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stage runs nearly or quite equatorially, namely, if a change of position of the first four segmentation-spheres round a right angle has occurred. By further divisions, all of which really run parallel to one another and appear to be radially directed towards the centre of the embryo only in consequence of the continued incurvation, the stage fig. 1 c (section) is produced; this already shows a distinct cavity, which, however, is still open at the inferior surface. Finally, this stage passes, in an easily intelligible manner, by further increase of cells and final closure, into the blastula, which, according to our view, originates in accordance with the blastula of the Volvocineæ. All the cells of this blastula are still composed of the two elements, the ecto- and entodermal parts, which are now severed by an equatorial groove dividing each cell into an external and internal portion (fig. 1 e). The cutting off of the entodermal portions of the delamination-blastula appears not always to proceed so uniformly as is here represented in accordance with the process demonstrated in the Geryonida by Fol and Metschnikoff. At least the representation that Kowalevsky gives of the delamination in *Encope* seems to indicate that the division sometimes takes place successively, and thus the central cavity of the blastula is gradually filled with the entodermal cell-material. That here perfectly solid entodermal contents are first of all produced, in which an archenteric cavity only subsequently makes its appearance, may certainly be regarded as a secondary variation. The Siphonopora, however, present another variation of the delamination-blastula, as in them the development of a blastula-cavity is suppressed, and an archenteric cavity is only subsequently developed in the entodermal cell-mass. The reference of this modification to the mode in the Geryonida, which I regard as the original mode, appears to present no particular difficulties.

XLIV.—On *Mesozoic Dicotyledons*. By LESTER F. WARD*.

IN the following remarks on Mesozoic Dicotyledons, I confine the term *Dicotyledons* to that subclass of the vegetable kingdom which is embraced under the term *Angiosperms* in most modern text-books of botany. This is the usage of most vegetable palæontologists †, and the reasons of adopting it have been frequently stated‡.

The Dicotyledons occupy somewhat the same position in the history and development of plants that the Mammalia occupy with respect to animals. They constitute the dominant type, and in their rapid march have now so completely

* From the 'American Journal of Science,' April 1884, pp. 292-303.

† Göppert, Geinitz, and one or two others conform to the Jussiean system.

‡ See the 'American Naturalist,' vol. xii. (June 1878), pp. 359-378.

gained the ascendant as to dwarf all other forms into relative insignificance. They include nearly all the deciduous forest trees, the shrubby undergrowth, the leafy herbage, and the weeds of all temperate regions.

But this has not always been the case. In fact the reign of the Dicotyledons, geologically considered, has been very brief. Although there is evidence that the earth has been covered with vegetation since the beginning of the Carboniferous age at least, still there is nothing to warrant us in saying that a single dicotyledonous plant existed prior to the close of the Jurassic. Indeed, we do not know from the actual discovery of specimens that this type appeared earlier than the second recognized group of the Cretaceous—the Urganian. Until quite recently the presence of these plants in formations lower than the Miocene was so rare that it was with the Tertiary rather than with the Cretaceous that the existing dominant vegetation of the globe was assumed to have originated.

Notwithstanding this, some of the earliest, if not the very earliest, discoveries of these forms were in Cretaceous strata. In the stone-quarries of the Harz Mountains near Blankenburg, were found, near the beginning of the eighteenth century, prints of large leaves which the workmen believed to be those of the grape-vine, and which were mentioned by Scheuchzer, Brückmann, and Walch, but without any attempt at their scientific determination.

A brief historical review of the discovery, identification, and publication of dicotyledonous species in Cretaceous strata of Europe and America, including the arctic regions, will show the importance which this subject is assuming among palæontologists.

In 1833 Zenker* took up in earnest the study of the Blankenburg leaf-prints, and described, figured, and named five species belonging to two genera. One of these genera he rightly concluded to have no living representatives, and he therefore named it *Credneria*, after his friend Prof. Credner, who collected the specimens.

In 1841 Göppert† figured a number of dicotyledonous leaves from the Quadersandstein of Silesia, but did not venture to give names to them.

* 'Beiträge zur Naturgeschichte der Urwelt,' von Jonathan Carl Zenker. Jena, 1833.

† 'Ueber die fossile Flora der Quadersandsteinformation in Schlesien,' c., in Nova Acta Acad. Naturæ Curiosorum, vol. xix. Taf. xlvii., li., liii.

The next year Geinitz* identified three species in the lower Quader of Saxony at Niederschöna, the fossil flora of which place was so well worked up by Ettingshausen in 1867.

In 1845 Corda† figured some dozen leaves from Trziblitze, Luschnitz, Perutz, and Weberschan, in Bohemia, some of which localities he placed in the Gault, but they are probably all in the Lower Quadersandstein, or Cenomanian. He made no attempt to refer these forms to genera and species.

Unger's 'Synopsis' ‡ appeared the same year, in which sixteen species of Cretaceous Dicotyledons are recognized down to that date. Göppert§, however, admitted only thirteen species in his table published in Bronn's 'Naturgeschichte,' which also appeared in 1845.

Debey||, in 1848, enumerates sixteen species as previously published, and adds to these twenty-seven others from the neighbourhood of Aix-la-Chapelle, most of which, however, he contents himself with calling *Phyllites*; and as no figures were made, it is possible that some of these were not Dicotyledons. He also gives four *Carpolithes* which he identifies with dicotyledonous orders.

The same year Göppert¶ published a supplement to his Flora of the Quadersandstein, in which a number of Dicotyledons are recognized.

In Ettingshausen's 'Proteaceen der Vorwelt,' 1851**, four Cretaceous species are enumerated, and Von Otto†† in his 'Additamenta,' 1852-54, also described Proteaceæ from the Quader of Saxony; while Miquel‡‡, in 1853, described a few Dicotyledons from the Upper Cretaceous of Limburg.

* 'Charakteristik der Schichten und Petrefacten des sächsisch-böhmischen Kreidegebirges,' von Dr. Hans Bruno Geinitz. Heft 3, Dresden and Leipzig, 1842, p. 97.

† In: 'Die Versteinerungen der böhmischen Kreideformation,' von Aug. Em. Reuss. Stuttgart, 1845-46, Taf. 1, li.

‡ 'Synopsis plantarum fossilium' autore Fr. Unger, M.Dr., Lipsiæ, 1845.

§ 'Naturgeschichte der drei Reiche,' vol. xv. 2 ('Handbuch einer Geschichte der Natur,' iii. 2), von Heinrich G. Bronn. Stuttgart, 1849, pp. 44-57, 66.

|| 'Uebersicht der urweltlichen Pflanzen des Kreidegebirges überhaupt und der Aachener Kreideschichten insbesondere,' von Dr. M. Debey, in 'Verhandlungen des naturhistorischen Vereines der preussischen Rheinlande,' 5. Jahrgang, 1848, p. 113.

¶ 'Zur Flora des Quadersandsteins,' in Nova Acta Acad. Nat. Cur. xxii. 1, p. 365.

** 'Sitzungsberichte der mathem.-naturw. Classe der kaiserlichen Academie der Wissenschaften, Wien,' Bd. vii. Heft iv. 1851, p. 711.

†† 'Additamenta zur Flora des Quadergebirges in Sachsen,' von Ernst von Otto, Heft ii. Leipzig, 1854, p. 44.

‡‡ 'De fossile planten van het Krijt in het hertogdom Limburg,' § rlem, 1853; Verhandl. Geol. Kaart Nederl. i. pp. 33-56.

In 1856 Dunker* described and figured in the 'Palæontographica' four species from Blankenburg in addition to those of Zenker, and one cluster of fruit which he believed to belong to *Credneria*, and to indicate strongly that those ancient plants belonged to the Polygonaceæ. Zenker had divined that they might be amarantaceous.

One year later Stiehler† reviewed in the 'Palæontographica' the whole subject of the Cretaceous flora of the Harz Mountains, and added to all previous results the discoveries made by Hampe, a druggist of Blankenburg, in the marls near that place. Out of the numerous forms of *Credneria* he carves a new genus which he calls *Ettingshausenia*, and of which he makes eight species. He admits seven species of *Credneria*, and figures several others which he calls new species, but without assigning specific names to them.

Thus far America had contributed nothing to the flora of the Cretaceous, but in 1858 Heer described, in the proceedings of the Academy of Natural Sciences of Philadelphia‡, eight species of Dicotyledons which had been collected by Dr. Hayden in Kansas and Nebraska. These, however, he erroneously believed to be Miocene.

The next year Mr. Lesquereux§ contributed a paper to this Journal, in which a number of fossil plants from Nanaimo, Vancouver's Island, and from Bellingham Bay were described as Miocene. It is now known that Nanaimo is Cretaceous, and his paper enumerates six species of Dicotyledons from that locality.

Nothing further appears to have been done until 1863, when Dr. Newberry|| reported, in the 'Boston Journal of Natural History,' upon certain fossil plants from Orcas Island, British Columbia, collected by the North-west Boundary Commission. He declared the horizon Cretaceous, and among the plants described were four Dicotyledons.

* "Ueber mehrere Pflanzenreste aus dem Quadersandsteine von Blankenburg," von Wilhelm Dunker. Palæontographica, iv. 1856, pp. 179-183, tab. xxxii.-xxxv.

† "Beiträge zur Kenntniss der vorweltlichen Flora des Kreidegebirges im Harze," von August Wilhelm Stiehler. Palæontographica, v. pp. 45-80, Taf. ix.-xv.

‡ "Fossil Plants of the Lower Cretaceous beds of Kansas and Nebraska," by Oswald Heer, Proc. Acad. Nat. Sci. Phil. 1858, pp. 265, 266.

§ "On some Fossil Plants of recent Formations," by L. Lesquereux, Amer. Journ. Sci. 2, xxvii. 1859, pp. 359-366.

|| "Descriptions of Fossil Plants collected by Mr. George Gibbs, Geologist to the U. S. North-west Boundary Commission under Mr. Archibald Campbell, U. S. Commissioner," by J. S. Newberry, Boston Journ. Nat. Hist. vii. 1863, pp. 506-524.

In 1866 appeared the somewhat famous "*Phyllites crétacées du Nebraska*" of Capellini and Heer*, the latter of whom determined the fossil plants which the former had himself helped to collect at Blackbird Hill, Nebraska, in the now well-known Dakota group. The Cretaceous character of these fossils was here rather grudgingly conceded, and has never since been seriously doubted.

While America had been thus coming forward Europe had remained in the background for about ten years, or since Stiehler's monograph of the Harz in 1857. It was not till 1867 that Ettingshausen † published in the 'Sitzungsberichte' of the Vienna Academy his valuable paper on the fossil flora of Niederschöna in Saxony. The horizon of this place is considerably lower than that of Blankenburg, and belongs at the base of the Quadersandstein formation of Germany. Nevertheless, the species nearly all belong to living genera—*Quercus*, *Fagus*, *Ficus*, *Laurus*, *Protea*, &c. Twenty-eight species are enumerated.

In the same volume Unger‡ described and figured four Dicotyledons, thus far unknown, from the Gosau (Upper Senonian) of Austria, at St. Wolfgang and Neue Welt. Though contenting himself with calling them all *Phyllites*, he yet ventured to assign two of them to the Magnoliaceæ and two to the Proteaceæ.

Returning to America, we find in 1868 the two most important contributions yet made in this country to the Cretaceous flora of the west. These were Dr. Newberry's "Notes on the later extinct floras of North America," published in the 'Annals of the New York Lyceum of Natural History' (April) §, and Mr. Lesquereux's paper in this Journal || for July of the same year. Though prepared quite independently of each other, these two papers followed the same method and reached the same results. Both authors give lists of the American Cretaceous species known up to that date, Dr. Newberry enumerating 20 and Mr. Lesquereux 21 Dicotyledons.

* Verhandl. d. schweiz. Gesellsch. d. Naturf. Zürich, 1866.

† "Die Kreideflora von Niederschöna in Sachsen, ein Beitrag zur Kenntniss der ältesten Dicotyledonengewächse," von Const. Freih. v. Ettingshausen. Sitzb. lv. Abth. 1, pp. 235-264, Taf. i.-iii.

‡ "Kreidepflanzen aus Oesterreich," von Dr. F. Unger, l. c. pp. 642-654, Taf. i., ii.

§ The figures corresponding in the main to the species here described were published in separate form by the U. S. G. and G. Survey of the Territories, F. V. Hayden, Geologist-in-charge, under the title "Illustrations of Cretaceous and Tertiary Plants of the Western Territories of the United States," which did not appear until 1878.

|| "On some Cretaceous Fossil Plants from Nebraska," by L. Lesquereux. Am. Journ. Sci. 2, xlv. 1868, pp. 91-105.

The number of species described by Dr. Newberry as new was 45, and the number by Mr. Lesquereux was 47. Nine species from Fort Ellsworth, Kansas, included in Mr. Lesquereux's list, the descriptions of which did not appear until the following year*, do not enter into the figures above given. It will thus be seen that about 75 species of Dicotyledons had been described from the Dakota Group and other American Cretaceous strata down to the year 1869.

Far less could be said for Europe at this date. Hosius †, in 1869, was able to enumerate in his 'Geognosie Westfalens' twenty-five characteristic species of the Quadersandstein, which had been described and figured either by Von der Marck ‡ or by himself §. In this year, too, Heer || published his 'Fossil Flora of Moletein in Moravia,' which belongs to the Lower Quadersandstein, or base of the Cenomanian. Twelve species are described and carefully figured.

In Hayden's annual reports of the geological survey of the Territories for 1870 and 1871 ¶, Lesquereux continues to enlarge the list of American species; and in 1872, Heer **, in his "Fossil Flora of Quedlinburg," makes further additions to that of Europe.

We are thus brought down to the year 1874, which is marked by three very important publications.

Schimper's 'Traité de Paléontologie Végétale' was completed in that year, and in its fourth volume †† 109 species of Cretaceous Dicotyledons are recognized. Of these 46 are American, which shows that the author was far behind in the literature of the subject. He also expresses serious doubts as to the Cretaceous age of these plants, although this had been long settled here beyond a peradventure.

Next should be mentioned Heer's "Kreideflora der arc-

* "On Fossil Leaves from Fort Ellsworth, Nebraska," Transactions of the American Philosophical Society, Philadelphia, vol. xiii. new series, pp. 430-433, pl. xxiii.

† "Die in der westfälischen Kreideformation vorkommenden Pflanzenreste" (Beiträge zur Geognosie Westfalens), von A. Hosius. Münster, 1869.

‡ "Fossile . . . Pflanzen aus dem Plattenkalk von Sendenhorst," Palæontographica, xi. 1865.

§ "Ueber einige Dicotyledonen der westfälischen Kreideformation," Palæontographica, xvii. 2, pp. 89-104, Taf. xii.-xvii.

|| Beiträge zur Kreideflora. I. Flora von Moletein in Mähren. Zurich, 1869.

¶ "On the Fossil Plants of the Cretaceous and Tertiary Formations of Kansas and Nebraska," Ann. Rep. 1870, p. 370. "Fossil Flora, Cretaceous Strata, Kansas," Ann. Rep. 1871, p. 301.

** Beiträge zur Kreideflora. II. Zur Kreideflora von Quedlinburg.

†† Pp. 677-679.

tischen Zone," which appeared in 1874 in volume iii. of his 'Flora Fossilis Arctica.' In this work he describes one solitary dicotyledonous species (*Populus primæva*) in the schists of Kome—Urgonian—by far the most ancient form thus far met with, and 33 species in the higher strata of Atane, which are now generally believed to correspond with the Cenomanian of Europe. These researches of Heer appeared too late to be embodied in Schimper's great work.

Finally, as crowning this fruitful year's labour, appeared Mr. Lesquereux's important quarto volume on the Cretaceous Flora of the Western Territories*, reviewing the results of all previous researches in this country, and describing and illustrating 107 species of American Cretaceous Dicotyledons. In Hayden's annual report for the same year† 26 species are described and some figured, but most of these were also more fully treated in the 'Cretaceous Flora.'

During the succeeding six years little activity was manifested in this field, the attention of palæobotanists being principally directed to the floras of later formations; but in 1880 Hosius and Von der Marck published, in the 'Palæontographica'‡, their "Flora der westfälischen Kreideformation," an important work reviewing the entire Cretaceous flora of Westphalia. Although fossil plants have been found throughout almost the entire Cretaceous series as there represented, still it was only in the Senonian that any Dicotyledons were detected. At two quite distinct horizons within the Senonian such plants were found, 37 species being credited to the Upper and 24 to the Lower Senonian, or 61 species.

Quite an important paper by Dr. Debey appeared in 1881§, describing certain very interesting querciform leaves from the sands of Aix-la-Chapelle. Fifteen species are described and well illustrated, all of which are referred to *Dryophyllum*, a genus founded long ago by Debey on unpublished material, and to which Saporta refers four of the forms from the travertines of Sézanne. It had been announced|| that Debey had collected in the vicinity of Aix-la-Chapelle no less than two

* "Contributions to the Fossil Flora of the Western Territories, Part 1. The Cretaceous Flora." By L. Lesquereux, being Report of the U. S. Geological Survey of the Territories, F. V. Hayden, Geologist-in-charge, vol. vi. Washington, 1874.

† Pp. 271–365, pls. i.–viii.

‡ Vol. xxvi. 1880.

§ "Sur les feuilles querciformes des sables d'Aix-la-Chapelle," par M. Debey. Bruxelles, 1881. (Compte rendu du Congrès de botanique et d'horticulture, 1880.)

|| Schimper, 'Traité de Paléontologie Végétale' (Paris, 1869–1874), tome iii. pp. 671, 673.

hundred species of dicotyledonous plants; and it is to be hoped that this paper may form a beginning, at least, of the much-needed work of acquainting vegetable palæontologists with the nature of this remarkable flora.

The sixth volume of Heer's '*Flora Fossilis Arctica*' appeared in 1882. In this the Cretaceous flora of Kome and Atane are reviewed with fresh materials. While unable to find any companions for the solitary *Populus* of Kome, he adds largely to the dicotyledonous flora of Atane. From 33 species in 1874 this flora now rises to 95. In the seventh volume of the same work, which unfortunately must now be the last, a new Cretaceous flora is announced, that of Patoot, also in Greenland, which is regarded as extreme Upper Cretaceous. Dicotyledons here abound; and no less than 74 species are made known in Heer's work.

Within the past few months an important paper has been contributed to the Royal Society of Canada by Principal Dawson*, in which 30 species, mostly new, from two distinct horizons of the Cretaceous of British Columbia, are described and figured.

Lastly, I am able to add to this enumeration one of the most important works that has ever been produced on vegetable palæontology, but which is still unpublished, though now ready for the press. I refer to Mr. Lesquereux's '*Cretaceous and Tertiary Floras*,' which is to form the eighth volume of the series of quartos of the U.S. Geological Survey of the Territories in charge of Dr. F. V. Hayden. In this work the author again exhaustively reviews the entire subject of the American Cretaceous flora, and we find the number of Dicotyledons thus far yielded by the Dakota Group to have reached 167. In his table of distribution he attempts to embrace the flora of the entire Cenomanian Formation, to which he doubtless rightly believes our Dakota Group to belong. The total number of Dicotyledons thus marshalled is 312. Large as these figures seem, there is much reason to believe that they fall in both cases considerably below the actual state of science at the present time, as will be seen by the tabular statement given below.

If we now turn from this strictly chronological enumeration to a consideration of the stratigraphical position in which these plants have been found, as indicating their relative age, we shall find the results no less interesting than is the history of their discovery.

The various countries of the globe where geology is studied

* '*Transactions*,' pp. 15-34, pls. i.-viii.

have adopted divisions for their geological formations corresponding to the character of the rocks in each country. These divisions cannot be made to harmonize with exactness when it is sought to compare widely separated regions. The attempt here made to correlate the subdivisions of the European, Arctic, and North-American Cretaceous can therefore at best only lay claim to approximate accuracy.

The Quadersandstein of Germany, in which the greater part of the European fossil plants have been found, is an extensive formation, reaching in Saxony and Bohemia from the Lower Cenomanian to the White Chalk, or Upper Senonian. Its middle portion is occupied by the Pläner sandstone and Pläner marls, which extend downward into the Upper Cenomanian and upward to the base of the Senonian. The somewhat local character and indefinite boundaries of the Quader formations have rendered it customary on the Continent, even with German geologists, to adopt the system of D'Orbigny as now modified, and to speak of the Cenomanian, Turonian, and Senonian instead of Lower Quader, Pläner, and Upper Quader; and it is also now common to apply these terms to formations in other parts of the world which are supposed to occupy the same stratigraphical positions.

The leading European localities from which Cretaceous Dicotyledons have been collected are—Saxony (Niederschöna), Moravia (Moletín), Bohemia (Trzibitz, Perutz), Silesia (Oppeln, Tiefenfurth), the Harz district (Blankenburg, Quedlinburg), Westphalia (Legden, Sendenhorst), and the vicinity of Aix-la-Chapelle. The first four of these localities belong to the Lower Quadersandstein, or Cenomanian, that of Niederschöna lying near its base. The Cretaceous of the Harz district is probably Lower Senonian. In Westphalia, Hosiüs and Von der Marck find fossil Dicotyledons at two different horizons, both of which, however, they place in the Senonian. The region about Legden, Ahaus, Haltern, &c. is regarded as Lower Senonian, while Sendenhorst, Haldem, &c. are said to be Upper Senonian. The iron-sand near Aix-la-Chapelle is probably still higher, and occupies the extreme Upper Senonian.

The next greatest source, outside of the United States, of the class of fossils under consideration is Greenland. The Kome beds, as already remarked, are distinctly fixed in the Urganian, which is Lower Cretaceous, and lies between the Neocomian and the Gault. The discovery of a dicotyledonous plant at this horizon is one of the most interesting facts of palæontological science. The beds of Atane, where the greater part of the species were found, although called

Upper Cretaceous by Heer, are admitted by him to exhibit in their fossil remains so close a relationship with the American Dakota Group as to render it probable that they are of the same age. Patoot, on the other hand, is set down as extreme Upper Cretaceous; and Heer says that its invertebrate fauna indicates its identity with the Fox Hills of our Western Territories.

The localities in British Columbia from which Cretaceous Dicotyledons have come are all regarded by the Canadian geologists as Upper Cretaceous. The inland portions, situated on the Pine and Peace rivers, are said by Dr. Dawson to correspond to the Niobrara of the north-western United States, which he also correlates with the Lower Senonian of Europe. Vancouver's Island and the localities on the Pacific coast are higher, and are placed in the Upper Senonian, though he does not correlate them with any of the groups of American geologists. Fossil plants were found on the Bow and Belly river, which is said to agree with the Pierre Group; but the dicotyledonous remains appear to have been indistinct and undeterminable.

With the exception of the Dakota Group, which is commonly regarded as Cenomanian, and in which such a profusion of dicotyledonous vegetation is imbedded, no fossil plants have thus far been described from the Cretaceous of the Western Territories. Nevertheless, I have myself collected and brought to Washington during the past season some dicotyledonous leaves from a locality on the Upper Missouri river some seven miles below Coal Banks, whose position is fixed with certainty in the Fort Pierre Group, No. 4 of Meek and Hayden, which Dr. C. A. White regards as merely forming the lower portion of the Fox Hills. The material thus obtained, though meagre and fragmentary, is sufficient to render it quite certain that we here have forms nearly allied to *Platanus latiloba* of Newberry (*Sassafras mirabile*, Lesqx.), and perhaps connecting this with *Platanus nobilis*, Newb., from the Laramie strata that overlie these beds, as well as forms resembling *Quercus salicifolia*, Newb., and other Cretaceous genera and species. There is therefore ground for hoping that when this and other similar localities are thoroughly studied a new Cretaceous flora may come to light in the North-west.

I have in this paper intentionally omitted all consideration of the great Laramie Group, although this is regarded by many as Cretaceous. This is because it seems at least to be more recent than any of the European, Arctic, or British-American plant-bearing beds, while its abundant flora con-

sists in large part of types represented in the Miocene of Europe.

It thus appears that throughout both hemispheres the conditions required for the preservation of vegetable remains in Cretaceous time have existed in a marked degree during two epochs only, the Cenomanian and the Senonian, separated from each other by a period, perhaps equal to either, during which marine forms of animal life are chiefly found. A few Dicotyledons only occur in the Turonian of Europe, as e. g. *Magnolia telonnensis* from Toulon, while the Colorado Group (Fort Benton, Niobrara) of our Western Territories has thus far proved destitute of plant life.

If now we take up the several subdivisions of the Cretaceous formation in their stratigraphical order, beginning with the lowest, we shall see that in the Neocomian, or lowest member, no plant-remains of the subclass we have been studying have as yet ever been detected*.

In the Urgonian, or next higher group, one species, *Populus primæva*, Heer, has been collected at Pattorfik, in Greenland. In volume vi. of his 'Flora Fossilis Arctica,' which appeared in 1882 (or eight years subsequent to the original description of this plant), Heer continued to adhere to this species as well as to its anomalous stratigraphical position.

The Gault, like the Neocomian, has thus far furnished no Dicotyledons, though not always destitute of plant-remains †.

It is with the Cenomanian that there seems to have burst in upon the world a great and luxuriant dicotyledonous vegetation. It is found alike in Saxony, Bohemia, Silesia, in Greenland, and in the western United States. Upwards of three hundred and fifty species, representing all three of the divisions of the subclass (Apetalæ, Polypetalæ, Gamopetalæ), and consisting chiefly of living genera, have been described.

It was formerly supposed that the beds at Blankenburg occupied a much lower position than that to which I have assigned them, and such as would place them in the Turonian at least, if not in the Cenomanian; and Mr. Lesquereux, in the large and important work which is about to appear ‡,

* The supposed Neocomian Dicotyledons of Russia (Eichwald, 'Lethæa Rossica,' ii. pp. 58 *et seq.*) are shown by Heer (Fl. Ross. Arct. iii. Theil 2, S. 26) to come from the Lower Senonian corresponding to the Harz district.

† Heer assigns the plant-beds of Spitzbergen to the Gault (*l. c.* S. 24), and Coemans finds nine new species of fossil plants in the Cretaceous of Hainaut (Mém. de l'Acad. Royale de Belgique, xxxvi., 1867), which Briart and Cornet (*l. c.* xxxiii. p. 46) placed in the Gault.

‡ "Cretaceous and Tertiary Floras," Report of the U.S. Geol. Survey of the Territories, vol. viii. (Washington, 1883).

includes the species of Heer's Quedlinburg flora in his table of distribution of the Cenomanian. It is now quite certain, however, that the Cretaceous of the Harz district is much higher, and authorities seem to agree in placing it in the Lower Senonian. On the other hand, the upper boundaries of the Cenomanian in France and elsewhere are somewhat imperfectly established. For this and other reasons I have felt justified in relegating the few species that have been classed as Turonian to the Cenomanian, of which great group they seem to be but straggling outliers.

In the Senonian, both in Europe and in British Columbia, two quite distinct horizons for fossil plants seem to occur, separated from each other by a considerable interval. In view of this I have attempted to divide this group into two horizons, and am thus able to show the Lower and Upper Senonian separately. From the Lower Senonian we have about eighty species and from the Upper about one hundred and eighty.

The following Table exhibits the number of dicotyledonous species thus far recognized in each of the groups of the Cretaceous for the four principal geographical areas within which they have been collected:—

Cretaceous Dicotyledons.

Geological Position.	Europe.	Greenland.	British America.	United States.	Total.
Upper Senonian	81	74	24	..	179
Lower Senonian	67	..	14	..	81
Turonian	..	..	..	..	..
Cenomanian {	53	114	..	..	351
Dakota Group {	..	..	..	184	
Gault	..	..	..	..	..
Urgonian	..	1	..	..	1
Neocomian	..	..	..	..	..
Total.....	201	189	38	184	612

As all the plants with which we are here concerned are found in the Cretaceous, some may be surprised that this paper should have been entitled *Mesozoic* rather than *Creta-*

ceous Dicotyledons. The reason for the title chosen is simply that it may tend somewhat to enlarge the view of the true history and age of this great type of vegetation. When we see that more than three hundred and fifty species of fully developed Dicotyledons, implying the existence of many more, were flourishing in all their present luxuriance in the Middle Cretaceous, and that even in the Lower Cretaceous one species is known to have existed belonging to a genus that still survives, we cannot, if we would, repress the thought that the ancestors of these forms must have come down through older periods of the Mesozoic.

That we shall ever discover the true progenitors of the known Dicotyledons it is, of course, impossible to say; but that they had progenitors science no more hesitates to assume than any one would hesitate to assume that a founding child must have had parents. Moreover, such is the slow and secular character of the development of living forms on the globe, that no one would suppose it possible for so prominent a group of plants as were the Dicotyledons in the Cenomanian age to have attained that condition in any thing short of a vast geologic period.

It is to be hoped that we are at last approaching the beginning at least of a solution of this truly great problem of the origin of the Dicotyledons. I have myself seen at least one slight, it may be, but very interesting sign of possible progress in this direction. Certain very defective, but very instructive, specimens collected in the Upper Jurassic of Virginia by Professor Wm. M. Fontaine, and which he kindly brought to Washington for my inspection, certainly possess all the essential elements of dicotyledonous leaves, although at the same time bearing a certain recognizable stamp of the cryptogamic and gymnospermous vegetation that characterizes that earlier age. What is to be the final verdict of science upon these forms cannot now be told; but it is to be hoped that the Mesozoic strata, not only in Virginia, but in all parts of the world, may be diligently searched and the materials carefully studied, with a view to discovering these certainly merely "missing links" of a chain that can but have been once complete.

It is remarkable that in both its flora and its fauna the life of this continent has been thus abruptly truncated. The sudden irruption of a perfectly developed mammalian fauna at the beginning of the Tertiary is not less astonishing than the appearance unannounced of many hundreds of species of highly organized dicotyledonous plants in the Middle Cretaceous. The advocates of special creation, and likewise

the hunters after a lost Atlantis, were they informed upon the facts which science itself so plainly teaches, could ask no stronger argument for either of their positions. But such persons are usually not so informed, and it seems almost impossible for them to become so and still hold such views, for, fortunately, knowledge is a poison that contains its own antidote, and the very possession of the facts suffices to preclude a perverse use of them.

XLV.—*Descriptions of new Species of Reptiles and Batrachians in the British Museum.*—Part II. By G. A. BOULENGER.

Blanus Bedriagæ, sp. n.

In a recent paper *, Dr. J. v. Bedriaga has established the specific distinctness of two forms of *Amphisbænas* which have hitherto been confounded under the name of *Blanus cinereus*, Vandelli, viz. a Western form, inhabiting the Spanish peninsula, Morocco, and Algiers, for which the name *B. cinereus* must be retained, and an Eastern form, occurring in Asia Minor, which he named *Amphisbæna Strauchi*. My attention being drawn to this question, I have reviewed the series of *Blanus* in the British Museum; and the result has not only confirmed Dr. v. Bedriaga's conclusions, but brought to light a third form, represented by several specimens from the river Xanthus, Asia Minor, and which must likewise be regarded as a species, which I will name *B. Bedriagæ*; its characters are as follows:—

Intermaxillary teeth seven, maxillaries three on each side, mandibulars seven on each side. Snout prominent. Three lower labials, the first and second large, the third small; the suture between the frontal and the second labial nearly as long as that between the latter and the ocular. No cervical fold separating the head from the body. Annuli 101 to 114 on the body, 19 to 21 on the tail; an annulus contains 16 to 18 dorsal and 18 to 20 ventral segments. Preanal pores ten.

The other Oriental specimens of *Blanus* in the collection, and which bear the localities Constantinople and valley of the Meinder, agree in every respect with *B. Strauchi*, of which a specimen from Smyrna has been obtained from Dr. v. Bedriaga.

Stenostoma affine, sp. n.

Allied to *S. albifrons*, but distinguished by the much larger

* Arch. f. Naturg. 1884, p. 23, pl. iv.