

DESCRIPTIONS OF THE SPECIES OF CYCADEOIDEA, OR  
FOSSIL CYCADEAN TRUNKS, THUS FAR DETERMINED  
FROM THE LOWER CRETACEOUS RIM OF THE BLACK  
HILLS.<sup>1</sup>

By LESTER F. WARD,

Associate Curator, Section of Palaeobotany.

Within the past five years there have come into my hands for determination 155 specimens of cycadean trunks, counting the perfect trunks and the fragments or parts of trunks in all states of completeness and of preservation, but exclusive of such duplicate fragments as are known to belong to the same individual. Of these, 25 specimens belong to the U. S. National Museum; 2 to the State School of Mines, South Dakota; 2 to the Woman's College of Baltimore; and 126 to Yale University. Out of all this material I have distinguished 21 species, all but one of which are new to science. The following are the species, systematically arranged:

1. *Cycadcoilex dacotensis* (McBride) Ward emend.
2. *colossalis*, new species.
3. *wellsii*, new species.
4. *minnekahtensis*, new species.
5. *pulcherrima*, new species.
6. *ciatricula*, new species.
7. *turrita*, new species.
8. *mcbridei*, new species.
9. *marshiana*, new species.
10. *furcata*, new species.
11. *colei*, new species.
12. *paynci*, new species.
13. *aspera*, new species.
14. *insolita*, new species.
15. *occidentalis*, new species.
16. *jenneyana*, new species.
17. *ingens*, new species.
18. *formosa*, new species.
19. *stillwelli*, new species.
20. *excelsa*, new species.
21. *nana*, new species.

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

The following is a systematic description of these species:

Genus CYCADEOIDEA Buckland.

1827. *Cycadeoidea* BUCKLAND, Proc. Geol. Soc., London, I, No. 8, pp. 80-81 (session of June 6, 1827).

1828. *Cycadeoidea* BUCKLAND, Trans. Geol. Soc., London, 2d ser., II, pp. 375-401, pls. XLVI-XLIX (volume dated 1829, but memoir probably issued separately in 1828).

CYCADEOIDEA DACOTENSIS (McBride) Ward emend.

1893. *Beunettites dacotensis* McBRIDE, in part, American Geologist, XII, p. 249, pl. XI, fig. 1 (non f. 2).

1894. *Cycadeoidea dacotensis* (McBRIDE) WARD, in part, Proc. Biol. Soc., Washington, IX, p. 86.

Trunks large (30 to 50 cm. high, 30 to 50 cm. in diameter, 100 to 150 cm. in girth), short-cylindrical, contracted below, dome-shaped above, symmetrical, sometimes laterally compressed and elliptical in cross section, probably subsequent to entombment; bearing a number of short secondary axes or undeveloped branches in the form of rounded protuberances, or, in case of decay, of corresponding saucer-shaped depressions; apex presenting a flattened surface with a central elevation studded with polygonal bract scars and bases arranged in rows which sometimes proceed in helicoid form from the center outward; rock substance of a dark brown or reddish color, firmly silicified, hard and heavy, sometimes weighing over 100 kg., fine grained; organs of the armor slightly ascending except near the base, the angle increasing toward the summit where they become vertical; leaf scars where not interrupted forming two series of spiral rows which proceed in different directions and intersect one another, those from right to left nearly horizontal below and curving upward until they form an angle of  $45^{\circ}$  with the vertical axis, the opposite series less distinct forming a small angle ( $5^{\circ}$  to  $10^{\circ}$ ) with the axis; scars subrhombic and nearly uniform in shape, larger below, diminishing upward, the distance between the lateral angles varying from 16 to 26 mm., and that between the vertical angles from 10 to 16 mm., empty from decay of the petioles, at least to considerable depth, sometimes to a depth of more than 5 cm.; interspaces between the scars very thick, though variable, sometimes 16 mm., presenting an undulate or wrinkled surface with indications of deeper lines of separation of the walls; spadicces large and somewhat elliptical in outline, the longer axis nearly horizontal, 8 to 10 cm. long, the shorter nearly vertical and 5 to 7 cm.; involueral bract scars numerous, arranged in concentric ellipses around the central organs in many somewhat distinct rows, increasing in size from the center outward, subrhombic, triangular, or polygonal in shape, 2 to 20 mm. in diameter, apparently passing insensibly into the normal leaf scars, empty like them\* forming deep cavities or punctations; essential organs of the buds, flowers, or

fruits sometimes wanting, their place occupied by a deep circular cavity, more frequently represented by a dark and firm substance, which in some of the smaller ones projects beyond the general surface; armor 5 to 7 cm. thick, separated from the ligenous axis by a definite line; cortical parenchyma 5 cm. thick, fibrous zone 4 cm. thick with three or more rings of wood, or sometimes presenting a number of thin concentric laminae of alternating black and brown substance, apparently representing as many rings of wood, and inclosing the homogeneous medulla 5 to 15 cm. in diameter, conforming in cross section to the trunk.

Only one of the specimens belonging to the U. S. National Museum is referable with certainty to this species. This is the fine trunk, No. 1, of the collection of six purchased of Mr. Cole. That this is specifically identical with Professor McBride's specimen represented by fig. 1 of his plate there is no room to doubt. It is, however, difficult to reconcile it with his description, in view of the fact that in that description he has included two specimens belonging to entirely different species, his fig. 2 showing none of the external characters of fig. 1, or of the specimen in hand, but clearly belonging to the same specific group as several of the fragments collected by Professor Jenney and myself from the Minnekahta locality in 1893, as will be shown below. As Professor McBride in his description includes characters that could scarcely have been exposed in the perfect trunk represented by his fig. 1, it seems clear that he derives such from the specimen fig. 2, which was probably a fragment showing these characters in the fractures. It was therefore a question whether to retain the name or not. I conclude to do so for so much of Professor McBride's description as applies to his fig. 1.

The Museum specimen is somewhat larger than the one in the University of Iowa, standing over 44 cm. high, having a girth of 122 cm., and weighing 90.27 kg. It is one of the most perfect and beautiful cycadean trunks that have thus far been brought to light.

Thirteen of the specimens in the Yale collection are referred to this species. These are Nos. 1, 3, 5, 6, 13, 30, 39, 43, 54, 62, 63, 95, and 106. Of these Nos. 3, 5, and 54 are nearly perfect trunks, and one of these, No. 54, is larger than the one in the U. S. National Museum.

#### CYCADOIEDEA COLOSSALIS, new species.

Trunks colossal, subconical or subcylindrical, more or less laterally compressed, dark colored, hard and heavy, weighing from 100 to over 300 kg., 38 to 79 cm. high, 40 to 66 cm. in major, 26 to 46 cm. in minor diameter, 100 to 180 cm. in girth, bearing numerous relatively small branches not projecting far beyond the general surface; terminal bud low, set in a circular platform of small polygonal scars filled by the bases of the leaves or bracts; organs of the armor and secondary axes horizontal at the middle portion of the trunk, somewhat descending at the lower portion and ascending at the upper portion; phyllotaxy much obscured

by the intrusion of other organs, but spiral rows ascending from left to right at an angle varying from  $75^{\circ}$  below to  $45^{\circ}$  above plainly traceable; leaf scars subrhombic to nearly rhombic, very small relatively to size of trunk, 13 to 16 mm. between lateral, and 8 to 12 mm. between vertical angles, empty to a depth of 13 to 50 mm., the bottoms of the cavities apparently occupied by portions of the leaf bases; interstices between the scars very variable, but, except at the summit, generally large, sometimes 25 mm., nearly even on the surface but finely marked with mostly horizontal but variously curved or crooked ridges or wrinkles, with occasional indications of planes of separation into two, three, or even five plates; walls much thinner in the upper portion, often broken down in the specimens, displaying the striate inner surface of the scars diminishing in size below; reproductive organs abundant at all parts of the trunk, large, well developed, and conspicuous, often rising somewhat above the surface, forming gentle swellings or more abrupt protuberances, elliptical in shape, the major axis nearly horizontal, 5 to 10 cm. long, the minor axis 3 to 5 cm., usually with a solid center, sometimes with a small central cavity surrounded by firm substance, the whole inclosed within concentric elliptical rings or rows of involucreal bract scars which increase in size from the center outward, are empty, and have the form of the leaf scars, into which they occasionally seem to graduate; armor 5 to 10 cm. thick, attached to the woody axis by a uniform layer of bark 6 mm. thick; cortical parenchyma 4 to 6 cm. thick; fibrovascular zone also 4 to 6 cm., separated into two distinct rings of wood, each consisting of a loose spongy substance inclosed in a firm plate or thin hard layer, the outer ring 35 mm. and the inner 25 mm. in thickness, through all of which the medullary rays pass forming a sort of columnar structure; medulla more or less elliptical in cross section, 11 to 13 cm. by 15 to 20 cm. in diameter, decayed leaving a cavity at the base in one specimen, and in another having a concentric structure consisting of four zones or rings of soft porous material scarcely differing except in coloration.

The large perfect specimen, No. 6 of the Cole collection, is the largest cycadean trunk known in the world. Prior to its discovery the great *C. reichenbachiana* (Göppert) Capellini & Solms-Laubach from Galicia which is at the Mineralogical and Geological Museum in Dresden, and which I have not seen, had taken the lead. Prof. H. B. Geinitz was so kind as to send me an excellent photograph of that specimen, and on this I find the dimensions marked. It is 50 cm. high, 51 cm. in major, and 44 cm. in minor, diameter, and 157 cm. in girth. It is therefore not so tall as the American specimen by 29 cm., has a major diameter 25 cm. less, and a minor diameter 2 cm. less, showing that it is less flattened, but the circumference is 23 cm. less. [The photograph sent me by Professor Geinitz was taken from the specimen in position as mounted on a support in the Dresden Museum. Judging from it alone I should say that the trunk is here inverted, but to be certain it would



be necessary to examine it. It is clear that in the present position the leaf scars have a decided downward direction, which is rare but not unknown (e. g., *C. uhleri*). Moreover, the scars, which are subtriangular, have now their sharp angle upward, which, if the specimen is right side up, would indicate that the keel of the petioles was on the upper side, a condition which I have only met with in two other species, *C. aspera* and *C. insolita* described below. Göppert's figure<sup>1</sup> shows the specimen in the same position, that is, probably inverted.]

Eight of the specimens in the Yale collection belong to this species, namely, Nos. 2, 7, 9, 10, 17, 37, 40, and 55, of which Nos. 2 and 10 are perfect trunks, but are both much shorter in proportion to their size than the great National Museum type. They are also less laterally compressed. They may have been somewhat vertically compressed. No. 37, though incomplete, is a fine specimen, weighing nearly 150 kg., and has a height of 71 cm. No. 55, though it has lost considerable at the summit, still weighs 110.68 kg. No. 40, which represents less than half of the original trunk, is also a fine fragment. The rest are smaller and more imperfect.

#### CYCADEOIDEA WELLSII, new species.

Trunks large, ellipsoidal, subcylindrical, or somewhat barrel-shaped, more or less laterally compressed, rounded at the summit, bearing numerous small secondary axes in the form of protuberances, light reddish brown or drab colored, fine grained, hard and rather heavy, sometimes weighing nearly 100 kg., 40 to 55 cm. high, 30 to 45 cm. in diameter, and more than 1 meter in girth; terminal bud not prominent; organs of the armor about horizontal except near the summit; phyllotaxy much disturbed and not traceable; leaf scars rather small, subrhombic or nearly rhombic, often trapeziform or very irregular in shape, average distance between the lateral angles 20 mm. and between the vertical ones 12 mm., none of the angles rounded, all except the small ones at the apex empty to considerable depth; ramentaceous interspaces exceptionally thick, sometimes 2 cm., presenting a smooth but gently undulating surface, lowest in the middle part rising to the scar which forms a sharp edge, producing the general effect of being molded in plastic clay; reproductive organs very large, abundant, and conspicuous, greatly distorting the arrangement of the leaf scars as well as their form, often nearly circular in cross section, 4 to 5 cm. in diameter, showing the remains of the central organs surrounded by concentric circles of large, empty, and deep involueral bract scars which are semilunar or somewhat triangular in shape, and may reach 7 mm. in length; armor about 7 cm. thick, cortical parenchyma 4 cm., fibrous zone 4 cm. showing two rings, the inner projecting at the base, concentrically laminated and inclosing the much decayed medulla about 12 cm. in diameter.

<sup>1</sup>Jubiläums-Denkschr. d. Schles. Ges. f. nat. Cult., 1853, pl. viii, fig. 1.

There are two specimens of this species in the Yale collection, namely, Nos. 21 and 59, the former of which is a fine, nearly perfect trunk, large and handsome, weighing 92.76 kg. I was at first inclined to regard them as belonging to *C. minnekahtensis* on account of the general resemblance of the external surface; but this obviously can not be done, because these trunks are unbranched and symmetrical in form. In this respect they approach *C. dacotensis* and *C. colossalis*, but here the surface differs completely. No forms intermediate in either of these respects occur in either collection, and there is no escape from regarding these two trunks as constituting a new species.

I have named the species for Mr. Henry F. Wells, who obtained these and nearly all the rest of the Yale collection, and from whom Professor Marsh purchased them. He may therefore be regarded as the collector, which, under the approved rules for naming species, requires the use of the genitive form.

#### CYCADEOIDEA MINNEKAHTENSIS, new species.

Trunks gigantic, much branched and irregular in form, the type and only perfect specimen known weighing 219.09 kg., 74 cm. high, 50 cm. in diameter exclusive of branches, 79 cm. across at maximum spread of branches, 150 cm. in girth, light brown or chestnut colored, smooth on the outer surface presenting the appearance of having been molded in plastic clay, moderately heavy; branches very large forming conical protuberances projecting from the middle portion of the trunk giving it a winged appearance, other branches proceeding from other parts, especially below, composite, that is, the main branches or primary axes having lesser or secondary branches; prominent terminal buds, sometimes themselves compound, on all the branches, often very perfect with a sort of neck; organs of the armor declined over most of the surface; phyllotaxy obscure and not traceable; leaf scars subrhombic to nearly rhombic, averaging 22 mm. wide by 10 mm. high, the unusual vertical narrowness perhaps due to compression, very variable, however, in all respects, those on the lesser branches smaller, usually empty and striate within; ramentaceous interstices usually thick, 5 to 15 mm., firm and fine-grained, smooth and polished but somewhat undulating, the edges of the scars sharp, always without signs of subdivision; reproductive organs numerous, simulating the small branches, the central part preserved but heterogeneous, showing scars and markings of the essential organs, varying from 12 to 50 mm. in diameter, surrounded by small involucrel bract scars; armor about 6 cm. thick, separated from the underlying tissues by a thin porous layer; cortical parenchyma about 5 cm. thick; fibrovascular zone 8 cm. thick without visible subdivision into rings; medulla not clearly shown, and internal structure generally more or less conjectural.

The remarkably fine but weird and anomalous specimen upon which the above description is almost wholly based was found by our party lying partly buried in the ground, in the same place where the other trunks

had been gathered. It was overgrown with lichens in many places, and had been regarded so uncouth as not to be worth transporting to Hot Springs. I arranged with Messrs. Payne and Cole to have it shipped to Washington, and it arrived in due time in safety. It holds the fourth rank as to size and weight, but differs from all others in so many respects that a comparison with any is difficult. Specifically it approaches most closely to *C. pulcherrima*, but lacks all the symmetry and definiteness of that form. It is only in the fact that both are very branching, especially around the middle part of the trunk, that they have an external resemblance.

The specimen shows a fine terminal bud at the apex of the principal trunk and several others on the other branches. Except near the summits of the several branches the leaf scars and other organs of the armor are decidedly descending, but on the main branch or trunk, some distance above all the lateral branches, there is a sharp line separating the descending from the ascending scars above. This feature I have only seen elsewhere in *C. goucheriana* from Maryland.

The only other specimen in the collection that could with any propriety be included under this specific head is the small trunk picked up at the same time and place and numbered 19. This may represent a very young state of this species with all the characters in miniature and devoid of reproductive organs. It is branched much in the same way, longitudinally compressed, lacks a little of the base and part of one side below, but for purposes of description is practically complete. The entire trunk was only 18 or 20 cm. high, 14 or 15 cm. in its longer and 7 or 8 cm. in its shorter diameter, with a maximum girth of 36 cm. Its present weight is 1.81 kg. The dimensions are therefore less than one-fourth, and the weight is less than one-twelfth of the large trunk. It might even have been wholly subterranean as in the living *Zamia integrifolia*.

Among the fragments in the Yale collection I found eight that belong to these species, and as the National Museum type is nearly perfect, these add somewhat to our knowledge of the inner parts of the trunk. These specimens are numbered 14, 22, 24, 32, 41, 71-72, 83, and 86. They consist chiefly of branches torn away from large trunks, and several of them may have belonged to the same trunk. Some of them may be found to fit together, but as they were lying about in different rooms and even on different floors of the Peabody Museum, it was impossible for me to correlate them. Certain ones, as No. 14, consist of a mere gnarl of branches, and most of them are proliferous or composite, the branches often having fine, sometimes compound, terminal buds.

CYCADEOIDEA PULCHERRIMA, new species.

Trunks large (38 cm. high, 4 cm. in diameter, and 130 cm. in girth in the only complete specimen known), short ellipsoidal or subspherical, of a light ash color and moderately heavy, bearing numerous large, short branches at and below the center all round, forming conical protuber-



ances, some of which are 8 to 10 cm. long and 12 to 18 cm. in diameter at the base, rarely compound, that is, the branches themselves bearing other smaller ones, or two or more arising side by side; branches and all other organs radiate, that is, proceeding in the direction from the center of the trunk, those of the equatorial zone horizontal, or making a right angle with the axis, those below descending, and those above ascending; leaf scars arranged in definite rows intersecting one another, somewhat spiral, but so placed as to simulate meridians and parallels of latitude, the former series, however, rising from left to right and making an angle which varies with the curvature from  $5^{\circ}$  to  $10^{\circ}$  with the vertical axis, the other series, rising from right to left, varying from horizontal to an angle of  $45^{\circ}$ : scars varying in shape from subrhombic to nearly true rhombs and in size from 10 by 19 cm. or smaller near the summit to 16 by 22 cm. measured between vertical and lateral angles, which are usually quite sharp, the sides straight, and the whole very definite and symmetrical, usually empty to considerable depth, but partially filled by the remains of the leaf bases, which occasionally show punctations representing the vascular bundles; ramentum walls 2 to 5 mm. thick, wrinkled on their outer edges, often with a distinct median groove, sometimes reduced to thin lamellae with sharp edges, striate within the scars in the direction of the petioles; reproductive organs not abundant, the more typical ones mostly in the equatorial zone among the branches which they sometimes resemble, being large with a solid central axis surrounded by relatively large bract scars, nearly circular with a diameter of 5 cm., other smaller ones scattered among the leaf scars only slightly disturbing their arrangement, often abortive and reduced to collections of pits in the angles of the walls; armor 6 to 8 cm. thick, irregularly attached to the ligneous axis, which consists of a parenchymatous zone 3 cm. thick, inclosing a fibrous zone 25 to 35 mm. thick and divided into two to four exogenous rings; medulla 10 cm. in diameter at the base, enlarging upward to more than twice that size, porous in structure, its outer surface marked with longitudinal ridges which are interrupted and alternating, forming the bases of the medullary rays.

The trunk upon which the above description is almost exclusively based is the one which was called No. 3 of the collection obtained from Mr. Cole and is certainly, in my judgment, artistically the most beautiful cycadean trunk known. I say this deliberately, after having seen the greater part of all thus far discovered in all countries, and where I have not actually seen the specimens themselves I have, in almost all cases, seen artistic models, or at least excellent photographs or drawings. The specific name is therefore fully justified.

The characters of the internal structure and the medulla are derived from the large decayed area at the base on one side, which well exposes them, leaving the other side still perfect. The total weight of this specimen is 85.73 kg.



Only one imperfect specimen, namely, No. 78, of the Yale collection could be referred to this species, and this not without some doubt.

CYCADEOIDEA CICATRICULA, new species.

Trunks small and short, subconical, more or less laterally compressed, smooth and symmetrical, unbranched, light yellowish-brown on the weathered surfaces, fine-grained and flinty within, about 20 cm. high, 18 by 22 cm. in diameter, with a girth of about 60 cm., and weighing 13 or 14 kg.; organs of the armor nearly horizontal; leaf scars arranged in two definite series of spiral rows, those from left to right forming an angle near the base of about  $70^\circ$  with the axis but curving inward in their upward course so that the angle progressively diminishes to about  $30^\circ$  at the summit; those from right to left only slightly curving and making an angle of about  $45^\circ$ ; scars very small, almost exactly rhombic, uniform and definite with all the angles sharp, distance between lateral angles 9 to 12 mm., and between vertical ones 6 to 8 mm.; leaf bases present filling the scars to near the top presenting a roughened spongy tissue; ramentaceous walls very thin, varying from the thickness of tin foil to 2 mm., presenting a beautiful and regular network of whitened lines over the entire outer surface of the trunk, with a faint commissure or elongated openings between the contiguous plates of the thicker ones; reproductive organs not abundant nor well developed, the most typical 3 cm. in diameter, variable in shape and character, consisting of protuberances with a depression at the top or ridges with bract scars on the sides, others anomalous consisting of small projections or elevations, probably abortive, none of them greatly disturbing the form or arrangement of the leaf scars; armor 3 cm. thick, separated from the wood by a definite line or crack; cortical parenchyma 2 cm.; secondary wood 3 cm., consisting of an outer ring 2 cm. thick and an inner one 1 cm. with a fissure between; medulla elliptical, 5 by 7 cm. in diameter, consisting of a homogeneous substance resembling fine yellow sandstone, clearly marked off from the inner ring of wood.

This species is one of the best defined of all, notwithstanding that it is based upon a single specimen, namely, No. 118 of the Yale collection. This is an almost perfect trunk, and is only obscured by sand and gravel cemented in the scars so that very little can be seen of the summits of the leaf bases. It was collected by Mr. H. F. Wells three-fourths of a mile north of Black's ranch, about 3 miles north of Blackhawk, South Dakota. Its only affinities are with *C. pulcherrima*, with which it shares the rhombic scars and their definitely arranged rows.

CYCADEOIDEA TURRITA, new species.

Trunks of moderate size, profusely and irregularly branched, the primary branches often bearing secondary ones, the branches symmetrical, abruptly contracted at the base into cylindrical, turret-shaped projec-

tions, dome-shaped at the summit, with a terminal bud at the apex composed of small polygonal organs, usually light reddish, soft, friable, and of low specific gravity, but sometimes darker, harder, and heavier, 20 to 40 cm. high, 25 to 50 cm. in diameter, the branches 10 to 20 cm. long, 10 to 30 cm. in diameter, 30 to 90 cm. in girth; leaf bases slightly ascending; leaf scars very irregularly distributed over the surface except of the branches, here sometimes arranged in two sets of spiral rows which intersect each other at about the same angle ( $60^{\circ}$ ) with the axis of the branch, subrhombic, the upper and lower angles reduced to mere curves, 23 mm. wide, 12 mm. high; leaf bases almost always present, usually projecting, porous; vascular bundles often distinct, set well apart in a row some distance from the margin with a few others near the center, appearing either as small pits or black dots; ramentum walls thin, 1 to 2 mm., usually with a groove or commissure, sometimes thickening at the angles and affected with elongated pits and other openings, some of these latter passing into abortive flower buds, which constitute all that is known of the reproductive organs of the species; armor 5 cm. thick; woody axis only known in certain branches, thin, 2 to 3 cm., and not visibly divided; medulla in one specimen 9 cm. in diameter, black and homogeneous.

Twelve of the specimens of the Yale collection have been referred to this species, namely, Nos. 15, 45, 49, 51, 65, 66, 67, 70, 74, 75, 82, and 85, and still much remains uncertain as to the characters. They nearly all agree in the most striking feature, the possession of peculiar turret-like branches, but owing to the fragile nature of the rock and the sprangling habit of the species all the specimens were badly broken to pieces and nothing remains but *dissecta membra*. Some of these plants evidently consisted entirely of branches and possessed no trunk proper which could be regarded as bearing these branches, but usually there was a large shapeless mass at the base from which they proceeded in all directions. Such was the case in Nos. 45, 51, 66, and 67, some of which must be nearly complete. Nos. 45 and 75 belong to the harder and heavier sort, and possibly may not belong to this species. They might be referred to *C. minnekahntensis* or *C. marshiana* but for differences in the leaf scars and petioles, which agree with this species. No. 74 is very anomalous and is only placed here to avoid making new species out of deficient material. The turret, if such it was, is reduced by erosion to a pointed cone without character. The specimen is worn to and into the medulla on one side, but the opposite side is well preserved. The leaf scars are typical, but there is a number of large projecting axes looking like horns, and the specimen, laid on the worn side, has the shape and semblance of a gigantic "horned toad." All the other specimens are much alike, and No. 82 is taken as the type for most of the characters.

So far as the rock substance, color, and external organs are concerned, this species is very close to *C. mebridei*, but that species is always simple and consists of one large short trunk, constituting a broad dis-

tion which all the numerous specimens of both species do not tend in any way to obliterate. In its branching habit it approaches *C. minnickahtensis* and *C. marshiana*, but the external characters persistently keep it separate from either. In color it somewhat resembles the former, but this is all that can be said.

CYCADEOIDEA McBRIDEI, new species.

1893. *Bennettites dacotensis* McBRIDE, in part, American Geologist, XII, p. 249, pl. XI, fig. 2; Bull. Lab. Nat., Hist. State Univ. of Iowa, II, No. 4, pp. 391, 392, pl. XI, fig. 2.

1894. *Cycadeoidea dacotensis* (McBRIDE) WARD, in part, Proc. Biol. Soc., Washington, IX, p. 86.

Trunks large and very short (25 to 40 cm. high, 25 to 75 cm. in diameter with a girth of 80 to 250 cm.), more or less laterally or longitudinally compressed, well silicified but somewhat porous or spongy and therefore only moderately heavy, reddish brown in color, occasionally bearing small secondary axes which only slightly project; organs of the armor variable but usually radial in direction; leaf scars arranged in spiral rows intersecting each other at various angles, usually forming an angle with the axis in either direction of from  $40^{\circ}$  to  $55^{\circ}$ ; scars subrhombic or lozenge shaped, the distance between the lateral angles varying from 22 mm. to 35 mm., that between the vertical angles varying from 13 mm. to 16 mm., nearly always filled with the well-preserved bases of the leaves which have disarticulated at natural joints, leaving a smooth surface either convex or concave, or occasionally nearly flat, presenting a spongy appearance; vascular bundles of the leaves usually distinct in the form of pits or of dots of darker color arranged in one row all round the margin a short distance from it and with a few additional ones near the center; ramentaceous interspaces thin for the size of the trunks (1 to 4 mm.), compound, that is, consisting of two or more plates of firmer material separated by intervals of loose porous tissue, very uniform in character and little distorted, the porous tissue often worn to some distance leaving fissures divided by thin projecting walls; reproductive organs sometimes abundant and conspicuous, but usually rather scarce and poorly defined, some quite large with a cavitous funnel-shaped or crater-shaped center, others simulating leaf scars except that they are surrounded by a loose porous tissue in which angular pits occasionally occur, still others resembling small branches, making it difficult in some cases to decide to which class to refer them, one which has been cut through the center longitudinally showing a heterogeneous mass of internal organs resting on a conical receptacle 25 mm. below its somewhat projecting summit; armor 4 to 8 cm. thick, separated from the cortical parenchyma by a layer of true bark 6 mm. in thickness of soft texture, its inner surface (exposed in one specimen) covered with small pits or punctations and definitely marked by elliptical scars about 9 mm. long and 5 mm. wide which are aligned horizontally around the trunk the longer axis being in this direction, the



upper side of the scars usually so indistinct as to make them appear kidney-shaped, the lower side and ends consisting of a dark raised ring or welt with a groove all round it and exterior to it, the central portion occupied by a number of punctations more or less concentrically arranged; woody axis 9 to 12 cm. thick, of which the parenchyma occupies somewhat more than half and is very porous except where traversed by the medullary rays of firmer consistency; fibrous zone divided into an outer soft and an inner harder ring, the inner wall of the latter conspicuously marked by the scars of the medullary rays; medulla in the larger specimens 15 cm. in diameter, but usually elliptical and about 8 by 11 cm. of a uniform porous consistency.

I name this species for Professor McBride because he was the first to deal with it, although he confounded it with *C. dacotensis*, and parts of his description apply to the one and parts to the other species. Still his figures are clear and leave no doubt that his fig. 2 belongs here. In his description of that figure he says that it belongs to "another individual," which of course would have been otherwise evident, and parts of his description show that either this or other material in his hands consisted of fragments showing the interior of the trunks, which could not have been exposed in the "large, perfect individual." Most of his description of the internal parts must have been based on such fragments, and the following words appear to apply entirely to the present species: "Leaves not known; their bases as perceived are fusiform or lozenge-shape in cross section, one-half inch by one inch in dimensions, and show the remains of numerous equally developed fibro-vascular bundles."

His specimens seem to have come from exactly the same locality as those purchased from Mr. Cole, which I subsequently visited in company with Professor and Mrs. Jenney, with Messrs. Cole and Payne as our guides. There was found the large branching specimen, *C. minnekahtensis*, and there, too, I picked up twelve fragments of different sizes and shapes. These were numbered in continuation of the Black Hills collection, of which there are seven nearly perfect trunks, and therefore included Nos. 8 to 19. Of these six certainly belong to the present species, namely, Nos. 8, 9, 10, 13, 14, and 16. Two of these fragments, Nos. 10 and 14, are found on comparison to fit together and therefore of course to belong to the same trunk. When placed in their proper position they constitute the greater part of it, but a large segment is missing from one side. Among these specimens, all differently broken, a much larger number of characters are exposed than could be seen in any number of perfect trunks. Wherever two or more display the same parts they are in substantial agreement, and it is therefore assumed that such features as are only visible in some one specimen would be found in the rest if the proper parts could be exposed. The beautiful markings on the inner surface of the liber zone, as above described, are to be seen only in specimen No. 16. That all trunks of the species were of the short conical shape indicated by Nos. 10 and 14 when placed in



their natural position can not of course be demonstrated, but the other specimens do not negative this view.

Professor McBride remarks that "the present species is near *Bennettites gibsonianus* Carr., from which it may be distinguished by greater size and by the fact that in our species the fibro-vascular bundles of the leaf-stems are of uniform size and distribution, and do not form a horseshoe shape in cross section, as is said to be the case in the English species." In this last one would suppose he was confounding the undivided vascular bundle as it appears in the axis, and especially in its passage through the cortical layer<sup>1</sup> before it divides, with the form assumed by the numerous strands that enter the petiole and appear as small dots on a cross section of the latter.<sup>2</sup> Neither in the American Geologist nor in the Bulletin of the Laboratory of the State University of Iowa do these strands show clearly in fig. 2, still I think I can detect them, but in nearly all our specimens these bundles are very clearly shown, and they do agree remarkably well with those of Carruthers's figure.<sup>2</sup> Still I should hesitate to refer the American forms to *C. gibsoni* on this character alone, and having myself examined the British specimen I do not think it is very close in other respects.<sup>3</sup>

The absence of perfect trunks of this species in the U. S. National Museum collection is not due to its rarity in the Black Hills, as I was satisfied after examining the large number of fragments picked up by myself, but to the frailty of the species. There is in fossil cycads certainly a close connection between the mineral constitution and the original nature of the tissues, and both vary with the species, much as different kinds of wood differ in their qualities of hardness, durability, tenacity, etc., in our living forests. Accordingly the substance of the rock in this species is always soft, porous, and light, easily worn by attrition, and therefore frail. Moreover there is a tendency to early decay of the medulla and woody axis, which caused many of the trunks to become hollow before they were entombed. This made compression and general destruction easy and accounts for the difficulty in securing good specimens.

In view of these facts I was not surprised to find a large number of specimens of this species in the Yale collection. There are no less than 13 which I have so referred, although several of these are very abnormal and doubtful. The ones so classed are Nos. 8, 19, 23, 26, 27, 29, 38, 42, 46, 53, 73, 76, and 110. No one of these is absolutely complete, and the greater part of them are mere fragments. In the majority of cases the specific determination is clear at a glance, and this is true even of the smaller fragments. No. 19 is a typical and nearly complete trunk, weighing 51.46 kg., and No. 23 is by far the most perfect specimen of the species known to me. It weighs nearly 59 kg., but there is a vast cavity at the summit. No. 76 is also nearly complete and a fine

<sup>1</sup> Carruthers, Trans. Linn. Soc., XXVI, pl. LVII, fig. 3.

<sup>2</sup> Idem., pl. LVIII, fig. 2.

<sup>3</sup> Sixteenth Ann. Rept. U. S. Geol. Surv., Pt. 1, p. 487.

example, weighing 23.59 kg. There are three dwarf specimens, Nos. 26, 29, 42, and 53, which, though nearly perfect, must be immature trunks if they belong here. They differ too much from each other to constitute a specific group, and I have been obliged to treat them as young, dwarf, or aberrant forms of this species. Nos. 26, 29, and 42 have each a good terminal bud, the only such seen in the species. No. 53 is very small, only 11 cm. high, weighing only 1.57 kg., short-conical, and very symmetrical. It represents the species in miniature, and is doubtless undeveloped.

Only one of the specimens of the Yale collection from the Blackhawk region belongs to this species, namely, No. 110, which consists of nearly half of a large trunk, showing the much worn outer surface, with deep holes, which are often united a short distance within by the decay of the walls so as to produce communicating chambers. The opposite side exposes a large hollow or trough, consisting of the inner wall of the woody zone. It also shows the attachment of the armor and the underlying axis in an exceptional manner.

#### CYCADEOIDEA MARSHIANA, new species.

Trunks very large, profusely branched, the primary branches often bearing secondary ones, the whole individual frequently consisting of branches, sometimes with a sort of common base, the branches irregular in size, form, and direction, making shapeless or grotesque objects; summits of the branches rounded, bearing small polygonal scars with depressed or cavitous centers separated by deep channels as if from the disappearance of the walls, or filled with the bases of the apical leaves often set in a circular, smooth flattened area and having a small conical protuberance or terminal bud at the center; rock substance hard, heavy, and dark colored, general external appearance rough and massive; forms very variable in size and difficult to measure, the largest attaining 91 cm. in its greatest dimension, the lateral generally greater than the vertical dimensions when standing on the base, the former often 50 to 60 cm., the latter 30 to 40 cm., branches 15 to 30 cm. long, 10 to 40 cm. in diameter, and often over a meter in girth; organs of the armor ascending on all the branches; phyllotaxy usually so disturbed as not to be traceable, but consisting of at least one series of spiral rows of scars passing from right to left at an angle of about  $75^{\circ}$  with the axis of the branch; leaf scars of medium size or small for the size of the trunks, normally subrhombic, but varying from triangular, or with a mere groove to represent the upper angle, to nearly rhombic, 15 to 30 mm. wide, 7 to 15 mm. high, averaging 12 by 25 mm. for the body of the trunk and 10 by 18 mm. for the branches, usually empty to considerable depth, sometimes filled with the leaf bases, which either present a smooth concave surface or a rough projecting surface formed in part by rows of pointed elevations consisting of the exposed extremities of the vascular bundles lying on the sides of a central con-

ical protuberance the apex of which is formed in part of the more interior strands; ramentaceous interstices usually thick, 5 to 15 mm., hard, roughened, wrinkled, or grooved, often highest next to the scars, sometimes thinner with only a median line; reproductive organs generally abundant on the body of the trunk and larger branches, large, 7 cm. long in a circumferential direction, 5 cm. high, conspicuous, either projecting or cavitous and crater-shaped from the decay of the essential organs, surrounded by concentric rows of large bract scars, sometimes more rare and smaller; armor 4 to 7 cm. thick, but difficult to observe except on the branches where it has little significance, cortical parenchyma 3 to 4 cm., fibrous zone 2 to 4 cm. with two rings; medulla sometimes seen at the compound base, 12 cm. in diameter, often decayed leaving a large cavity, its surface exposed in one specimen showing the scars of the medullary rays in the form of elongated ridges increasing in thickness upward and terminating in a sharp point.

This magnificent species was first clearly made known to me in the Yale collection, where it is represented by four, and probably six, specimens. These are Nos. 4, 11, 33, 44, 47, and 79. The doubtful ones are Nos. 33 and 79. These are single branches of much larger trunks and their characters are somewhat aberrant. Of the other five there is no doubt, as they agree in all their characters. No. 11 is taken as the type. It is larger than any of the rest and the next largest specimen in the Yale collection, weighing 221.35 kg., and therefore holding the third rank in this respect among the cycads of the world. It has the form of a huge animal, has five primary branches, and, when placed in the position in which it probably grew, four of these, with the mass to which they are attached, constitute a sort of fore part, with head, thorax, and fore limbs, while the other represents the hinder part and is aligned in the opposite direction. Between these parts is a constriction dividing the two systems. It is very complete, so much so that it has furnished few of the internal characters.

Nos. 4 and 47 are also large trunks, weighing respectively 52.62 and 34.93 kg., and the other fragments supplement the more perfect specimens, so as to make a pretty full description of the species possible.

I have named the species in honor of Prof. Othniel Charles Marsh, to whose energy and munificence this great collection is wholly due.

When engaged in examining and describing these specimens in the Yale collection I supposed that none existed in the United States National Museum, but on revising all my previous descriptions in the light of the new material I discovered that I was mistaken and that specimen No. 15 belongs to this species. I had referred it with doubt to *C. colossalis*, and under that head had made the following remark: "The only other specimen in the collection of the United States National Museum that I can refer to this species is the fragment No. 15, collected by myself in 1893 on the same spot where the others were found. This is a very irregular block or segment, broken from near the top of



a great trunk. It is similar in mineral character to No. 6, and the leaf scars and other organs agree well with the upper parts of that specimen. The fractures are downward, but follow the plane of the petioles, which are here erect. In No. 15, however, two large and nearly equal branches, whose axes were nearly at right angles to each other, are represented. Viewed from the broken sides the two axes are clearly seen in contact, having a gnarly appearance, such as is normally produced at the junction or crotch between two branches."

This branching character, as I was well aware, does not belong to the large perfect specimen, but having no others, I thought it possible that some of the small secondary axes might in other cases become primary branches. But after seeing so many other specimens of *C. colossalis*, all agreeing in this respect, and also a large number of the present species also all agreeing and exhibiting no tendency to vary in the direction of the other species, it became obvious that the branching forms all belonged to one species and the simple ones to another. The specimen No. 15 clearly belongs to the branching species, and now it is easy to see other specific differences.

#### CYCADEOIDEA FURCATA, new species.

Trunks large, forking above, or sometimes with a third branch, simple below, laterally compressed, eccentric, light colored, soft and of low specific gravity, 35 to 45 cm. high, 25 to 30 by 35 to 40 cm. in diameter, 90 to 110 cm. in girth; organs of the armor mainly horizontal; leaf scars sub-rhombic or somewhat triangular, the vertical angles generally rounded, the lateral acute, variable in size, averaging 15 by 25 mm., those on the branches smaller, or sometimes nearly as large, empty; ramentaceous walls variable, usually thin, 1 to 5 mm., much thicker in the angles, firm in texture, grooved or divided into two or three plates; reproductive organs few, large, elliptical, 4 to 7 by 7 to 10 cm. in diameter, either set in depressions or somewhat elevated, surrounded by bract scars, either cavitous in the center or solid, the larger ones simulating small branches; armor 4 to 7 cm. thick; cortical parenchyma 7 cm., clearly distinguishable from the darker zone of wood 6 cm. in thickness; medulla elliptical, 9 to 11 cm. in diameter.

This species is thus far represented by only two specimens, namely, Nos. 18 and 60 of the Yale collection, the latter of which is in such a complete state of preservation that little can be known of its internal structure. It is distinguished from all other trunks known to me by a true dichotomy, consisting of a simple trunk with two nearly equal erect branches and a natural junction or crotch at their joint of separation. The axis is far to one side and the trunk is flattened on that side, the entire true base being lateral and the trunk standing on a false base belonging to the armor, but naturally flattened in transverse direction. These peculiarities were doubtless the result of the position in which the trunk originally grew among rocks. Besides this striking charac-



teristic, the light color and soft constitution of the rock, as well as the form and arrangement of the scars, ramentum walls, reproductive organs, etc., distinguish this from all other cycadean trunks. It is a fine specimen and weighs 49.9 kg.

No. 18 consists of two nearly equal branches and one somewhat smaller, arranged in a triangular cluster. Two of them are flat on one side from growing against rocks. The trunk proper can scarcely be said to be represented. The two larger branches are each about 30 cm. in diameter and 23 cm. long, with rounded summits, forming something analogous to terminal buds. Fractures about the lower portion yield elements of internal structure, but they relate to the branches only. The external surface is beautifully preserved. This specimen weighs 66.22 kg.

CYCADEOIDEA COLEI, new species.

Trunks rather large, ellipsoidal, 34 to 48 cm. high, elliptical or nearly circular in cross section, 30 to 39 cm. in diameter and 90 to 118 cm. in circumference at the thickest part, simple, the apex studded with polygonal small scars and presenting a smooth disk with a central elevation; rock substance dark brown in color and moderately heavy; organs of the armor except the very lowest manifestly ascending; leaf scars arranged in two series of more or less distinct spiral rows, those passing from left to right forming an angle of  $75^\circ$  and those from right to left of  $45^\circ$  to the vertical axis; scars subrhombic, varying from almost rhombic to nearly triangular with rounded angles, large, averaging 22 mm. wide and 13 mm. high, but ratio of width to height variable, empty to a depth of 2 to 5 cm.; ramentaceous walls usually thick, but very variable, doubly grooved or wrinkled, cracked or fissured, often pitted by the scars of small bristles or perulae; fruiting axes numerous, small, most or sometimes all of their surface occupied by bract scars, central portion correspondingly small, generally cavitous from the disappearance of the essential organs, which appear to have often been immature or abortive; armor about 6 to 7 cm. thick; cortical parenchyma 3 cm. thick; fibrous zone 2 cm., consisting of two rings of wood; medulla about 9 cm. in diameter.

This is a very handsome species of which the type specimen was purchased of Mr. F. H. Cole, for whom the species is named. That specimen weighs 63 kg.

The Yale collection contains nine specimens that I was obliged to refer to this species. These are Nos. 12, 20, 25, 28, 48, 52, 57, 68, and 80. Of these Nos. 25 and 80 are small and either dwarfed or immature, and Nos. 28 and 52 are small fragments. The rest are fairly typical and furnish good characters. No. 48, though small, weighing only 29.49 kg., is perhaps the most typical. No. 57, though not complete, weighs 56.24 kg., and was doubtless originally quite the equal of the United States National Museum type. No. 12 has an unusual number of fruiting axes.

## CYCADEOIDEA PAYNEI, new species.

Trunks medium sized, laterally compressed, usually enlarging from the base upward to near the summit but sometimes subcylindrical, 30 cm. to 55 cm. high, 65 cm. to 85 cm. in average girth, 20 by 25 cm. to 25 by 35 cm. in diameter, light or darkish brown in color, not specially firm or heavy, bearing few or not any secondary axes; organs of the armor horizontal; phyllotaxy rather obscure, but scars arranged in imperfect spiral rows, chiefly subrhombic, but varying to rhombic or triangular, much distorted in the specimens in hand, but where clearly shown 10 to 16 mm. high and 16 to 31 mm. wide, empty to some depth, their bottoms filled with the partially decayed remains of the petioles; ramentaceous interstices rather thin but variable, usually with a more or less distinct commissure; reproductive organs or their remains numerous and conspicuous, often projecting considerably beyond the general surface in the form of protuberances or terete spongy cylinders, often decayed leaving large cavities, more or less crater-shaped or funnel-shaped, the interior sometimes definitely grooved or marked, surrounded by numerous, sometimes large triangular involueral bract scars; armor varying in thickness from 2 cm. to 7 cm., attached by an irregular line or thin layer of bark to the cortical parenchyma which is 1 to 2 cm. thick and incloses a fibrous zone of about the same thickness, which is divided into two or three rings; medulla less compressed than the outer parts, 6 to 10 cm. in diameter.

The only specimens that certainly belong to this species are Nos. 4 and 5 of the collection purchased from Mr. Cole. The description of the internal parts is chiefly based on No. 5, which is the smallest of that collection and has been cut longitudinally through the axis, one of the halves cut transversely 12 cm. above the base, and the surfaces polished. These sections furnish clear views of the organs of the armor and of the relations of the armor to the underlying parts. The specific identity of the two specimens is based on the external characters, which substantially agree. No. 4 weighs 33.11 kg., and No. 5, 22.22 kg. I name the species for the ranchman, Mr. Payne, who originally discovered the cycads of that region and from whom Mr. Cole obtained them. He it was, moreover, who finally guided us to the locality after Mr. Cole had vainly sought to take us to it the previous day, missing the way, notwithstanding that he had been at the spot.

In the Yale collection there are three specimens, Nos. 58, 69, and 77, which I have doubtfully referred to this species, although some of the characters are different from those above described. Nos. 58 and 69 are vertically instead of laterally compressed. If this is due entirely to pressure of the superincumbent mass after entombment, it has no systematic value and depends upon the position occupied by the specimen; but eminent authorities have insisted that it is a condition of growth. I am inclined to think that this may be true in some cases, but that the former explanation is the chief one.

No. 77 of the Yale collection is smaller above than below, and if it belongs to *C. paynei* this is not a constant character. There is, moreover, a peculiarity in No. 77 which distinguishes it from all other cycadean trunks known to me, and which could not well be described as a specific character. I therefore set it forth here as an individual trait, due perhaps entirely to the particular time at which the trunk was entombed and the conditions under which its mineralization took place. The specimen shows a large number of fruits on its surface, which are filled and protrude in greater or less degrees. Many of them consist of protuberances or gentle swellings presenting a uniform granular surface. These apparent granules are about 1 mm. in diameter, and have the character of vein quartz or chalcedony, sometimes with a blueish cast, as if partially opalized. They are very uniform in size and appearance, and look much like little seeds. In some of the fruits, however, they are so exposed as to show what lies below the immediate surface, and here they have the form of the terminal portions of small rods or the silicified cores of tubes. The fact that they occupy the whole central portion of the organ precludes the possibility of their being the bases of involucreal bracts, and, besides, they are not angular nor semilunar, but cylindrical. They must, therefore, represent some of the growths from the receptacle of the spadix, and the only such growths thus far found in fossil cycads are the seminiferous peduncles and the interseminal scales or chaff. I incline to regard them as the representatives of the former of these organs, but they are probably not the organs themselves silicified, but simply the homogeneous and structureless siliceous rods or cores that have filled the tubes caused by the decay of these organs.

The Yale specimens are all smaller than either of the National Museum types, No. 77 weighing 21.09 kg., No. 69, 20.86 kg., and No. 58, which is dwarf, abnormal, and perhaps immature, 5.33 kg.

#### CYCADEOIDEA ASPERA, new species.

Trunks small, subconical, simple, very rough on the surface, light brown varying to whitish, dark with white streaks within, moderately heavy, about 20 cm. high, nearly the same in diameter, and 70 cm. in circumference; organs of the armor somewhat declined throughout; phyllotaxy not traceable; leaf scars anomalous in having the upper angle much sharper than the lower, the reverse of the usual case and only elsewhere observed in *C. insolita*, lower angle reduced to a groove, a curve, or a straight line, lateral angles always sharp; scars small, 12 to 25 mm. wide, 10 to 15 mm. high, subrhombic; leaf bases present usually projecting 5 to 10 mm. above the walls, presenting a light brown, very spongy and porous surface, without evidence that any of the pores represent the scars of vascular strands; rametaceous interstices thin, 1 to 5 mm., dark reddish brown, sunk to varying depths among the projecting leaf bases and other organs, scaly and laminated with crooked and twisted plates; reproductive organs as

numerous as the leaf scars, projecting much beyond the petioles, sometimes 3 cm. high, solid or variously broken and jagged, occasionally somewhat cavitous, scarcely showing any involneral scales, but in addition to all the other organs described are small angular bracts, mostly broken down, presenting sharp edges and projections over the surface, intermediate in character between scales and leaves, properly to be classed as bristles or perulae; all the different projecting organs giving the trunk a ragged and horrescent appearance; armor, including projections, 6 cm. thick, the vascular strands traceable far into the woody zone and inner limit not definite; parenchymatous layer 15 mm. thick penetrated by the whitened leaf bundles; secondary wood 2 cm. thick, consisting of two nearly equal rings, the outer white, the inner black or dark blue in the only specimen known; medulla 6 cm. in diameter, dark, fine-grained and homogeneous.

This species is based on the single specimen, No. 104, of the Yale collection from the Blackhawk locality, which is somewhat less than half of a trunk that divided along a vertical plane from top to bottom almost as smooth and even as if sawn through by a gang saw, exposing the interior in an admirable manner. Its only affinities are with *C. paynei*, and the specimen, though smaller, has a remarkable resemblance to No. 5 of the U. S. National Museum, which was cut through on the same plane as this specimen. The resemblance is, however, more apparent than real, and the descending leaves, and especially the inverted scars, clearly exclude it from that species. Add to this that no specimens of *C. paynei* have been found elsewhere than in the original Minnekabta locality, and the improbability of this belonging to that species is very great. It is too perfect a specimen to class as undeterminable, and there seems no course left than to treat it as constituting a new species.

CYCADEOIDEA INSOLITA, new species.

Trunks medium sized, unbranched, somewhat elliptical in cross section, subcylindrical or subconical; rock substance light colored, moderately hard and heavy; height of trunks 30 to 40 cm., diameter 30 to 35 cm., girth about 1 meter; organs of the armor nearly horizontal; leaf scars irregularly distributed over the surface, very variable in size and shape, rhombic or subrhombic, in the latter case having the more acute angle above and the more obtuse one below, that is, the opposite of the normal condition, 15 to 25 mm. wide, 8 to 15 mm. high, sometimes empty to some depth, but in some such cases the summits of the leaf bases showing the vascular bundles in the form of little rods or pins projecting upward and forming a row all around the leaf bases close to the margin with others near the center, about 18 to each leaf; leaf bases sometimes projecting in the form of small cones, in which cases the bundles can be seen either as black dots or as little protuberances around the sides of the cones; ramentum walls thin but variable, 1 to 4 mm., firm and sharp on the edges of the scars, grooved along the



middle; reproductive organs abundant, disturbing the phyllotaxy, tending to congregate and blend together, presenting a rough surface, usually projecting, rather small and with few bract scars; armor 4 to 6 cm. thick, cortical parenchyma 2 to 3 cm., fibrous zone 15 to 30 mm. with two or three rings, the outer either preserved and showing fine-grained structure or much decayed, in either case conspicuously partitioned off by the medullary rays, the others also showing woody wedges; medulla 8 by 12 cm. in diameter at the base, enlarging upward, hard and homogeneous in structure.

This species is founded on two specimens in the Yale collection, Nos. 50 and 64, chiefly the latter, No. 50 being only a small fragment. The characters can not be forced into any other species, especially the inverted leaf scars and the peculiar habit of the vascular bundles in the petioles. In No. 33, which is a branch of the type of No. 11, and has been referred to *C. marshiana*, this latter peculiarity is nearly repeated, but this happens in no other specimen of that species.

No. 64 is the lower part of a trunk irregularly broken across the top and down one side to near the middle. The apex is therefore unknown. It is this specimen that has furnished all the external characters, but No. 50 shows precisely the same characters, so far as it goes, and adds somewhat to the knowledge of the internal parts. No. 64 weighs 24.95 kg. and No. 50, 3.29 kg.

#### CYCADEOIDEA OCCIDENTALIS, new species.

Trunks medium sized, conical or ellipsoidal, simple or with a few small secondary axes, well silicified, moderately hard and heavy, reddish brown without, dark or nearly black within; organs of the armor generally ascending; phyllotaxy not traceable in any of the specimens; leaf scars subrhombic, variable in size, 16 to 25 mm. long, 10 to 16 mm. high, usually filled by the leaf bases; bundles not visible; ramentaceous interspaces thin, less than 2 mm., roughened without, white within, contrasting strongly with the black petiolar substance in longitudinal section; reproductive organs rare, slightly protruding, usually having remains of the organs preserved, occasionally decayed so as to leave openings, obscure from without, distinct in sections longitudinal to them, penetrating to a depth of 6 cm.; the substance above the fruit light colored; fruit dark, elliptical or ovate, nearly homogeneous and showing no structure, subtended by strong involueral bracts and crowded by a mat of chaff probably consisting of the summits of the interseminal scales, seeds not detectable; armor 5 to 8 cm. thick, irregularly joined to the woody axis, the outer or parenchymatous portion of which to a thickness of 3 cm. is more or less decayed in most of the specimens, the fibrous zone divided into two rings each about 15 mm. thick, the innermost very firm and fine-grained, its inner wall (exposed in two specimens) regularly marked by the scars of the

medullary rays, the scars consisting of conspicuous elongated depressions arranged in longitudinal rows at equal distances (1 cm.) from one another; the scars nearly the same distance one above another but alternating so as to form diagonal rows crossing the vertical ones at an angle of nearly  $45^{\circ}$ ; inner face of the second ring of wood (exposed over a small area in one specimen) nearly smooth but faintly striate in a horizontal direction, marked with smaller, more distant scars; medulla (represented only in one small disk-shaped specimen from near the top of a trunk, and here thoroughly crystallized) scarcely known.

Four of the fragments picked up by me belong to this species. They are Nos. 11, 12, 17, and 18. No. 11 is a large block weighing over 7 kg., showing considerable of the external surface, which is not very clear. Portions of it have been detached and cut in several directions to show the internal structure. Most of such characters above given are derived from this source. No. 12 is a very small piece, consisting entirely of the fibrous zone of wood, of which it shows the inner wall with the scars identical in character with those of No. 11, of which it is probably only a detached fragment. No. 17 is a crescent-shaped fragment from a small trunk and weighs 2.27 kg. It appears to have come from near the top of the trunk. No. 18 is a thin, horizontal zone or disk from near the top of a small trunk. The internal portion is much crystallized.

#### CYCADEOIDEA JENNEYANA Ward.

1894. *Cycadeoïdea jennyana* WARD, Proc. Biol. Soc., Washington, April 9, 1894, IX, p. 87.

Trunks large and tall, attaining a height of 130 cm., cylindrical, little compressed, 30 to 50 cm. in diameter, the girth reaching over a meter and a half, firmly silicified, more or less chalcedonized or opalized within, very hard and heavy, light brown or reddish externally, white or reddish, sometimes black within; organs of the armor horizontal except near the summit; leaf scars arranged in intersecting spiral rows, those passing from left to right making an angle of about  $40^{\circ}$  and those from right to left of about  $50^{\circ}$  with the vertical axis; scars subrhombic to subtriangular with mostly rounded angles, sometimes kite-shaped, large, 20 to 30 mm. wide, 12 to 25 mm. high, partially or wholly filled with the remains of the leafstalks; vascular bundles in the petioles arranged in an imperfect row all round near the margin with other straight rows, or somewhat scattered in the interior, numerous (forty were counted in one cross section), circular, elliptical, crescent-shaped, or kidney-shaped in section; ramentaceous interspaces very thick but somewhat variable (6 to 13 mm.), sometimes roughened or irregularly affected by small pits representing bract scars, a line of which may run through the center dividing the walls, or by cracks which divide them into plates or small partitions; reproductive organs numerous, large, and well developed, often protruding, sometimes cavitous, scattered over all parts of the surface, axillary to

the leaf scars, whose shape and order they distort, elliptical in outline, 25 to 40 mm. in a horizontal and 18 to 26 mm. in a vertical direction, surrounded by concentrically arranged semilunar or somewhat triangular bract scars which are sometimes continued in a horizontal direction, converging and blending with the rows dividing the walls, the central portion when exposed at the margin of a fracture taking the form of an elongated cylindrical spadix or fruit, which, seen in cross section, proves to be made up of four large organs which seem to contain two axes, and seen in longitudinal section, to constitute a convex receptacle from which arise seminiferous peduncles (or filaments) and interseminal (or interstaminate) scales, the seeds (or anthers) having disappeared leaving a region of amorphous decayed tissue occupied by the matted prolongations of the chaff; armor 8 to 9 cm. thick; liber zone very indistinct; cortical parenchyma 3 to 4 cm. thick; fibrovascular zone about 2 cm., without visible subdivision into rings; medulla slightly elliptical, the major diameter 16 to 17 cm., the minor 13 to 14 cm., black and cherty in all the specimens, showing no structure, giving off rays which may be seen traversing the woody cylinder.

The above description is based mainly on two large trunks, or parts of the same trunk, which, through the intervention of Professor Jenney, were generously loaned to the Smithsonian Institution by Dr. V. T. McGillienny, director of the State School of Mines of South Dakota in Rapid City, where they had been deposited. There are many reasons for believing that these two pieces belong together, and, with a small missing intermediary piece, constituted a tall, cylindrical trunk. One of the pieces, about 40 cm. long, represents the true base, and the other, 58 cm. long, the true summit. The former is scarcely worn at all, while the latter is deeply eroded all round as the result of having been long exposed to adverse influences, probably by having lain in the bottom of a gulch. It is therefore considerably smaller than the normal diminution upward would require. The difference applies, however, wholly to the exterior, and the medulla and woody cylinder are no smaller than would be the case in an entire trunk at different heights. After a careful examination I have arrived at the conclusion that if they are parts of one trunk it would only indicate the loss of about 30 cm., which would give a total height for the trunk of about 130 cm.

Only two other tall, cylindrical species of Cycadeoidea are known to me, namely, the *C. excelsa*, described below, and the *C. gigantea* of Seward from the Purbeck beds of Portland.<sup>1</sup> Specifically, of course, *C. jenneyana* is very distinct from both of these, but in its straight, erect habit it somewhat resembles *C. gigantea*. It is much less compressed laterally, and if my conclusions are correct as to the amount missing between the two sections, it was taller by 11 or 12 cm. Mr.

<sup>1</sup>A. C. Seward, on *Cycadeoidea gigantea*, a new Cycadean stem from the Purbeck beds of Portland. Quart. Journ. Geol. Soc. London, February, 1897, LIII, pp. 22-39, pls. 1-v.



Seward does not state the weight of his specimen, but if the material at all resembles that of all other cycads from those quarries its specific gravity is low and the weight would be small in relation to the bulk. He states the girth of the specimen at 107 cm., while that of *C. jenneyana* is very nearly 130 cm. More exactly, the lower piece, measured at the middle, is 129.54 cm., while the upper piece, both at the lower end and at the middle, measures 107 cm. The difference, as explained above, is chiefly due to erosion of the surface of the latter. The lower piece weighs 95.26 kg. and the upper, 86.18 kg., a total of 181.44 kg. The entire trunk must therefore have weighed nearly 250 kg., which would have given it the third rank, from this point of view, among the fossil cycads of the world.

The question whether there are any other specimens in our collection that belong to the same species is a more difficult one. In 1893 I visited the spot where the large trunks were originally found. I was accompanied by Professor and Mrs. Jenney, and we took with us as our guide Mr. Gilbert Getchell, of Rapid City, who said he helped load the specimens into the wagon in 1876, in company with Mr. Leedy, who had discovered them some time earlier, but who was no longer in those parts. Mr. Getchell showed us the locality, on the ranch of a Mr. Black, 2½ miles north of Blackhawk. No other fragments were found by any of our party, although we all searched diligently for several hours and collected a large amount of silicified wood. We were told at the ranch that a man named McBride (not Professor McBride, of course) had been in the region and had gathered and taken away all the specimens he could find.

Later in the summer, when I was in California, Professor Jenney learned the whereabouts of Mr. McBride, who was then in Deadwood, and purchased two fragments of cycads from him that he said came from that locality. He also purchased two other fragments from a man named Stillwell, in Deadwood, also as he was informed, from the same place. All these he sent to Washington, and they constitute a part of the cycad collections in my hands.

Upon careful examination of all four of these fragments I conclude that there is nothing to negative the supposition that three of them belong to the same species as the large trunks, and I have accordingly included them under *Cycadeoidea jenneyana*. They were numbered in the collection as: McBride Fragments, Nos. 1 and 2, and Stillwell Fragment, No. 1.

These fragments are irregular and not well preserved, but they evidently came from large trunks, and all the characters that they show agree substantially with those of this species. As they come from the same locality, and as a portion of the great trunk is missing, I have examined them carefully to see whether they might possibly belong to that trunk, but I find no evidence of this. These fragments weigh, respectively, 12.25, 11.34, and 7.26 kg.



A few days after visiting this locality on Black's ranch I was in Hot Springs, and purchased a number of fragments of cycads from a dealer named Homer Moore. Two of these, which fitted together, forming a block weighing a little more than 7 kg., evidently belonged to a very large trunk, and these show a number of characters which agree with those of *C. jenneyana*. In fact they very closely resemble the Stillwell Fragment, No. 1, so that whatever is done with the one must be done also with the other. Mr. Moore thought that these specimens came from the Minnekalita region, but was uncertain as to their source. They certainly differ specifically from any of the material from that region, and agree substantially with most of that from Black's ranch. I shall therefore include them under *C. jenneyana*.

I had in hand two small slabs belonging to the Woman's College of Baltimore, purchased in Germany by Dr. John F. Goucher, president of that college, and sent over, along with the Bibbin's collection, from Maryland. Dr. Goucher informed me that when he purchased these fragments he was told that they came from the Black Hills in America. I can well believe this, as, so far as they go, they are substantially identical with the material from Black's ranch, and I am obliged to refer them to the present species. They contain none of the woody cylinder, but are confined to the armor, of which they show a thickness of 3 to 5 cm. The exterior is obscure and closely resembles the Stillwell Fragment, No. 1, and the Homer Moore Fragment, but the inner face is cut and polished in a direction transverse to the leaf bases, which are beautifully shown, and also in the opposite direction, showing the organs in longitudinal section. Fruiting axes are also thus exposed, and much of the above description relating to the structure of these organs is derived from a study of these sections. I have no doubt that the other specimens, when similarly cut, as they will be eventually, will furnish the same characters. In fact, they can now be less distinctly seen on a number of fractured surfaces.

These specimens bear the labels of the Museum of the Woman's College, Nos. 1501 and 2128. The former weighs 532 grams and the latter 489 grams. They are exactly alike in all essential respects and may well have belonged to the same trunk.

In the Yale collection there are 24 specimens that appear to belong to this species. These are Nos. 81, 87, 88, 90, 91, 93, 96, 97, 98, 101, 102, 108, 109, 111, 112, 113, 114, 115, 116, 120, 121, 124, 125, and 126. It will be observed that all but the first two of these came with the two last invoices, and are from the Blackhawk region, the same from which the original type of the State School of Mines was obtained. The two reported from the Minnekalita region, Nos. 81 and 87, also belong to this species beyond a doubt. No. 81 consists of eight small fragments, which all fit together and form an irregular segment from a large trunk similar to those belonging to the State School of Mines of South Dakota. Indeed, they might have belonged to the supposed

missing portion of the tall trunk which those two pieces are believed to have so nearly constituted. The eight fragments together weigh 9.5 kg.

No. 87 also consists of a number (five) of small fragments that can be built up into a segment of a trunk, and altogether weigh 7.6 kg., but these do not so closely resemble the type specimens. Still, the characters they possess are those of this species. Professor Marsh thought that these specimens came from the Blackhawk locality, but Mr. Stillwell, from whom they were purchased, states that they were obtained 3 miles southwest of Minnekahta station. This agrees closely with the original locality. I am disposed to believe that there has been some mistake, and that these particular specimens are, after all, from the Blackhawk region.

Of the other 22 from the Blackhawk region Nos. 91, 113, 120, and 124 are somewhat doubtful. No. 91 has a large terminal bud, 8 cm. high, elliptical in cross section, and 15 by 20 cm. in diameter, studded with polygonal bract scars, 5 to 8 mm. in diameter, filled with the bases of the bracts or small leaves matted together and exposed on the sides of the terminal bud which have suffered from erosion. I have not included this bud in the description of the species on account of doubts as to the true affinities of this specimen, which, if it belongs here, is the only one in which the bud is preserved. The surface is so badly worn that all the reliable characters are obscured except that in general shape the specimen agrees with others of this species. The scars are large and the walls thick, which further confirm this supposition. No. 113 is also badly worn and metamorphosed, but probably belongs to this species. It is a fine trunk, nearly complete, 55 cm. high, and weighs 91.17 kg. No. 120 is an interesting specimen, and shows a great number of large fruits which stand out, having resisted the deep erosion of the surface. No. 124 is a mass of quartz and only a fragment, but in all probability came from a trunk of *C. jenneyana*.

The rest of the specimens, though mostly fragments and segments from large trunks, are not doubtful, as they show surface characters in all cases which are distinctive. Several, however, are fine trunks. No. 101, though in three sections perfectly fitting together, is an almost perfect trunk, laterally compressed, 97 cm. high, and weighs 183.71 kg., which is a little more than one kilogram heavier than both pieces of the type specimen from the State School of Mines of South Dakota. Unfortunately the surface is badly worn and the most important characters are obscured. No. 102 is the lower part (36 cm.) of the largest trunk of the species thus far known. It is nearly circular in cross section, has a diameter of 47 cm. and a girth of 156 cm. Its surface is also in a fair state of preservation. No. 121 is a similar but much smaller basal portion. No. 115 is anomalous in many respects and might have been included among the doubtful cases. Though in two pieces it is nearly complete and weighs 87.77 kg., having a height of 60 cm. and a girth of 106 cm. Some of the leaf bases are horizontal, while others

are strongly declined. The latter are all on one side below the middle, and in the case of certain abnormally small but strongly projecting leaf bases there is the additional peculiarity that they are converted into impure opal or blue quartz. No. 116 is also a fine, nearly complete trunk 49 cm. high, 42 by 36 cm. in diameter, 120 cm. in girth, and weighs 85.73 kg.

CYCADEOIDEA INGENS, new species.

Trunks large or colossal, ellipsoidal in form, thickest at the middle part, diminishing and more or less rounded off at both base and summit, slightly elliptical or nearly circular in cross section, unbranched or with a few small secondary axes in the form of protuberances, usually of a dark color, hard consistency, and high specific gravity, attaining a maximum height of 85 cm., girth of 170 cm., and weight of over 300 kg.; organs of the armor slightly declined near the base, horizontal in the middle portion, ascending above, and erect at the apex, producing a large terminal bud consisting of the bases of somewhat flattened leaf-like bracts or scales; leaf scars arranged in two sets of rows passing spirally round the trunk, intersecting each other, and forming each a different angle with the axis, those passing from left to right forming an angle of about  $35^{\circ}$  to  $45^{\circ}$ , while those passing from right to left form an angle of  $50^{\circ}$  to  $60^{\circ}$ ; scars large, 35 to 50 cm. wide, 20 to 35 cm. high, peculiar in shape, the lateral angles drawn out into sharp points by the incurving of the sides, the vertical consisting of mere curves, varying from this to simple gibbosity; leaf bases always present filling the scars and often projecting, presenting either plane or slightly convex surfaces; vascular bundles in one row closely set together and very near the margin and an irregular ring at the center inclosing an empty space: ramentaceous interspaces thin, 3 to 10 mm., scaly or laminated, sunk below the leaf bases forming grooves on the surface of the trunk, often white in color contrasting with other parts; reproductive organs abundant especially in the upper part of the trunks, very different from the leaf bases, usually large, elliptical, 5 to 6 cm. wide by 3 to 4 cm. high, sometimes solid and projecting, but usually with an opening at the top or cavitous and crater-like, surrounded by numerous bract scars filled with the bases of the bracts which are usually narrowly triangular or nearly flat; armor 5 to 10 cm. thick, more or less clearly marked off from the underlying tissues; cortical parenchyma 3 to 4 cm. thick; zone of secondary wood 4 cm.; medulla 10 to 20 cm. in diameter.

A perfectly well characterized species, differing entirely from any of those based on specimens from the Minnekahta region. It is also very distinct from *C. jenneyana*, which is the leading form of the Blackhawk region. Still this species is also common there, and is represented in the collection by eight specimens, namely, Nos. 92, 94, 99, 100, 103, 117, 122, and 123. No. 100 is taken as the type and is the next largest cycadean trunk known in the world, weighing 303.91 kg. It slightly exceeds in height the U. S. National Museum type of *C. colossalis*,

having a maximum length of 85 cm. Its diameters are, respectively, 62 cm. and 49 cm., and it has a girth of 170 cm. But like all other specimens of this species it diminishes in size toward each end and is somewhat barrel-shaped.\* Nos. 103 and 117 represent the lower part of two other large trunks, and the summit is represented only in No. 100. No. 94 comes next in point of interest in affording most of our knowledge of the internal structure of the species, including the markings on the medulla. No. 123 is also instructive from this point of view. The rest are fragments, but all add to the complete conception of the species.

The form of the leaf scars is imitated very closely by two other species, one of which, *C. formosa*, is represented by only one specimen, No. 89. The other is *C. stillwelli*, and this is made very clear by the new material added by the specimens last sent from the Blackhawk region by Mr. Wells, especially No. 105. In both these cases, however, the scars are much smaller, and this is particularly the case with *C. stillwelli*.

#### CYCADEOIDEA FORMOSA, new species.

Trunks of moderate size, short-conical, unbranched, dark brown, nearly black within, of average specific gravity, about 25 cm. high, nearly 30 cm. in diameter and having a girth of somewhat less than a meter; organs of the armor, even the lowest, somewhat ascending with a uniform angle; leaf scars arranged in two series of spiral rows, those of both series making an angle with the axis of about 50°; scars large for the size of the trunk, peculiar in shape, the lateral angles very sharp, the vertical ones very obtuse and rounded, the bounding sides usually curving downward and upward on the right and left causing the scars to be drawn out laterally corresponding to wings of the petioles, lower side more pronounced than the upper in such a manner that a line joining the lateral angles divides the scar into unequal areas, varying to simply gibbous by the absence of the above described curves; distance between lateral angles 25 to 30 mm., that between highest and lowest points 16 to 20 mm.; leaf bases always present, usually projecting somewhat, sometimes nearly 1 cm., outlines definite, conforming to shape of scars, exposed ends presenting surfaces that are exactly square or tangential to the trunk, never convex nor concave, smooth but not polished, covered by a diaphragm representing a natural plane of disarticulation, this layer, however, sometimes removed, in which case small projecting points are irregularly scattered over the surface of the leaf base; outer row of leaf bundles very close to the margin, faintly visible at the ends, more clearly as striae on the eroded sides of projecting leaf bases; ramentum walls thin, 1 to 3 mm., thickening at the angles, sunk below the petioles and usually separated from them by a crack, dull colored, loose in structure and somewhat pitted, having the appearance of cracks filled with mud or extraneous matter; reproductive organs numerous and well marked, occurring at all points,



but tending to an arrangement in vertical rows one above another with a trend different from that of either of the rows of leaf scars, projecting beyond the leaf bases to which they bear no resemblance, rounded or elliptical, 3 to 6 cm. in diameter, never cavitous, usually exhibiting concentrically arranged scars, the circular central portion inclosed in a tube surrounded by involueral bract scars occupied by the bases of the bracts which project in miniature imitation of the leaf bases, the central portion sometimes occupied by small cylindrical bodies or rods 1 mm. in diameter and 1 to 5 mm. long, consisting of nearly pure quartz; armor 5 cm. thick, definitely separated from the axis by a porous liber zone of appreciable thickness; cortical parenchyma 15 mm. thick; secondary wood 4 cm. thick consisting of two distinct rings of about equal thickness separated by a peculiar scalloped line, apparently caused by the convex edges of woody wedges 5 mm. thick separated by thin medullary rays; medulla 9 cm. in diameter, somewhat heterogeneous or chambered in structure.

This species is represented by the single specimen No. 89 of the Yale collection. It has close affinities on the one hand with *C. ingens* and on the other with *C. stillwelli*, while all these are related to *C. mebridei*, but it is impossible to refer it to any of these species.

#### CYCADEOIDEA STILLWELLI, new species.

Trunks small, cylindrical, or more or less laterally compressed, 30 to 40 cm. high, 15 to 25 cm. in diameter, 40 to 70 cm. in girth, reddish or light colored externally, cherty, flinty, or more or less agatized within, simple, or bearing a few small branches in the form of projections or protuberances, short conical at the summit, with a natural depression at the apex, studded with small polygonal scars and a gentle swelling at the center; organs of the armor nearly horizontal; leaf scars arranged in two series of spiral rows, those from left to right making an angle of  $40^{\circ}$  to  $50^{\circ}$ , those from right to left of  $30^{\circ}$  to  $50^{\circ}$  with the axis of the trunk; leaf scars normally almost exactly rhombic or diamond-shaped, but with a tendency on the one hand to the rounding of the vertical angles and on the other to the incurving of the sides so as to exaggerate the acuteness of the lateral ones, this sometimes very marked; scars small, 20 to 25 mm. wide, 15 to 20 mm. high, occasionally almost as high as wide, the lateral diagonals about horizontal and the vertical ones perpendicular to them, or vertical; leaf bases always present, filling the scars, often projecting, sometimes considerably, the petioles disarticulating at several different points by means of a diaphragm which forms a thin layer over the exposed summits, the occasional absence of which leaves a rough spongy or porous structure; vascular bundles arranged in two rows, one near the margin and parallel to it, the other forming an elliptical ring at the center 3 by 4 mm. in diameter, both rows usually appearing in the form of denticulate ridges; ramentaceous walls very thin, 1 to 2 mm., often sharp at the surface,

generally sunk below the leaf bases forming grooves or deep chambers between them, the surface therefore consisting chiefly of the latter, in the more abnormal forms of scar describing a double curvature and having somewhat the shape of a "line of beauty," in penmanship or one of the parts of a Buddhist cross or "swastica," sometimes, however, projecting so as to leave a groove around the outer edge of the convex summits of the leaf bases; reproductive organs few, more numerous on the narrower sides of the trunk, disposed somewhat in rows or chains, generally parallel to the axis but sometimes running round the trunk, more or less contiguous, consisting of protuberances, some rising above the highest leaf bases, closed, or more commonly open at the top, sometimes crater-like but generally truncated, presenting an irregular surface with numerous pits or pores at the center surrounded by bract scars which are sometimes empty, but usually occupied by the bases of narrowly triangular or flattish bracts projecting and squarely truncated with thin interspaces in miniature imitation of the leaf bases; armor much thicker on the narrower than on the broader sides of the trunk, 3 to 6 cm. thick in the former and 2 to 3 cm. in the latter case, clearly and definitely marked off from the woody axis by a cambium line; cortical parenchyma 15 to 20 mm. thick; secondary wood zone 10 to 20 mm., very fine-grained and clearly marked off from the last; medulla somewhat elliptical, 5 to 8 cm. in diameter, marked on its external surface by rows of small rhombic projections of a dark color terminating in small longitudinal ridges representing the origin of the medullary rays.

The small, cylindrical section of a trunk acquired through Professor Jenney's intervention from Mr. J. W. Stillwell, of Deadwood, exhibited so many good characters, all different from those of any other specimen in the U. S. National Museum collection that before I had seen the Yale collection, in fact long before it was made, I had described it as a new species and named it for Mr. Stillwell. It was reported to have been found in the Blackhawk region, and there is every reason to believe that such was the case.

The Yale collection contains six specimens of this species, each of which adds something to our knowledge of it. These are Nos. 16, 36, 56, 105, 107, and 119. The first three of these purport to come from the Minnekahta region, while the others are certainly from the Blackhawk region. The first of these is somewhat smaller than the type, and has near its summit two small branches. The leaf scars are normal and confirm my suspicion that the peculiar form which they have in the original specimen is due to lateral compression. It weighs nearly 5 kg. No. 36 represents the upper part of a trunk of exactly the same diameter as the Stillwell specimen, but with the outer parts all worn away. The summit, however, is perfect. The transverse fracture has supplied a number of otherwise missing or imperfect characters. This specimen weighs 8.17 kg. No. 56 is larger and entire from base to summit, but broken in two near the middle. It is very elliptical in cross section from

lateral compression, badly worn like the others, and has a slab scaled off from one side, exposing the outer surface of the medulla and corresponding inner wall of the woody zone. This specimen is 39 cm. high, 15 by 20 cm. in diameter, and has a girth of 54 cm. Its ellipticity is, however, exaggerated by the greater erosion of the flat sides. It weighs 12.7 kg.

No. 105 is only a section, weighing 12.8 kg., with base and summit wanting, also a piece from one side, part of which was saved, but the part that remains shows the outer surface in the most perfect state of preservation, and much of the above description of the phyllotaxy, leaf scars, petioles, vascular bundles, ramentum walls, etc., is derived from it. No. 107 is also an exceedingly interesting specimen, weighing 9.07 kg., and is especially valuable as showing the true base. It is obliquely broken through from the top to near the bottom, but one side shows the spiral rows of leaf scars. No. 119, although larger, weighing 14.29 kg., is not as well preserved, but also shows the base, which is slightly concave.

Upon the whole, this species may be regarded as one of the best characterized of all that have been based on cycadean trunks alone:

CYCADEOIDEA EXCELSA, new species.

Trunks tall, compressed-cylindrical (only specimen known 91 cm. high and truncated), with an enlarged base, 112 cm. in circumference at the base, 80 to 90 cm. at all other points, light ash-colored without, whitish or bluish within, soft externally, fine-grained inside and moderately hard, with the specific gravity rather low, unbranched but more or less irregular, crooked, zigzag, and inclined; organs of the armor horizontal, or at right angles to the axis; leaf scars disposed in two series of spiral intersecting rows, those from left to right making an angle of  $20^{\circ}$ , those from right to left of  $50^{\circ}$  with the axis; scars imperfectly rhombic or rectangular, the diagonals 16 to 25 mm., the lateral angles nearly alike, the vertical ones usually unlike, the upper consisting of a deep but obtuse sinus, the lower also obtuse but relatively shallow, sometimes reduced to a gentle concave curve formed by the two lower sides; leaf bases generally preserved to within 2 cm. of the surface, disarticulated at a natural joint, its surface even and concave but roughened and affected by many small dots of a dark color, irregularly arranged, perhaps representing gum ducts, and some large pits which may have contained leaf bundles; ramentaceous walls thin and frail, 1 to 2 mm., of a light color within contrasting with the darker leaf bases, thickened at the angles and more or less compound, with a few small pits representing scars of bracts or perulae; reproductive organs numerous, usually solid, harder than the remaining parts, hence often projecting from the eroded surfaces, of different sizes, the smaller ones probably abortive and occupying angular spaces among the leaves, the walls dividing and surrounding them, circular in



section, with or without bract scars, the larger ones lying in interrupted rows running in the same direction as those of the scars which they crowd and distort, elliptical in section, the longer diameter being along the line of the rows, 25 mm. by 38 mm. in diameter, usually solid except their roughened extremities, sometimes open or crater-like at the summit, a few solid and cylindrical (one of which has been detached and will be sliced for microscopic sections); armor 4 to 7 cm. thick, separated from the axis by an even line; parenchymatous zone 2 cm. thick; fibrous zone 3 cm., divided into three rings, one of which exhibits a somewhat open structure in places crossed by thin medullary rays and inclosed between walls or sheaths of harder material; medulla 13 cm. in diameter and nearly circular, solid, fine-grained, and homogeneous in structure.

The fine specimen upon which the above description is wholly based was purchased by me from Mr. Homer Moore in Hot Springs, South Dakota, on August 22, 1895, together with the two fragments above described, belonging to *C. jenneyana*. It consists of four pieces which belong together and form a very remarkable trunk, differing greatly from any other from the Black Hills or from any other section.

I inquired carefully into the history of these specimens and learned that some years before they had been found by a railroad employee named A. B. Noble, who was no longer in that region, some two miles below Hot Springs in a canyon or ravine which makes into Fall River from the northeast. No further details could be gathered, but as it is 4 miles to Evans's quarry, where the true Dakota group is exposed, it is certain that the horizon must be in the Lower Cretaceous, and it is probably substantially the same as that of all the other trunks.

The four pieces or sections which have been numbered from 1 to 4, beginning with the basal one, may be briefly described as follows:

1. No. 1, which is considerably the largest in all respects, represents the true base, and swells out below to a diameter of over 40 cm. and a girth of nearly 112 cm. It is slightly elliptical, the minor axis of a cross section being only 33 cm., but part of this difference is due to the erosion of the armor on the broader sides.

2. No. 2 is a shorter and smaller piece, but fits perfectly upon the upper fracture of No. 1, which is somewhat oblique. On one side a large elliptical area has decayed, forming a depression which reaches to the bottom of the leaf stalks. This depression is about equally divided between Nos. 1 and 2.

3. No. 3 is a much shorter piece, the upper fracture of which is very oblique, so as to make it almost wedge-shaped. The upper surface of No. 2 and the lower surface of No. 3 do not form a perfect joint. A thin slice, or a number of such pieces, have apparently scaled off and are wanting. There is, however, abundant evidence of the general agreement of the two sections, and one decayed area extends across the break and reappears on No. 3.

4. No. 4, which is the uppermost section, fits perfectly upon No. 3.



The fracture across the top is oblique in the opposite direction from that of the lower end, thus increasing the cuneiformity of both sections. When superposed upon each other these two upper sections form a sort of crook or bend in the trunk, so that the center of gravity falls considerably on one side and the upper piece falls off unless supported.

The trunk has evidently long lain on one side or the other as determined by the above-mentioned crook or bend and been subject to much erosion on the two exposed sides, while the other two sides have correspondingly escaped. The result is that the leaf scars are deeply worn over much of the surface, while along the protected sides they are preserved or only irregularly broken down, leaving what look like jagged projections.

The weight of the several pieces is as follows:

	Kilograms.
No. 1 .....	50.80
No. 2 .....	21.32
No. 3 .....	17.02
No. 4 .....	18.37
Total .....	107.51

Nothing at all approaching this species was found in the Yale collection.

CYCADEOIDEA NANA, new species.

Trunks very small, symmetrical, short-conical, laterally subcompressed, 12 cm. high, 15 by 17 cm. in diameter, 49 cm. in girth, dark colored, well silicified, of medium hardness and specific gravity, unbranched, summit not depressed, terminal bud projecting from apex; leaf bases ascending even the lowest ones, scars arranged in two series of spiral rows, those from left to right making an angle of  $80^\circ$  and those from right to left of  $50^\circ$  with the axis, very small, subrhombic, averaging 10 mm. wide by 6 mm. high, smaller near the summit, empty to considerable depth; ramentaceous interstices 1 to 3 mm. thick, firm in texture, usually consisting of three layers which may be regarded as a lining to each of the adjacent scars with a thicker membrane between; reproductive organs few, poorly defined, slightly projecting with irregular markings on their outer surfaces, probably for the most part immature or abortive; armor 3 to 5 cm. thick; axis 8 cm. in diameter, somewhat clearly marked off from the armor but without clear boundaries between the cortical parenchyma and fibrous zone or between the latter and the medulla, so far as the single known specimen shows without cutting.

This species differs from all others in a number of characters besides its small size. The only specimen is No. 84 of the Yale collection, a small, almost perfect trunk weighing only 2.95 kg. At first glance it recalled the *C. pygmaea* of England from the Lias of Lyme Regis, figured by Lindley and Hutton,<sup>1</sup> but on confronting the specimen with

<sup>1</sup> Fossil Flora of Great Britain, II, pl. CXLIII.

that figure the differences are obvious. Except for its small size it might be compared to *C. marylandica* from the Iron Ore Clays of Maryland, and of all the specimens of that species it most resembles the fragment which Professor Fontaine designated as No. 2,<sup>1</sup> and which I have described as Johns Hopkins Cycads, No. 3.<sup>2</sup> That specimen, however, has a large secondary axis, which with better material might take it out of that species.

Of all the forms from the Black Hills it most resembles in the character of the scars, etc., some of the smaller branches of *C. marshiana*, in which these are considerably reduced in size. I have, therefore, had a faint suspicion, which I would not leave the subject without expressing, that it might be one of these secondary axes or knots, as it were, wrenched from the larger trunk and found in an isolated position. I have, with this thought in my mind, examined a great many such cases, but I can find none in which the fracture at the point of separation at all resembled the base of this specimen, they all showing the break to have been due to some extraneous cause, whereas the base of this specimen is perfectly natural, not torn nor cracked, and shows the medulla at the center. Nevertheless, there is something a little anomalous in the way the armor surrounds the axis.

The above arrangement of the species of Cycadeoidea from the Black Hills is not wholly without method. It is true that there is no lineal arrangement that can be regarded as satisfactory, and yet there are decided affinities among the species. These affinities, however, are shown in particular characters, and the same species may have some characters almost in common with two or more other species that are otherwise very different. This is specially the case with branching species in which other characters resemble those of unbranched species. For example, *C. turrita*, except in its branching habit, is closely allied to *C. nebridei*, which never branches; *C. marshiana*, but for its branching, would be nearly related to *C. colossalis*; and *C. wellsii* may be almost regarded as an unbranched form of *C. minnekahtensis*.

In view of these and many other more subtle peculiarities, I have sought, since the arrangement must be lineal, to compromise in such a manner as to bring those species most akin as near together as possible, but it is clear that any arrangement would widely separate species that are similar in one respect or another.

*C. dacotensis* and *C. colossalis* are obviously very closely allied species. *C. wellsii* can scarcely be said to form a transition from *C. colossalis* to *C. minnekahtensis*, but it resembles the former at least in the one fact of being simple. *C. pulcherrima* is somewhat close to *C. minnekahtensis*. *C. cicatricula* can not be said to form a transition from *C. pulcherrima* to *C. turrita*, but it has considerable affinity to the former. *C. turrita*

<sup>1</sup> Potomac or Younger Mesozoic Flora, Monogr. U. S. Geol. Surv., 1890, XV, p. 192.

<sup>2</sup> Proc. Biol. Soc. Washington, March 13, 1897, XI, p. 11.

is related to *C. minnekahensis* and *C. pulcherrima*, and from it to *C. mebridei*, as already remarked, the distance would be very small but for the branching habit of the former.

Between *C. mebridei* and *C. marshiana*, however, there is scarcely any bond, and it might have been as well to place the latter immediately after *C. colossalis*. We virtually begin a new series here and pass naturally through *C. furcata* to *C. coleii* and *C. paynei*. *C. aspera* closely resembles the last of these in external aspect, but the two anomalous characters noted clearly distinguish it from all others. It fits in here, however, and *C. insolita* and *C. occidentalis* belong to this same general group.

*C. jennyana*, *C. ingens*, *C. formosa*, *C. stillwelli*, and *C. excelsa* may also be said to form a group. The first and the last two constitute the only cylindrical forms known in America. The shape of the scars in *C. ingens*, *C. formosa*, and *C. stillwelli* unite these three from that important point of view, while those of *C. jennyana* and *C. ingens* tend to approach each other. *C. excelsa* has little in common with any other species, and *C. nana* almost nothing. These two are therefore properly made to close the series.