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A NEW *TEMPSKYA*

BY

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A NEW *TEMPSKYA*

BY
CHESTER A. ARNOLD

CONTENTS

INTRODUCTION

A SMALL collection of silicified plants received several years ago from Mr. N. H. Niles of Custer, South Dakota, contains four specimens of the Cretaceous fern *Tempskya*. Three of them represent *Tempskya knowltoni* or *T. minor,* but one belongs to an undescribed species. The matrix of all four specimens is brilliantly colored chalcedony which takes a high polish, and the specimens were collected for this feature rather than for their possible scientific value. Mineralization of the tissues has obliterated most of the cellular structure but the gross anatomical features are distinctly visible on the polished surface (Pl. III, Fig. 1). Thin sections are quite transparent and show little detail under the microscope, although in a few places enough cell and tissue structure is visible to make possible comparison with other species.

In addition to *Tempskya* the collection contains a portion of the trunk of an unidentified tree fern, pieces of coniferous wood, and fragments of massive cycadeoid trunks. The specimens were all found in the northwestern part of Dawes County, Nebraska, among loose boulders that had eroded out of the Oligocene Chadron formation in the valley of Cottonwood Creek, a tributary of the White River. At the site where the specimens were collected, which is "Locality 16" of Schultz (1955, Table 1), these boulders are spread over a wide area (Pl. I, Figs. 1 and 2, and Pl. II, Fig. 1). A few are a foot in diameter, but most of them are smaller. They are rounded,

very hard, and have obviously been stream-transported for a considerable distance (Pl. II, Fig. 1).

Although the plant specimens were found in an eroded Oligocene deposit, the presence of *Tempskya* and *Cycadeoidea* in this area demonstrates conclusively that some, if not all, of the boulders came from the late Lower Cretaceous Lakota sandstone, a highly indurated formation which has yielded large quantities of silicified cycadeoid trunks and coniferous wood. It forms a prominent hogback around the Black Hills and many *Cycadeoidea* trunks have been collected from it in the Minnekahta region a few miles north of the Nebraska site. The presumption is, therefore, that these silicified plants were eroded from the Lakota sandstone during the early part of the Oligocene epoch and that they were carried by swift streams over the intervening 50 miles to the site where they were found. Although *Tempskya* has never been identified from the Lakota sandstone, the silicification of the tissues of the specimens found in Nebraska is so similar to that of the Lakota cycadeoids that it dispels any doubt that they were all derived from the same source.

Tempskya has lately become a genus of considerable importance in American paleobotany. Throughout the first three-quarters of a century of extensive geological exploration and fossil collecting in the western part of the country this genus escaped notice. Cherty blocks of silicified *Tempskya* trunks were undoubtedly seen, but they were examined only casually or mistaken for palms or other plants. It was not until collectors, both professional and amateur, became familiar with the peculiarities of *Tempskya* that the general prevalence and widespread occurrence of this highly distinctive plant was realized. I recall how a chance spot identification of a small piece of *Tempskya* in a rock shop in Portland, Oregon, in 1940 started a multitude of rock hunters searching for it.

The first report of the existence of *Tempskya* in North America was Berry's discovery of *Tempskya whitei* in the Patapsco formation of the Potomac group of Maryland (Berry, 1911). The first account of a western American species was Seward's description of *T. knowltoni* from Montana (Seward, 1924). In 1937 Read and Brown described two more western species and gave a complete account of all the American material then known. They also discussed the relationships, the stratigraphic range, and the distribution of the genus. Additional material has since been described by Arnold (1944) and Andrews and Kern (1947). Read and Brown had previously cited eleven *Tempskya* localities in the Rocky Mountain and Great Basin regions, but in recent years many more occurrences of this plant have been reported, and a complete list would probably contain twice

as many localities as were known in 1937. Several of these new sites were found by amateur collectors in quest of gem stones.

Silicified *Tempskya* trunks are seldom found in place, and their occurrence among loose boulders, as in Nebraska, is not exceptional. This has, of course, introduced some uncertainty concerning the stratigraphic range of the genus. The only place where I have seen *Tempskya* in position is 6 miles southeast of Castledale, in Emery County, Utah, about one-half mile below the confluence of Rock Canyon Wash and Cottonwood Creek. Here the *Tempskya* bed is in what Stokes (1952) calls the Cedar Mountain formation and it lies about 50 feet below the so-called Dakota sandstone. The species found there has been tentatively identified as *T. minor.*

The descriptions of some of the European species of *Tempskya* are based on material that had been removed from the original site of deposition. For example, *T. rossica,* a Russian species, was described from a specimen in a Tertiary conglomerate (Kidston and Gwynne-Vaughan, 1912). Stopes (1915) believed that material found in the Lower Greensand, which was identified as *T. erosa,* had come from the underlying Wealden. Also, the specimen that Corda (1845) described as *T. pulchra,* which is now accepted as the type species of the genus, was a loose stone (Gerölle) that was picked up in the bed of the Elbe River. The three other species that Corda named were also of unknown origin. Thus much of our knowledge of the structure of *Tempskya* is the result of the fact that its tissues readily became silicified to form relatively indestructible objects.

GENERAL DESCRIPTION

The specimen under consideration is a transverse slab that measures about 6 by 12 cm. (Pl. III, Fig. 1). It was 2 cm. thick before cutting. The shape of the specimen indicates that it represents about a quarter of a complete trunk section. Although complete silicification of the tissues has obliterated most of the microscopic detail, the form of the individual stems is retained (Pl. II, Fig. 2).

About 21 large stems are displayed on the polished surface of the specimen. Without the attached leaf bases they would measure at least 1 cm. in diameter, but because almost all of them show at least one departing trace and a majority have four or five in various stages of departure, a single stem may measure 2 cm. across its greatest width. This large stem size characterizes the species. For this reason the name *Tempskya superba,* sp. nov., is appropriate. In comparison with the stems, the roots that comprise the binding mass of the trunk are small, resembling those of other species. In addition to the roots and stems, free petioles are also present. In cross section these are nearly round and measure about 5 by 6 mm.

STRUCTURAL DETAILS

As in other species of *Tempskya,* each of the individual stems contains a solenostele which is surrounded by a cortex, and which has a pith in the center. The thickness of the cortex varies, but at most places it measures about 1 mm. The cortex appears to be essentially three-zoned, although occasionally the middle zone is thin and the outer zone itself shows outer, middle, and inner layers (Pl. III, Fig. 2). It is not certain, however, that the three zones of this cortex are identical with similarly located zones described for other species. The original outermost cells (which probably correspond to the outer cortex of other species) are indistinctly preserved and show only as a band of light brown, structureless material. Although this band is narrow, it is probably what Read and Brown refer to as the "outer cortex." No further comment will be made about this layer in the specimen under discussion here as its identity is not beyond question. In our specimen the outermost zone that shows structure is probably what Read and Brown designate as the "middle or sclerenchymatous cortex." However, their description was largely based on *T. knowltoni,* which differs in some respects from our form. Therefore, reference herein to the outer, middle, and inner zones of our species does not imply that these zones are the same as the outer, middle, and inner cortical layers in other species of *Tempskya.*

The three layers of the outer zone of our specimen consist of (1) a band of cells with conspicuous dark contents, (2) a lighter layer, and (3) a darker but rather disorganized band (Pl. III, Fig. 2). The relative thicknesses of these zones vary.

The middle zone in our specimen probably corresponds to the outer part of the "inner cortex" of Read and Brown. This zone varies in width but is usually thin, and is sometimes scarcely discernible. It appears to be made up of small, rounded, compactly placed cells with thin walls. The inner zone in our specimen is an irregular sclerotic layer (not always distinctly preserved) which is similar to that described by Read and Brown for *Tempskya grandis* (see below).

In the better preserved stems an endodermis is visible just inside the cortex. It is followed first by a pericycle two cells thick and then by a thin band of delicate external phloem. This sequence of tissues occurs in reverse order inside the xylem cylinder, even to the the existence of an irregular sclerotic layer in the outermost pith. The central part of the pith is also sclerotic, the two zones being separated by ordinary pith tissue.

The xylem cylinder, which is about 0.4 mm. thick, resembles that of other species of *Tempskya.* It consists of tracheids and parenchyma cells

in approximately equal numbers, although the small parenchyma cells fit between groups of much larger tracheids. The protoxylem has not been located with certainty but the smallest recognizable elements are at the outer edge of the xylem cylinder.

The foliar traces depart in the same manner as in other species. Four or five in various stages of departure commonly show on each stem section. The internodes are therefore short. The strand of a detached or nearly detached petiole is strongly incurved and the arc is very slightly flattened.

COMPARISONS WITH OTHER SPECIES

On the basis of anatomical structure the American species of *Tempskya* appear to fall into two groups (Read and Brown, 1937; Andrews and Kern, 1947). One group, which consists of *Tempskya grandis, T. wesselii,* and *T. wyomingensis,* has relatively large stems with short internodes and much parenchyma in the xylem ring. The other group, represented by *T. knowltoni* and *T. minor,* is distinguished by a set of contrasting characters. Our specimen belongs to the first group and is very similar to *T. grandis,* which was originally described by Read and Brown from the Aspen shale of Wyoming. The irregular band of sclerenchyma in the inner cortex and the outermost pith is similar in both species, and so far has been described only in these two forms. The sole difference between *T. grandis* and the Nebraska specimen is the much larger size of the stems of the latter. Read and Brown do not give stem measurements for *T. grandis;* they merely refer to them as "large." They do state, however, that its stems are similar in size to those of *T. rossica* which, according to the original account, are 6 to 7 mm. in diameter. *T. wyomingensis* has stems that are similar in size to those of *T. grandis* (Arnold, 1944), and direct comparison of these two species with the new form shows a striking difference in size (Fig. 1). Because size as a taxonomic character in fossils and in living plants is regarded with mistrust, good reasons must be given for its use. It is, of course, possible that our specimen is merely an exceptionally robust individual of *T. grandis,* but the fact that the stems of different specimens of species of *Tempskya* are very uniform in size supports the use of size as a specific character in this instance. No form so far described from western North America shows as great a difference within the species as the difference between the Nebraska form and *T. grandis* or *T. wyomingensis.* Therefore, on the basis of our rather extensive knowledge of the internal structure of *Tempskya,* a size difference of the degree displayed is tentatively acceptable as a distinguishing character.

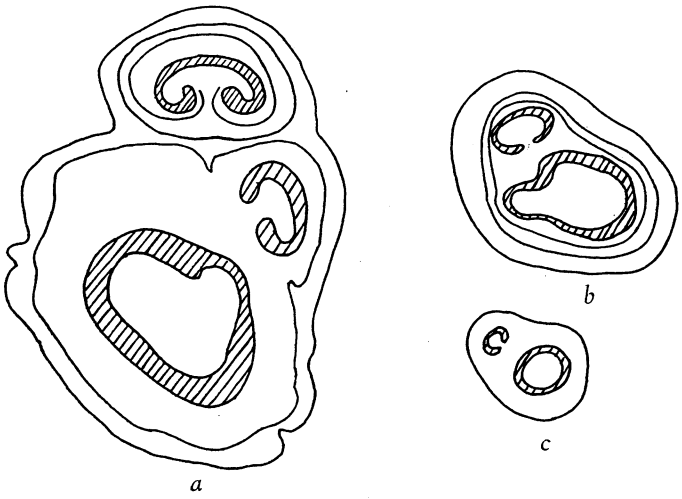

FIG. 1. Tracings to show relative sizes of stems of three species of *Tempskya*. *a, T. superba; b, T. wyomingensis; c, T. knowltoni.* × 4.

SPECIFIC DIAGNOSIS

Tempskya superba, sp. nov.

Similar to and showing the distinctive characters of *Tempskya grandis* but having stems which, including the petiole bases, measure up to 2 cm. in diameter.

Source.—Boulder bed in the early or middle Oligocene, but apparently derived from the Lower Cretaceous Lakota sandstone.

Locality.—Northwestern part of Dawes County, Nebraska.

Type.—Holotype No. 34561, Museum of Paleontology, University of Michigan.

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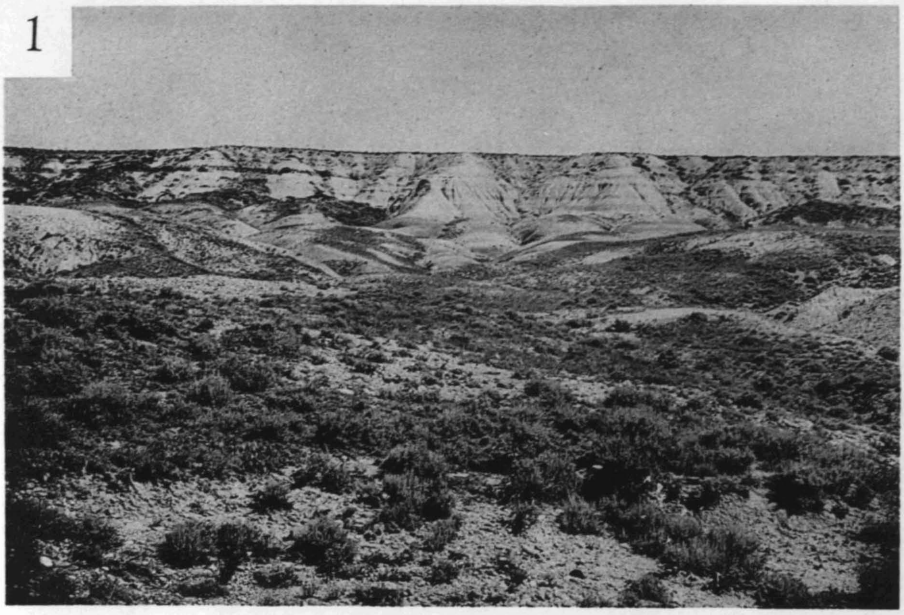
EXPLANATION OF PLATE I

FIG. 1. View looking north in valley of Cottonwood Creek, northwestern part of Dawes County, Nebraska, showing characteristic type of erosion of early and middle Oligocene shales. The foreground is strewn with rounded, stream-transported boulders, a few of which consist of silicified plant tissue.

FIG. 2. View of same locality showing boulder bed in shale.

PLATE I

1



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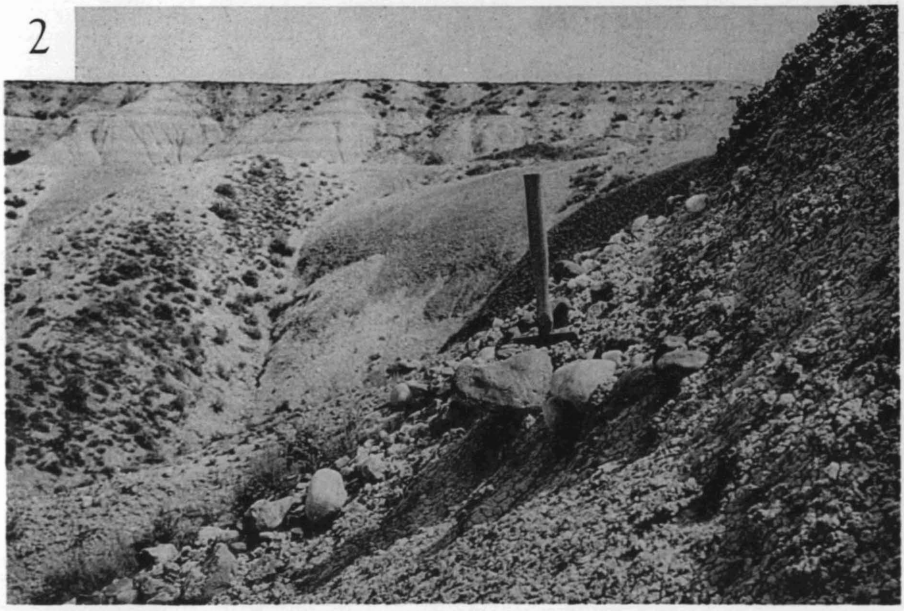
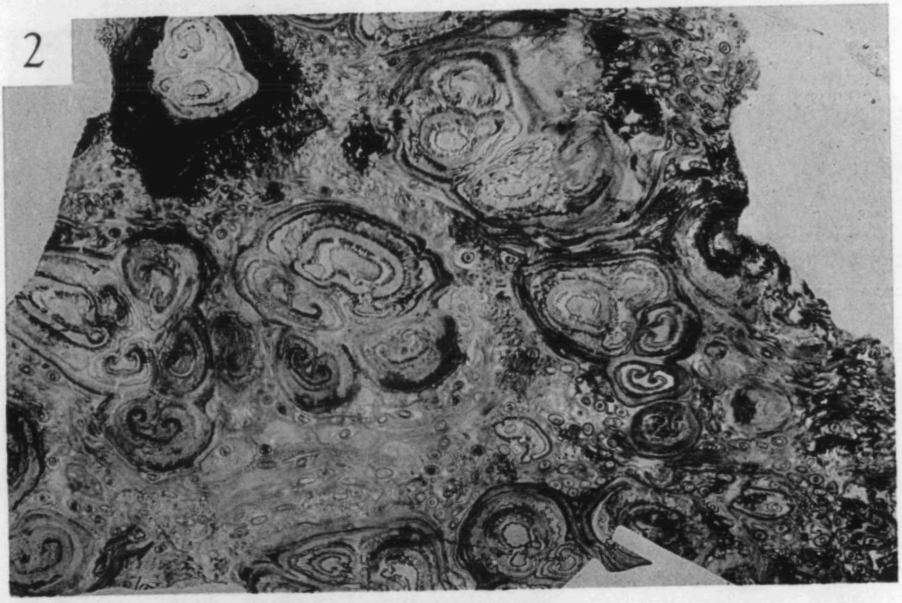


PLATE II

1

2



EXPLANATION OF PLATE II

FIG. 1. Accumulation of rounded boulders in valley of Cottonwood Creek. Same locality as shown in Plate I.

FIG. 2. *Tempskya superba,* sp. nov. Thin section showing large stems, free petioles, and small roots. Holotype No. 34561. × 2.

EXPLANATION OF PLATE III

FIG. 1. *Tempskya superba,* sp. nov. Photograph of polished surface of specimen. Holotype No. 34561. Natural size.

FIG. 2. Cortex, vascular cylinder, and pith of one of the better preserved stems. × 40.

PLATE III

1

2