—the diameter parallel to the sutures is slightly more than that

at right angles to the sutures, and this leads me to think that the relatively rare smaller stones are puny, and that the larger represent the normal size for the species. These dimensions come out in the following measurements, which are given in millimeters:

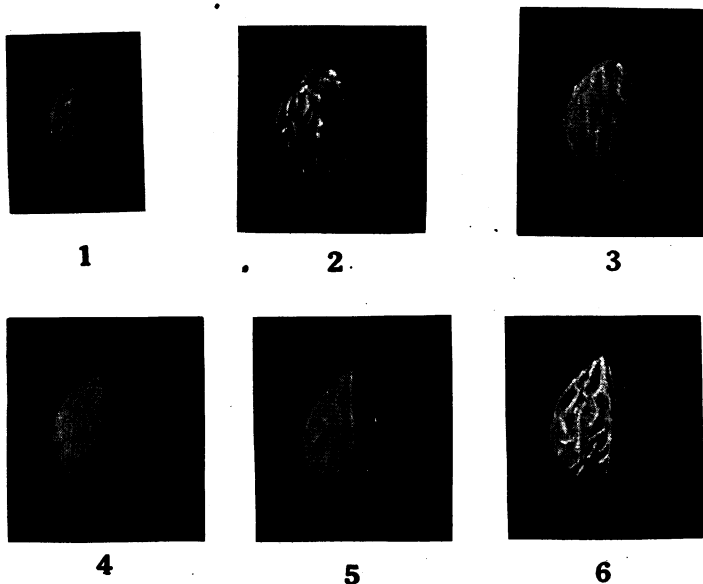


Fig. 1. Side view of minimum sized specimen from Kit Carson County, Colorado. Three times natural size.

Fig. 2. Side view of larger specimen from same locality. Three times natural size.

Fig. 3. Side view of a normal sized specimen from Phillips County, Kansas. Three times natural size.

Fig. 4. Sutural view of smooth form from same locality. Three times natural size.

Fig. 5 and Fig. 6. Sutural views of normal rugose forms from the same locality. Three times natural size.

Length.	Diameter, right angles to sutures.	Diameter, parallel with sutures.
3.25	3.00	3.10
4.00	3.25	4.00
3.75	3.25	3.50
6.50	5.00	4.60
6.00	4.50	5.00
6.00	4.50	4.50
6.70	5.00	4.50

The average length of the stones is about 6 millimeters and the length is more constant than the diameters.

The surface ornamentation is of the same type throughout all of the material, but varies considerably in intensity. It is not possible to determine to what an extent this variation is natural and to what degree it is artificial. *Celtis* stones of a single existing species show considerable variation with respect to this feature. I doubt very much if the fossils suffered any considerable wear before entombment, although they may have suffered some, as the matrix is an illy sorted and rather coarse sharp sand. That they have been abraded somewhat in the more than 40 years since they were collected is shown by the fact that of 171 loose specimens which I found in a bottle in the National Museum collections, the bottle contained a considerable amount of fine white dust due to attrition. How long they had been bottled or how much handling the bottle had undergone I do not know, but it was presumably not much.

The surface features of the highly ornamented stones, which outnumber the smooth stones five to one, may be described as follows: From the slightly umbonate or bluntly pointed apex a pair of opposite and relatively prominent keels or ridges extend downward to the base, becoming less prominent proximad. These are distinctly double with a suture between them all around and forming a complete circle, and evidently marking an absciss line along which the stones sometimes separate into two equal halves. There may or there may not be a pair of less prominent and less complete ribs between the sutural ridges. The remainder of the surface is covered with more or less conspicuous reticulating ridges or rugæ subtending irregular polygonal depressions. The surface, under a magnification of 41 diameters, appears compact, and shows no indication of the outlines of the stone cells of which it is composed. The wall is 0.5 millimeter in thickness.

In all of the foregoing features these fossils agree with the modern stones of *Celtis*. They differ from any *Euphorbia* seeds that I have seen in their larger size, in the absence of any trace of the raphe which is so prominent a feature in that group, in the presence of a sutural ridge around the whole circumference, and in the rugose surface—the last corresponding to what is met with in *Celtis*, and unlike that in any *Euphorbia* seeds studied.

It was the superficial resemblance of these fossils to the seeds of the common western *Euphorbia* or *Tithymalus marginata* that led to Williston's suggestion of the relationship for the fossils which was adopted by Cockerell. In the seeds of this species the raphe is conspicuous from the chalaza to the hilum—a characteristic of anatropous seeds—and there is no apparent reason why it should fail to become silicified along with the

rest of the seed coat. If it were conceivable that the raphe failed of preservation its position would surely be indicated by the configuration of the ventral face of the seed as compared with the dorsal face, because there is a smooth band along the raphe which is bordered on either side by a row of relatively prominent tubercles. The fossils are so numerous and so well preserved that it would certainly be possible to detect differences in ornamentation of the two surfaces if such had been present in life. Moreover the ornamentation in *Euphorbia marginata* is distinctly not of the rugose type which the fossils show, but is tuberculate or papillose, and not pitted. •

The lateral meridians of the *Euphorbia* seed  $90^\circ$  from the raphe on each side, show a row of prominent tubercles which coalesce upward to form a prominent keel of which the chalazal apex is the center. Under the microscope (41 diameters) the stone cells of the seed coat are readily seen to be from three to five times as long as wide and oriented with their long axes parallel with the long axis of the seed, whereas a similar magnification of the fossil or Recent *Celtis* stones shows a compact surface with no trace of the outlines of the constituent and much smaller cells.

