

THE GENESIS AND MIGRATIONS OF PLANTS

SUCH is the title of a paper, in a recent *Princeton Review*, by Prof. Dawson, whose intention in writing has been to place clearly and concisely before his readers the facts, as he interprets them, connected with the fossil floras of the Arctic and North American regions. The necessity to do so became apparent, he states, from the time that Heer described the cretaceous¹ Vancouver Island flora as miocene, and yet more when the Devonian Bear Island flora was described as carboniferous. The present publication, however, was immediately induced by Saporta's very remarkable essay on the northern origin of plant species and Hooker's latest anniversary address to the Royal Society.

The Professor commences the present essay by recalling that Asa Gray had, as early as 1867, suggested that the related floras of North America and Eastern Asia had a common northern origin; and that in 1872 he further developed this theory, embracing in it the work of Heer and Lesquereux on the tertiary floras.

He then proceeds:—

"Between 1860 and 1870 the writer was engaged in working out all that could be learned of the Devonian plants of Eastern America, the oldest known flora of any richness, and which consists almost exclusively of gigantic, and to us grotesque, representatives of the club mosses, ferns, and mares'-tails, with some trees allied to the cycads and pines. In this pursuit nearly all the more important localities were visited, and access was had to the large collections of Prof. Hall and Prof. Newberry in New York and Ohio, and to those made in the remarkable plant-bearing beds of New Brunswick by Messrs. Matthew and Hartt. In the progress of these researches, which developed an unexpectedly rich assemblage of species, the northern origin of this old flora seemed to be established by its earlier culmination in the north-east, in connection with the growth of the American land to the southward, which took place after the great upper silurian subsidence, by elevations beginning in the north while those portions of the continent to the south-west still remained under the sea.

"When, in 1870, the labours of those ten years were brought before the Royal Society of London in the Bakerian lecture of that year, and in a memoir illustrating no less than one hundred and twenty-five species of plants older than the great carboniferous system, these deductions were stated in connection with the conclusions of Hall, Logan, and Dana, as to the distributions of sediment along the north-east side of the American continent, and the anticipation was hazarded that the oldest Palæozoic floras would be discovered to the north of Newfoundland. Mention was also made of the apparent earlier and more opious birth of the Devonian flora in America than in Europe, a fact which is itself connected with the greater northward extension of this continent."

The memoir was not published by the Royal Society, and some little disappointment, he says, was thereby occasioned, but it appeared shortly after, although in a less perfect form.²

In the next place he contends that Heer was in error in supposing that the Bear Island plants are of carboniferous age, and attributes to Heer the responsibility of having led other European geologists to infer that the whole group of beds from the Hamilton to the Chemung were carboniferous, although they underlie the oldest beds of that stage and contain a Devonian fauna. He continues:—

"In 1872 I addressed a note to the Geological Society of London on the subject of the so-called 'Ursa stage' of Heer showing that though it contained some forms not known at so early a date in temperate Europe, it was clearly Devonian when tested by North American standards; but that in this high latitude, in which, for reasons stated in the report above referred to, I believed the Devonian plants to have originated, there might be an intermixture of the two floras. But such a mixed group should in that latitude be referred to a lower horizon than if found in temperate regions. In the discussion of these papers, both Sir C. Lyell and Dr. Carruthers argued that the Bear Island flora is truly Devonian.

"Passing over the comparatively poor flora of the earlier mesozoic, consisting largely of cycads, pines, and ferns, and as yet little known in the Arctic, though represented, according to Heer, by the supposed Jurassic flora of Cape Boheman, we

¹ Lesquereux considers this flora to be eocene.

² "Fossil Plants of the Devonian and Upper Silurian Formations of Canada," Pp. 92, twenty plates. (Montreal, 1871.)

find, especially at Komé and Atané in Greenland, an interesting occurrence of those earliest precursors of the truly modern forms of plants which appear in the Cretaceous, the period of the English Chalk and of the New Jersey greenlands. There are two plant-groups of this age in Greenland; one, that of Komé, consists almost entirely of ferns, cycads, and pines, and is of decidedly mesozoic aspect. This is called lower cretaceous. The other, that of Atané, holds remains of many modern temperate genera, as *Populus*, *Myrica*, *Ficus*, *Sassafras*, and *Magnolia*. This is regarded as upper cretaceous. Resting upon these upper cretaceous beds, without the intervention of any other formation,¹ are beds rich in plants of much more modern appearance, and referred by Heer to the miocene period, a reference warranted by comparison with the tertiary plants of Europe, but, as we shall see, not with those of America. Still farther north this so-called miocene assemblage of plants appears in Spitzbergen and Grinnell Land; but there, owing to the predominance of trees allied to the spruces, it has a decidedly more boreal character than in Greenland, as might be anticipated from its nearer approach to the pole.²

"If now we turn to the cretaceous and tertiary floras of Western America, as described by Lesquereux, Newberry, and others, we find in the lowest cretaceous rocks there known—those of the Dakota group—which may be in the lower part of the middle cretaceous, a series of plants³ essentially similar to those of the so-called upper cretaceous of Greenland. They occur in beds indicating land and fresh-water conditions as prevalent at the time over great areas of the interior of America. But overlying this plant-bearing formation we have an oceanic limestone (the Niobrara), corresponding in many respects to the European chalk, and extending far north into the British territory,⁴ indicating that the land of the lower cretaceous was replaced by a vast Mediterranean Sea, filled with warm water from the equatorial currents, and not invaded by cold waters from the north. This is succeeded by thick upper cretaceous deposits of clay and sandstone, with marine remains, though very sparsely distributed; and these show that further subsidence or denudation in the north had opened a way for the arctic currents, killing out the warm-water animals of the Niobrara group, and filling up the Mediterranean of that period. Of the flora of these upper cretaceous periods, which must have been very long, we know nothing in the interior regions; but on the coast of British Columbia we have the remarkable cretaceous coal-field of Vancouver's Island, which holds the remains of plants of modern genera, and indeed of almost as modern aspect as those of the so-called miocene of Greenland. They indicate, however, a warmer climate as then prevalent on the Pacific coast, and in this respect correspond with a peculiar transition flora, intermediate between the cretaceous and eocene or earliest tertiary of the interior regions, and which is described by Lesquereux as the lower lignitic.

"Immediately above these upper cretaceous beds, we have the great lignite tertiary of the west—the Laramie group of recent American reports—abounding in fossil plants, at one time regarded as miocene, but now known to be lower eocene, though extending upward toward the miocene age.⁵ These beds, with their characteristic plants, have been traced into the British territory north of the forty-ninth parallel, and it has been shown that their fossils are identical with those of the McKenzie River Valley, described by Heer as miocene, and probably also with those of Alaska, referred to the same age.⁶ Now this truly eocene flora of the temperate and northern parts of America has so many species in common with that called miocene in Greenland, that its identity can scarcely be doubted. These facts have led to scepticism as to the miocene age of the upper plant-bearing beds of Greenland, and more especially Mr. J. Starkie Gardner has ably argued, from comparison with the eocene flora of England and other considerations, that they are really of that earlier date.⁷

"In looking at this question, we may fairly assume that no

¹ Nordenskiöld, "Expedition to Greenland," *Geological Magazine*, 1872.

² Yet even here the Bald Cypress (*Taxodium distichum*), or a tree nearly allied to it, is found, though this species is now limited to the Southern States. Fielden and De Rance, *Journal of Geological Society*, 1878.

³ Lesquereux, "Report on Cretaceous Flora."

⁴ G. M. Dawson, "Report on Forty-ninth Parallel."

⁵ Lesquereux's "Tertiary Flora"; White, On the "Laramie Group"; Stevenson, "Geological Relations of Lignitic Groups," *Am. Phil. Soc.*, June, 1875.

⁶ G. M. Dawson, "Report on the Geology of the Forty-ninth Parallel," where full details on these points may be found.

⁷ *Nature*, vol. xviii. p. 124.

conceivable conditions of climate could permit the vegetation of the neighbourhood of Disco in Greenland to be identical with that of Colorado and Missouri, at a time when little difference of level existed in the two regions. Either the southern flora migrated north in consequence of a greater amelioration of climate, or the northern flora moved southward as the climate became colder. The same argument, as Gardner has ably shown, applies to the similarity of the tertiary plants of temperate Europe to those of Greenland. If Greenland required a temperature of about 50°, as Heer calculates, to maintain its 'miocene' flora, the temperature of England must have been at least 70°, and that of the South-western States still warmer."

The author then speculates upon the former migrations of plants, and although he does not assign, like Saporta, an unvarying north and south direction, he believes that in most instances these were the lines upon which they moved. He also places a cold period between the middle cretaceous (upper cretaceous of Atané, Heer) and the lower eocene (Greenland miocene, Heer), which had not been previously noticed.

We would here remark that there is, in like manner, evidence of a cool period at the base of the English eocene. Either one relatively cool period existed at the close of the upper cretaceous of America, and another at the base of the English eocene, or else too great an age is assigned to the American series. The latter supposition is supported by Lesquereux's researches. The beds showing the more temperate conditions on the two continents are either contemporaneous or else a geological interval exists between them. Much more evidence is required before the correlation of the American and European cretaceous and tertiary rocks can be finally determined, and it is satisfactory to know that Dr. Hayden is collecting evidence on the subject.

The lower eocene flora of Greenland "established itself in Greenland, and probably all around the arctic circle, in the warm period of the earliest eocene, and as the climate of the northern hemisphere became gradually reduced from that time to the end of the pliocene, it marched on over both continents to the southward, chased behind by the modern arctic flora, and eventually by the frost and snow of the glacial age. This history may admit of correction in details; but so far as present knowledge extends it is in the main not far from the truth."

Space does not permit us to reprint the pages devoted to the various theories that have been put forward to account for former vicissitudes of climate. While allowing due weight to Croll's ingenious and well known theories, and to the larger proportion in the past of carbonic dioxide, he nevertheless is convinced of the sufficiency of the Lyellian theory of former altered distribution of land and water to account for all the facts hitherto observed.

The author conceives, however, that in some recent publications the Lyellian theory has been misconceived, but this is not exactly the case. What he here terms the Lyellian theory was really shared by many contemporary writers on physical geography, and is, that when land surfaces are aggregated round the equator and the polar oceans are wide and open, a hot period results, and that the reverse distribution induces cold, thus giving to land the heating power. The more recent theory is a modification of this, requiring masses of water, warmed under the equator, to circulate, unchilled by polar currents, and the polar oceans to be dry or else more or less closed in by land. This view he adopts.

"If North Greenland were submerged, and low land reaching to the south terminated at Disco, and if from any cause either the cold currents of Baffin's Bay were arrested, or additional warm water thrown into the North Atlantic by the Gulf Stream, there is nothing to prevent a mean temperature of 45° Fahrenheit from prevailing at Disco; and the estimate ordinarily formed of the requirements of its extinct floras is 50°,¹ which is probably above rather than below the actual temperature required."

Professor Dawson believes that to whatever causes the cold periods may be traced, they drove the warm temperate flora to the south, unless protected in insular spots by warm currents, and that on the return of warmth the plants would return northward.

"If, however, our modern flora is thus one that has returned from the south, this would account for its poverty in species as compared with those of the early tertiary. Groups of plants descending from the north have been rich and varied. Returning from the south they are like the shattered remains of a beaten army. This at least has been the case with such retreating floras as those of the lower carboniferous, the permian,

¹ Heer. See also papers by Professor Houghton and by Gardner in *Nature* for 1878.

and the Jurassic, and possibly that of the lower eocene of Europe."

The great stretch north and south of the American continent favoured these migrations, and "is also connected with the interesting fact that, when new floras are entering from the arctic regions, they appear earlier in America than in Europe; and that in times when old floras are retreating from the south, old genera and species linger longer in America. Thus, in the Devonian and cretaceous new forms of those periods appear in America long before they are recognized in Europe, and in the modern epoch forms that would be regarded in Europe as miocene still exist. Much confusion in reasoning as to the geological ages of the fossil floras has arisen from want of attention to this circumstance."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

In reply to a question in the House of Lords the other day the Duke of Richmond and Gordon stated that it was only in 1875 that it was decided to add agriculture to the syllabus of the Science and Art Department. At the first examination in May, 1876, there were only 150 candidates. By the following year 72 classes had been established, and the number of candidates rose to 800. In 1878 the classes had increased to 91, and the candidates for examination to 1,265, and this year the number of classes had reached 147; the number of persons under instruction was 2,839, of whom 2,193 came up for examination. Prof. Tanner reported that the results of the examination were very satisfactory. Fifty selected teachers, it was stated, had been brought up to London to undergo a course of training at the expense of the department.

THE two silver medals which are annually given by the Royal Geographical Society to those candidates whom the examiners deem to be most proficient in geography at the Cambridge Local Examinations have this year been awarded as follows:—Physical Geography, J. R. Davis; Political Geography, Miss Helen Jones. This, we believe, is the first occasion on which a medal has been awarded to a lady.

THE professors of the Paris Museum of Natural History having to present to the Minister of Public Instruction the names of two candidates for the lectureship of Comparative Anatomy, vacated by the death of M. Paul Gervais, have selected M. Georges Pouchet for their first candidate, and M. Jourdain for the second. The appointment of the former is quite certain.

THE number of students at the German Universities during the winter semester 1878-9 was 18,770. Berlin stands at the top of the list with 3,213, while Rostock had only 161.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, June 19.—"Relations between the Atomic Weights and certain Physical Properties (Melting and Boiling Points and Heats of Formation) of Elements and Compounds." By Thomas Carnelly, D.Sc., Assistant Lecturer on Chemistry in Owens College, Manchester. Communicated by Prof. H. E. Roscoe, F.R.S.

Anthropological Institute, June 24.—Mr. John Evans, F.R.S., vice-president, in the chair.—The election of the following new Members was announced:—Mr. F. Du Cane Godman, F.L.S., F.Z.S., and Mr. Percy Cotterill Wheeler, Bengal Civil Service.—Prof. W. H. Flower, F.R.S., read a paper on the osteology of the natives of the Andaman Islands. There are few people whose physical characters offer a more interesting subject for investigation to the anthropologist than the native inhabitants of the Andaman Islands. Purity of type, due to freedom from mixture with other races for an extremely long period, owing to their isolated position and their inveterate hostility to all intruders on their shores, and exemplified in the uniformity of their physical characters, is to be found among them, perhaps in a more complete degree than in any other group of mankind. The type, moreover, is an extremely peculiar one, presenting a combination of characters not found in any race of which we have at present materials for a satisfactory comparison. It is, indeed, probable that the more or less mixed and now scattered fragments of Negrito population, found in the interior of various islands of the Indo-Malayan Archipelago, and even upon some parts of the