Report was made upon a depauperate form of *Bidens cernua* L., found on the Wabash banks.

Among the forest trees special notes were made upon distribution, size, &c., of *Celtis mississippiensis* Bosc.; *Carya olivæformis* Nutt; *Quercus lyrata* Walt.; *Diospyros virginiana* L., and *Taxodium distichum* Richard.

EPIDERMIS AND SPINES OF CACTACEÆ. By E. B. ULINE.

Before entering upon the revision of Cactaceæ now in preparation under President Coulter's direction at Indiana University, a series of investigations on the minute structure of such material as was then available was made during the winter and spring terms of 1892. It was our purpose not only to learn of the general morphological nature of the family, but also to discover, if possible, any new diagnostic characters that might be of service in the revision. I have therefore selected for presentation only such peculiarities of structure as may prove of most use in specific determination.

Though nearly a year had passed since the collection of the material, it was still green and in good condition, with tissues fresh and distended as in growing specimens—thus making it highly favorable for study. Sixty-five species were examined, represented generically in the following proportions: Mamillaria, 17; Echinocactus, 16; Cereus, 21; Opuntia, 11.

The most striking feature at first sight is the entire absence of true foliage. Naturally, my first inquiry was for some specialized organ or region which should represent, and perform the functions of the missing foliage. The even distribution of stomata and chlorophyll over the entire surface declares the plant itself to be one gigantic and curious leaf so far as function is concerned. However, regarding leaves as devices for increasing surface exposure (expansion of surface formed by the ultimate branching of the fibro-vascular system), I was led to look to the wart-like mamillæ of the genus Mamillaria, and to the tubercles and ribs of Cereus, Echinocactus and certain species of Opuntia as the homologues of leaves. Transverse sections of the tubercles of *Mamillaria macromeris* show fibro-vascular branching similar to that of the leaf,—the chief difference lying in the cylindrical nature of the one as distinct from the flat surface of the other. This conclusion is verified by the position of the flowers and branches, which in nearly all cases proceed from the axils of the tubercles and mamillæ. The genus Opuntia alone is described as having leaves.

The minute, subulate, early deciduous leaves of this genus furnish the nearest approach to true leaves found among our native species.

In all the specimens examined, true epidermal and hypodermal regions occur in sharply defined outline. The cuticular layer is generally thickened and is clearly distinguished from the true epidermal walls. It becomes thinner as it nears the stoma, and is easily traced into the air chamber (?) It completely lines this respiratory cavity, and, as Von Mohl shows, it even sends out open tubes into the adjoining inter-cellular spaces. The range in thickness passes from the very thin, almost imperceptible form seen in *Mamillaria macromeris* to the astonishing thickness of that seen in *Mamillaria* (*Anhalonium*) *prismatica*, where the cuticle is fully ten times the thickness of the true epidermal layer underneath. The stoma in this species communicates with the outer air by a chimney-like canal extending upward and outward through the cuticle. This canal or chimney is beset at three different elevations by sets of four flap like projections which extend out from the wall in such manner as to almost entirely close the orifice. I have failed to find anywhere any mention of these projecting appendages, but conclude that their function is undoubtedly that of accessory guard cells of the *stoma*. They readily expand on application of moisture, which fact in itself is sufficient evidence of their purpose. The outer wall of the true epidermis in this species barely reaches an average development; while the hypodermal region consists of but one layer of moderately thick-walled narrow cells. The only remaining feature of the cuticle worthy of note as a diagnostic character is the undulation of surface, which is displayed in certain species. Prominent elevations occur in *Cereus Greggii*, *Cereus horizonthalonius*, var. *centrospinus*, and in *Echinocactus polycephalus*.

Definitive characters in the true epidermis are not abundant; but, when they do occur, they are distinct and unmistakable. Three species of Opuntia show tangential (?) partitions in the epidermis, breaking it up into two or more rows. *Opuntia phæacantha* has its epidermis thus thrown into eight rows of exceedingly thin-walled cells. A new species of cereus (as yet unpublished) has as high as nine rows of this thin-walled epidermis. Species having two layers are *Echin. polycephalus*, three unnamed species of Cereus from San Louis Potosi, Mex., and a new species of Cereus from Casa Grande, Ariz. The most curious epidermis in the entire collection is that of *Echin longihamatus*. Since there is nothing like it in the entire number observed, it is well deserving of more than passing at-

tention. In other specimens, the epidermal cells when elongated lie in a parallel direction with the line of outer surface. In this case, they are elongated at right angles to the outer surface. Their thread-like walls are contiguous with the cuticle on the outside; while, on the inside, they are bounded by a single hypodermal row. Their only apparent outer wall is the thickened cuticle.

The hypodermal regions seen may be at once divided into two classes. Those of the first and larger class may be characterized as follows: cells irregular, in several layers: walls thick, pitted, collenchymatous. The second class, on the other hand, are thin-walled, regular, and disposed in one layer. Six Mamillariæ and five Cerei will fall under this latter class. The highest number of collenchyma layers is nine, found in *Cereus grandiflora*. The number of rows, shape of cells and relative thickness of walls appear to be constant within the limits of species, and may be of service as determinative characters.

It remains only to mention the calcium oxalate crystals, which are often distributed as constituents of the cell-contents, both in the epidermal and in the hypodermal tissue. These occur in the form of simple, solitary, klino-rhombic crystals, or more frequently in angular, stellate groups. In size, form and position they vary exceedingly, but appear uniform within the limits of the same species. Crystals occurred in every Opuntia and in every Echinocactus examined. In Mamillaria they were frequent, while in Cereus, they were with one exception entirely wanting.

The minute structure of the spines is exasperatingly uniform. The outer, or epidermal cells are usually large and thin-walled, while in the body of the spine the walls are so thick as to entirely close the cell cavities, as is the case in all dense woody tissues. Often there is a gradual transition from one to the other. The important characters are in the outer row of cells. Rough projections partaking of the nature of trichomes, and extending toward the spine tip are common in Cereus and Echinocactus. In Mamillaria the spines are smooth or rarely pubescent, as in *M. pusilla, Grahami* and allied forms. Those of the cylindrical and clavate groups of Opuntia are without exception clothed with a semi-transparent, glistening sheath; while those of the flat-jointed Opuntias are naked. Characteristic of Opuntia spines is the conical arrangement of fibers, distinctly seen with the low power objective. Spine fibers of other genera are usually parallel from base to tip, whereas here they are conically arranged with the summits of the cones at the extreme tips and

their bases communicating with the sheath to the rear of the tip and adjacent to it. When the sheath separates from the spine (which happens very early), these ends of the fibers at the base of the cones are slightly lifted from the surface of the spine, forming sharp barbs extending backward on the surface near the tip. This conical barbed structure is likewise common to the sheathless, flat-joint Opuntias, and extends even to the minute and much-dreaded bristles of the same genus. It is this property of conical arrangement that makes the prickly pear group the terror of all who have made its acquaintance.

While many of the characters brought to light in these investigations are artificial as must naturally result in tissues so responsive to environment as epidermal structures, the constancy of character within the same species, together with the requisite variation in features presented by different species, can not but be of service to those engaged in a critical study of the family.

THE GENUS CACTUS. By E. M. FISHER.

The genus *Cactus*, as it stands at present, consists of about 350 species and varieties from North America, of which only twenty-five species and seven varieties have been reported from the United States. All these forms are small, ranging from one-half to three inches in diameter, and are distinguished by their disconnected tubercles.

In this paper it is proposed to consider briefly the history of the genus, and the classification of its species. To give an accurate and satisfactory history of this genus or any of the genera of Cactaceæ is a very difficult thing, because of the meager descriptions and the scarcity of early literature. Taking 1753 (the date of the first edition of Linnæus' "Species Plantarum") as our datum-line, and tracing both backwards and forwards, we reach the following results: In this first edition of the "Species Plantarum," Linnæus published all the Cactaceæ with which he was acquainted under one genus, Cactus, which he subdivided into four groups called *Echinomelocactus* (subrotund), *Cerii* (erect, angular), *Cerii* (creeping with lateral roots), and *Opuntia* (jointed, compressed, proliferous). Previous to this (1737), in the first edition of the Genera Plantarum, Linnæus published *Cactus* as embracing the genus *Cereus* of Jussieu's Acta Gallorum (1719), and *Opuntia* and *Melocactus* of Tournefort's Institutiones (1719). *Melocactus*